The City of
WORCESTER

DEPARTMENT OF PUBLIC WORKS
STANDARD CONSTRUCTION SPECIFICATIONS AND DETAILS

February 2026

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SECTION 000 - SPECIFICATION

A SCOPE OF WORK

All work, under contract, shall be performed in accordance with Division II and III of the latest edition of the Massachusetts Standard Specifications for Highways and Bridges as amended, except as otherwise required in these specifications.

Unless otherwise specified, the work to be completed under contract, consists of the furnishing of all equipment, labor and materials and performing all work in strict compliance with these specifications for the construction of SUPERPAVE bituminous concrete pavement, drainage pipe, removal of designated trees, adjusting frames and covers and all else specified herein, together with all appurtenances. The work is located in the City of Worcester, Massachusetts, in the street noted in the proposal. All work shall conform to the standards and specifications on file with the City of Worcester, Department of Public Works and Parks – Engineering Division, and any changes, drawings, plans and written directions that may, from time to time, be issued by the Contracting Officer.

B MAINTENANCE OF TRAFFIC

Streets under construction shall be open to through traffic and provisions shall be made for access to all abutting land throughout the period of construction. Beginning at twilight and continuing through the night to dawn, the Contractor shall place and maintain over or near all obstructions within the construction limits, sufficient lights and guard to protect the general public from injury.

C MEASUREMENT AND PAYMENT

Unless specified otherwise herein, measurements and payment for all items of work shall be in accordance with the applicable provisions of the MassDOT 2024 Standard Specifications for Highways and Bridges.

SECTION 100 - EARTHWORK

The work to be done under Items 100 through 110 shall conform to the applicable provisions of Section 101, (MSSHB). Trees under 9 inches and stumps under 9 inches in diameter that are required to be removed are considered as a subsidiary obligation of the Contractor and are to be removed at the Contractor's expense.

ITEM 100.0000 CLEARING & GRUBBING

ITEM 104.0000 TREE REMOVAL (LESS THAN 24") INCLUDING STUMP

ITEM 106.0000 TREE REMOVAL (24" & OVER) INCLUDING STUMP

ITEM 107.0000 STREET TREE REPLACEMENT

ITEM 108.0000 STUMP REMOVED (LESS THAN 24")

ITEM 109.0000 STUMP REMOVED (24" AND OVER)

A. GENERAL

The Contractor shall provide all balled and bur lapped trees, all necessary hardware, materials, labor, tools, and equipment required to properly complete the work.

B. METHOD OF PLANTING

All trees required shall be transported, moved and installed with the fibrous root system as a solid mass of earth.

The diameter and depth of the earth mass must be sufficient to encompass the fibrous and feeding root systems necessary for the healthy development of the new trees, but not larger than the tree planting pit. All tree pits are to have the following minimum dimensions; 6 feet in length by 3 feet in width. If not previously done so, the entire tree pit shall be excavated to a depth of 2.5 feet over the entire 6 foot by 3 foot area. This shall then be filled with approved loam (ITEM 128). The loam will be paid for at contract price. No additional payment will be made for excavation or disposal of existing soil materials. All tree pit dimensions shall be approved by the contracting officer.

The Contractor shall provide at least one (1) person who shall be present at all times during the execution of

the work and who shall be thoroughly familiar and knowledgeable with the type of trees being handled in reference to the best methods for their proper delivery, handling and installation.

C. *PLANT MATERIALS*

All trees shall be nursery grown and shall have a caliper of 2 - 2-1/2 inches.

Tree type shall be London Plane Tree, Ginkgo Biloba (male only), Redmond Linden, Washington American Elm, approximately 18 feet in height.

The root shall be approximately 18 inches in diameter so that it may properly be located in the sidewalk minimizing pedestrian interference.

D. *FERTILIZER: 16-8-16 (3) YEAR RELEASE*

Tree fertilizer packets shall be installed in the tree planting pit during tree planting installations. A minimum of two (2) fertilizer packets per tree, or as recommended by the manufacturer.

E. *GUARANTEE PERIOD*

At the end of the establishment period of 120 days, formal written acceptance from the City Supervisor of Forestry/Parks Department stating that tree plantings and their care and maintenance has been completed by the Contractor in all respects and in accordance with the tree specifications shall be required.

After the establishment period, the Contractor shall guarantee that all trees shall be in good health and flourishing condition two (2) years from date of acceptance.

The Contractor shall note that the guarantee period of two (2) years begins at the end of the establishment period after acceptance from the City Supervisor of Forestry/Parks Department.

F. *SPECIAL CONDITIONS*

The Contractor shall install a root control system to create an in-soil barrier that can block roots without harming plants. The root control system shall be Typar bio barrier or equal that combines a fabric with time-release herbicide. The specified fabric width is 19.5 inches installed as shown on the figure below. All newly planted trees shall be watered in by the Contractor within twenty-four (24) hours after planting.

During the establishment period of 120 days, the Contractor shall be required to water trees adequately. An adequate supply of water is estimated to be the equivalent of one (1) inch of water per week, delivered at weekly intervals in the form of natural rain or augmented as required by the Contractor.

Guying all trees shall be completed immediately after planting. Drive ground anchors into the ground by manual or machine method at approximately 45-degree angle to the ground plane and at 120-degree intervals around the tree. Pre-load anchors after driving until anchor turns in ground at 90 degree angle to the line of driving force. Anchor assembly will rise 2 to 6 inches during pre-loading. Attach guying cables, turnbuckles and hoses. Tighten until tree is rigidly guyed. On all guys, 1/3 distance up from ground to trunk, secure white flagging, 1"x18" tied securely.

A diverse group of tree species should be utilized for new street trees. For every three trees at least one tree should be a different species from the approved tree list.

Stump material shall be removed to a minimum depth of 12 inches below sidewalk grade, for ITEMS 108 and

109. Any root material within the sidewalk shall be considered part of the stump.

G. *MEASUREMENT AND PAYMENT*

The work under Item 100 shall be paid by the acre. The work under items 104 – 109 shall be paid by each.

The work under Item 107 Street Tree Replacement will be paid per each installed, complete in place.

ITEM 110.0000 PINE BARK MULCH

A. *GENERAL*

The work to be done under this item shall conform to the applicable provisions of Section M6.04.5 and 767.61, (MSSHB).

Pine Bark Mulch shall be placed be loosely placed in the areas specified in the contract document or as directed by the contracting officer. Pine Bark Mulch shall be free of any extraneous material such as soil, stones, construction debris, or any other deleterious matter. Completed placement shall be no less than 3” in depth, or

as directed by the contracting officer.

B. MEASUREMENT AND PAYMENT

The work under item 110 shall be paid by the cubic yard, complete and in place.

ITEM 111.0000 HEDGE, REMOVE AND RESET

A. GENERAL

Where encountered within the limits of work, hedges shall be removed and reset as directed by the Contracting Officer.

This work shall consist of removing hedges, excavations of pits, placing of backfill mixture, mulching, watering, staking or guying, fertilizing and care of the hedges for a period of one year.

Whenever hedges cannot be planted on the day of removal, all those with bare roots shall be kept in moist soil in a satisfactory manner by the Contractor until they are planted. Throughout the work care shall be exercised to keep the roots of the hedges from drying out and prevent the hedges from being broken, scarred or damaged in any way. All emergency storage of materials shall be the entire risk of the Contractor.

B. MEASUREMENT AND PAYMENT

Hedges shall be measured as removed and reset in place and shall be paid at the price per linear foot bid in the proposal.

ITEM 111.1000 BUSHES, REMOVE AND RESET

A. GENERAL

Where encountered within limits of work, bushes shall be removed and reset as directed by the Contracting Officer.

This work shall consist of removing bushes, excavations of pits, placing of backfill mixture, mulching, watering, staking or guying, fertilizing and care of the bushes for a period of one year.

Whenever bushes cannot be planted on the day of removal, those with bare roots shall be kept in moist soil in a satisfactory manner by the Contractor until they are planted. Throughout the work care shall be exercised to keep the roots of the bushes from drying out and prevent the bushes from being broken, scarred or damaged in any way. All emergency storage of materials shall be the entire risk of the Contractor.

B. MEASUREMENT AND PAYMENT

Bushes shall be measured as removed and reset in place and shall be paid at the price per each bid in the proposal.

ITEM 112.0000 UNCLASSIFIED EXCAVATION & BACKFILL

A. GENERAL

The excavation done under this item shall conform to the applicable provisions of Section 140, (MSSHB). No allowance in addition to the prices paid for this item will be made for sheeting, shoring, pumps, pumping or bailing, equipment or labor necessary on account of water or unsuitable materials. Excavation regardless of depth shall be paid at the unit price of this item.

Backfilling and compacting of excavated areas shall be performed by the contractor at no additional cost to the City and shall be in compliance with Items #220 through #223 – Backfilling In Open Trench. Excavated material not classified as unsuitable may be used for backfilling. Where excavated material is found to be unsuitable, the Contractor shall supply gravel borrow for backfill conforming to the specifications of Item

126. Compensation for gravel will be as specified in Item 126.

Backfill materials shall be considered unsuitable when containing at least one of the following properties:

1. Material with a maximum unit dry weight per cubic foot less than 90 lbs., as determined by ASTM D 1557.
2. Material containing visible organic matter, topsoil, organic silt, peat, construction debris, roots and stumps.
3. Material which has a liquid limit greater than 55.

4. Material designated in the field by the Contracting Officer.

All excavated material, except as directed by the Contracting Officer, shall be removed from the site and disposed of at no additional cost to the City.

B. MEASUREMENT AND PAYMENT

The basis of payment for this item will be per cubic yard measured in place. Limits of excavation are as specified or as directed by the Contracting Officer.

ITEM 112.1000 UNCLASSIFIED EXCAVATION & BACKFILL (HOURLY RATE)

A. GENERAL

See Item 112 for General Information.

Work under this item shall include, but not limited to, excavation within the right-of-way to determine the depth from finished grade to underground utilities, such as water mains and individual water services. Note that elevation control must be established so that accurate depth measurements can be taken.

B. MEASUREMENT AND PAYMENT

Measurement and payment shall be by the hour. The hourly rate shall include all charges for the labor and equipment required to excavate, measure the depth, and backfill the hole or trench.

ITEM 112.2000 TEST PITS

A. GENERAL

See Item 112 for General Information.

This item will be used to determine the horizontal and vertical location of underground structures or utilities. Extents of the test holes shall be excavated as specified in the contract documents, or with direction from the contract officer.

B. MEASUREMENT AND PAYMENT

The basis of payment for this item will be per each, complete and in place. Limits of excavation are as specified or as directed by the Contracting Officer.

ITEM 113.0000 TREE PROTECTION

A. GENERAL

The purpose of this item is to prevent damage to branches, stems and root systems of existing individual trees as well as shrubs and other quality vegetation to remain, and to ensure their survival. To the extent possible, to avoid soil compaction within the root zone, construction activities including, but not limited to, vehicle movement, excavation, embankment, staging and storage of materials or equipment shall not occur underneath the canopy (drip line) of trees to remain. Where these activities will occur within 10 feet (3 meters) of the canopy of trees or where directed, the Contractor shall take the appropriate protective measures specified herein.

This item shall be used when construction activities are likely to occur within the canopy of individual trees or where there may be any risk of damage to trees.

The Contractor shall be solely responsible for judging the full extent of the work requirements, including, but not necessarily limited to any equipment and materials necessary for providing tree protection.

Incidental to the cost of this item, the Contractor shall retain the services of a certified arborist, with demonstrated experience in construction protection, who shall make recommendations as to the specific appropriate treatment of trees within or near the work zone.

Prior to any construction activities, the Contractor and Arborist shall walk the site with the Engineer and City Forester to identify which trees will require protection and to determine approved measures. The Arborist shall make recommendations as to appropriate methods to protect trees. The Engineer will have final decision as to trees and methods.

The Contractor is responsible for the protection of all existing trees and plants within and immediately adjacent to the construction area that are not designated to be removed for the length of the construction period.

B. SUBMITTALS

Incidental to this item, the Contractor shall provide to the Engineer one (1) copy American National Standards Institute (ANSI) Standard Z-133.1 and A300 Standard Practices for Tree, Shrub, and Other Woody Plant Maintenance, Part 1: Pruning. These references shall be kept by the Engineer at his office for the length of the Contract.

Prior to start of work, the Contractor shall submit to the Engineer the name, certification number and resume of the Massachusetts Certified Arborist referenced herein. Cost for Certified Arborist for all activities pertaining to this Item shall be incidental to this item.

Submit arborists report documenting site walk and summarizing trees protected (species and quantities) as well as recommendations for protection.

C. *MATERIALS*

Fencing for individual plants shall be polyethylene fencing or chain link fence (new or used).

Staking for individual tree protection fencing shall be steel posts or 2x4 lumber as directed and approved by the Engineer.

Wood chips shall conform to provisions of Wood Chip Mulch under MassDOT Highway Division Standard Specifications for Highways and Bridges Materials Section M6.04.3.

Trunk protection shall be 2x4 cladding, at least 8 feet (2.4 meters) in length, clad together with wire. Alternative materials shall be at the approval of the Engineer. Alternative materials shall provide adequate protection from anticipated construction activities and shall not injure or scar trunk. Trunk protection shall include burlap to separate trunk cladding from bark.

Incidental to this item, the Contractor shall provide water for maintaining plants in the construction area that will have exposed root systems for any period during construction.

D. *CONSTRUCTION METHODS*

To the extent possible, to avoid soil compaction within the root zone, construction activities including, but not limited to, vehicle movement, excavation, embankment, staging and storage of materials or equipment shall not occur underneath the canopy (drip line) of trees to remain. Where these activities will occur within 10 feet (3 meters) of the canopy of trees, the Contractor shall provide Individual Tree Protection as specified herein.

For individual tree protection, the Contractor shall set posts and fencing at the limits of the tree canopy. Where construction activities closer to the trees is unavoidable, the contractor shall tie branches out of the way and place wood chips to a depth of 6 inches (150 mm) on the ground to protect the root systems. The Contractor shall wrap the area of the trunk of the tree with burlap prior to armoring with 2x4 cladding. Cladding for tree trunks shall extend from the base of the tree to at least 8 feet (2.4 meters) from the base.

Where excavation within canopy is unavoidable, the Contractor shall use equipment and methods that shall minimize damage to the tree roots, per recommendations of the Certified Arborist. Such methods may require root pruning prior to, as well as during, any excavation activities.

All fencing, trunk protection, branch protection, and woodchips shall be maintained throughout the duration of the contract. Protective fencing shall be repaired and woodchip mulch replaced as necessary during the duration of the contract at no additional cost.

E. *CUTTING AND PRUNING*

Some pruning of roots and branches may be a necessary part of construction. Pruning will be performed on the same side of the tree that roots have been severed.

The Contractor shall retain the services of a Massachusetts State Certified Arborist to perform any cutting of limbs, stem or roots of existing trees. All cuts shall be clean and executed with an approved tool. Under no circumstances shall excavation in the tree protection area be made with mechanical equipment that might damage the existing root systems.

Any tree root area exposed by construction shall be covered and watered immediately. Exposed tree roots shall be protected by dampened burlap at all times until they can be covered with soil.

Where grading or other disturbance is necessary within the drip line of these trees or where the Engineer determines that an individual tree must be protected, these trees shall be protected.

F. *WATERING*

Water each tree within the construction area where work is in progress twice per week until the surrounding

soil of each tree is saturated for the duration of construction activities.

G. *REMOVAL OF PROTECTION*

After all other construction activities are complete, but prior to final seeding, wood chips, fencing, branch protection, and trunk protection materials shall be removed and disposed off site by the Contractor at no additional cost.

H. *TREE DAMAGE*

The Contractor shall be held responsible for the health and survival of the existing trees in the immediate vicinity of the of the construction area. Damage that, in the Engineer's opinion, can be remedied by corrective measures shall be repaired immediately. Broken limbs shall be pruned according to industry standards. Wounds shall not be painted. Trees or shrubs that are damaged irreparably shall, at the Engineer's discretion, be replaced per the requirements of the Certified Arborist and/or the City Forester. Cost of replacement trees shall be borne by the Contractor.

I. *MEASUREMENT AND PAYMENT*

Payment under this item shall be scheduled throughout the length of contract: 30 percent of value shall be paid upon installation, 30 percent approximately halfway through the contract, and the remainder to be paid at the end of the contract after completion of construction operations that would disturb plants and after the protection materials have been removed and properly disposed of off-site by the Contractor.

Individual Tree Protection will be paid for at the contract unit price per Each. This item shall include full compensation for all labor, equipment, materials, and incidentals for the satisfactory completion of the work, including the services of a certified arborist, wood chips, water, and fertilizer, and the subsequent removal and satisfactory disposal of the protective materials upon completion of the contract.

Submittal of arborist's report is incidental to and required for payment of this item.

ITEM 116.0000 EXCAVATION

A. *GENERAL*

The work to be done under this item shall conform to the applicable provisions of Section 120, (MSSHB).

The bituminous concrete pavement where it exists is to be removed and disposed of satisfactorily with due caution being taken by the Contractor not to disturb any of the castings that are now on the streets in question.

For the sum bid under this item the Contractor shall also excavate and salvage any inlet stone or capstones encountered in the working area. The inlet or capstone curb shall be stacked at the Department of Public Works and Parks – 1065 Millbury Street unless otherwise directed by the Contracting Officer.

B. *TRIMMING THE PAVEMENT*

Trimming pavement at intersecting streets, at driveways, and where required shall be included in the item Excavation. No additional payment will be made for this work. Trimming shall be a neat, straight line to the depth of the existing pavement, or as directed by the Contracting Officer.

C. *MEASUREMENT AND PAYMENT*

This item will be paid by the cubic yard.

ITEM 118.0000 CLASS "A" ROCK EXCAVATION AND DISPOSAL

A. *GENERAL*

The work to be done under this item shall conform to the applicable provisions of Section 120, (MSSHB) with the exception that method of payment will be made only for excavation to line and grades as indicated on the plans or as directed by the Contracting Officer.

B. *MEASUREMENT AND PAYMENT*

Measurement shall be in cubic yards.

ITEM 120.0000 CLASS "B" ROCK EXCAVATION AND DISPOSAL

A. *GENERAL*

The work to be done under this item shall conform to the applicable provisions of Section 140, (MSSHB). No allowance in addition to the price paid for the item will be made for pumps, pumping or bailing, equipment or labor necessary on account of water. All excavated and unsuitable material, except as directed by the

Contracting Officer, shall be removed from the site.

B. MEASUREMENT AND PAYMENT

Measurement shall be in cubic yards.

ITEM 121.0000 TRENCH ROCK EXCAVATION AND DISPOSAL

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section 140, (MSSHB), it shall include the removal and disposal of both Class "A" and Class "B" rock encountered during trench excavation. The payment of excavated material under this item is paid in addition to trench excavation covered in Items 220 thru 223 and Items 301 through 303. Payment lines shall be as shown on the detail entitled “Typical Trench Section in Rock” included in this book.

B. MEASUREMENT AND PAYMENT

Measurement shall be in cubic yards.

ITEM 122.0000 EARTH EXCAVATION BELOW NORMAL GRADE

A. GENERAL

The work to be done under this item shall consist of the excavation and disposal of unsuitable materials below the normal grade of trenches or structures, where directed by the Contracting Officer. The depths and widths of excavation under this item shall be as directed by the Contracting Officer.

Wherever material below normal grade is unsuitable for foundation and has been removed under Item 122 the Contractor shall furnish and place material subject to the approval of the Contracting Officer.

B. CUTTING PAVEMENT

When excavations are to be made in paved surfaces the pavement shall be cut ahead of the excavation by means of pneumatic or other suitable tools to provide a clean uniform edge with minimum disturbance of remaining pavements. The width of pavement removed shall not exceed the distance as measured between vertical planes two (2) feet outside the outside limits of the pipe or masonry.

C. SHEETING AND BRACING

The Contractor shall furnish, put in place, and maintain such sheeting and bracing, etc., as may be required to support the sides of the excavation and to prevent any movement of earth which could in any way diminish the width of the excavation below what is necessary for proper construction, or otherwise injure or delay the work or endanger adjacent structures.

Whenever possible, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting will be driven, but if voids are formed they shall be immediately filled with sand and compacted.

The Contractor shall leave in place to be embedded in the backfill or concrete all sheeting, bracing, etc. which is shown on the drawings to be left in place, and shall also leave in place any and all sheeting, bracing, etc. not shown on the drawings, which the Contracting Officer may direct him in writing to leave in place at any time during the progress of the work, for the purpose of preventing injury to structures or property.

Sheeting to be left in place shall be cut at an elevation as specified or as directed by the Contracting Officer.

All sheeting and bracing not to be left in place shall be carefully removed in such a manner as not to endanger the construction or other structures. All voids left or caused by withdrawal or sheeting shall be immediately backfilled with approved material and compacted by ramming with tools especially adapted to that purpose, by watering, or otherwise as may be directed.

As specified under Sheeting in Place, the Contractor shall be paid only for sheeting left in place.

D. MEASUREMENT AND PAYMENT

Earth excavation below normal grade ordered by the Contracting Officer shall be measured and paid for under Item 122 by the cubic yard to the depths and widths for the extent ordered. Disposal of unsuitable material shall be the responsibility of the contractor at no additional cost to the City.

ITEM 123.0000 STRUCTURES ABANDONED OR REMOVED

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section 140, (MSSHB).

B. MEASUREMENT AND PAYMENT

The unit bid price per each shall be full compensation for all work required including salvage and delivery to the City's Department of Public Works and Parks – 1065 Millbury Street of any castings as directed by the Contracting Officer.

ITEM 124.0000 ORDINARY BORROW/SELECTED COMMON FILL

A. GENERAL

The work to be done under this item shall consist of furnishing and placing ordinary borrow in trenches or other areas specified by the Contracting Officer.

B. MATERIAL

Ordinary Borrow/Selected Common Fill shall consist of a mineral soil substantially free from cinders, ashes, organic materials, loam, wood, trash and other objectionable materials that may be compressible or that cannot be properly compacted. It shall have no stone larger than six (6) inches in greatest dimension. The

fill shall not contain granite blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily compacted during backfilling. The material shall have a maximum unit dry weight per cubic foot greater than 90 lbs., as determined by ASTM D698 and have a liquid limit less than 55. Snow, ice and frozen soil shall not be permitted.

C. MEASUREMENT AND PAYMENT

The number of cubic yards of ordinary borrow to be paid under Item 124 shall be the quantity measured in place, or as ordered by the Contracting Officer.

ITEM 125.0000 SAND BORROW

A. GENERAL

Sand Borrow shall consist of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam or clay, surface coatings and deleterious materials. The allowable amount of material passing a No. 200 sieve as determined by AASHTO-T11 shall not exceed 10% by weight.

The maximum particle size for sand borrow shall be as follows:

M104.0 Type b, 3/8 in.

B. MEASUREMENT AND PAYMENT

The number of cubic yards of sand borrow to be paid under Item 125 shall be the quantity measured in place, or as ordered by the Contracting Officer.

ITEM 126.0000 GRAVEL BORROW

A. GENERAL

Gravel Borrow shall consist of inert material that is hard, durable stone and coarse sand, free from loam and clay, surface coatings and deleterious materials.

Gradation requirements for gravel shall be determined by AASHO-T11 and T27 and shall conform to the following:

SIEVE	PERCENT PASSING
½ in.	50 - 85
No. 4	40 - 75
No. 50	8 - 28
No. 200	0 - 8

Maximum size of stone in gravel shall be as follows:

M1.03.0 Type a	6 inches largest dimension
M1.03.0 Type b	3 inches largest dimension
M1.03.0 Type c	2 inches largest dimension

Gravel Borrow shall conform to MHD Standards, Section M1.03.0, and Type b with no stones greater than three (3) inches in diameter.

B. MEASUREMENT AND PAYMENT

The number of cubic yards to be paid under Item 126 shall be the quantity measured in place, or as ordered by the Contracting Officer.

ITEM 127.0000 DENSE GRADED CRUSHED STONE

A. GENERAL

Dense Graded Crushed Stone shall consist of inert material that is hard, durable stone and coarse sand, free from loam and clay, surface coatings and deleterious materials.

Gradation requirements for Dense Graded Crushed Stone shall be determined by AASHO-T11 and T27 and shall conform to the following:

SIEVE	PERCENT PASSING
2 in.	100
1 1/2 in.	70-100
3/4 in.	50-85
No. 4	30-55
No. 50	8-24
No. 200	3-10

Dense Graded Crushed Stone shall conform to MHD Standards, Section M2.01.7, with no stones greater than two (2) inches in diameter.

B. MEASUREMENT AND PAYMENT

The number of cubic yards to be paid under Item 127 shall be the quantity measured in place, or as ordered by the Contracting Officer.

ITEM 128.0000 SCREENED LOAM BORROW

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section M1.05.0 and 751, (MSSHB).

Loam shall be a “fine sandy loam” or a “sandy loam” determined by mechanical analysis and based on the “USDA classifications system”, modified by the addition of crushed stone to reduce compaction, as directed by the Owner. It shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than two inches (1”), lumps, plants and their roots, debris and other extraneous matter. It shall not contain toxic substances harmful to plant growth. Loam shall contain not less than 4% or more than 12% organic matter as determined by the loss on ignition of oven-dried samples.

At least 10 days prior to anticipated start of topsoiling operations, a 25 lb. sample of topsoil material shall be delivered to the Contracting Officer for testing and approval. Based on tests performed by the Contracting Officer, the top soil shall be identified as acceptable with certain fertilizer and limestone applications or unacceptable. If the topsoil is found acceptable, the fertilizer and lime requirements will be as specified or as recommended by the Contracting Officer. If the top soil is found unacceptable, the Contractor shall be responsible for identifying another source of topsoil and shall incur all expenses associated with testing additional samples. All topsoil incorporated into the site work shall match the sample provided to the Contracting Officer for testing.

B. MEASUREMENT AND PAYMENT

The number of cubic yards to be paid under Item 128 shall be the quantity measured in place, or as ordered by the Contracting Officer.

The work to be done under Items 130-132 shall conform to the applicable provisions of Section 150 and M2.01.0, (MSSHB). Item 131 shall include supplying and installing heavy duty commercial grade weed barrier. Items 130 thru 132 shall be furnished and placed by the Contractor as directed by the Contracting Officer.

ITEM 130.0000 CRUSHED STONE ¾”

ITEM 131.0000 CRUSHED STONE ¾" WITH HEAVY DUTY WEED BLOCK

ITEM 132.0000 CRUSHED STONE 1-½"

A. MEASUREMENT AND PAYMENT

Measurement for crushed stone and heavy duty weed block, not included in another item or as directed by the Contracting Officer, shall be in place. Payment shall be at the price per cubic yard bid in the proposal.

The work to be done under Items 134 and 135 shall conform to the applicable provisions of Section 983 and M2.02, (MSSHB). The contractor shall furnish and install complete in place rip rap or dumped rip rap per Items 134 and 135 as specified or as instructed by the Contracting Officer.

ITEM 134.0000 RIP RAP

ITEM 135.0000 DUMPED RIP RAP

A. MEASUREMENT AND PAYMENT

Measurement for rip rap shall be in place and payment shall be at the price per cubic yard bid in the proposal.

ITEM 138.0000 STONE FOR PIPE ENDS

A. GENERAL

The work to be done under this item shall conform to the provisions of Section 258 and M2.02.3, (MSSHB).

B. MEASUREMENT AND PAYMENT

Measurement shall be in cubic yards.

ITEM 150.0000 FURNISH AND SPREAD CALCIUM CHLORIDE

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section 440, Subsection M9.01.0, (MSSHB). Calcium chloride shall be uniformly applied by means of a mechanical spreader or other methods as approved by the Contracting Officer.

B. MEASUREMENT AND PAYMENT

Measurement for Calcium Chloride shall be in place and payment shall be at the price per pound as bid in the contract proposal.

ITEM 154.0000 TOPSOIL EXCAVATED AND STACKED

A. GENERAL

The work to be done under this item shall conform to the applicable provision of Section 120.65, (MSSHB). Also see Item 751.62, (MSSHB), Topsoil Rehandle and Spread.

B. MEASUREMENT AND PAYMENT

Measurement shall be in cubic yards.

ITEM 155.0000 TOPSOIL REHANDLED AND SPREAD

A. GENERAL

The work under this item shall conform to the applicable provisions of Section 751, (MSSHB).

B. MEASUREMENT AND PAYMENT

Measurement shall be in cubic yards.

ITEM 156.0000 SEEDING

A. GENERAL

The work to be done under this item shall conform to the provisions of Section 765, (MSSHB).

All seeding shall be applied using the Hydroseeding method of spraying a combination of seed, mulch, and fertilizer, over properly loamed areas, complying with Item 128. Hydroseed shall be applied in the following minimum quantities; 50lb seed per acre, 1500lb of hydro mulch per acre, and 200lb of 10-20-10 fertilizer. The contractor is responsible for the proper watering of the seed until it has become fully established. If the area

does not become established after 90 days, the contractor will be responsible for a reapplication and repair of any erosion occurring due to the exposed loam.

B. MEASUREMENT AND PAYMENT

Measurement shall be in square yards.

ITEM 158.0000 SODDING

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section 770, (MSSHB).

B. MEASUREMENT AND PAYMENT

Measurement shall be in square yards.

ITEM 160.0000 CLEANING UP

A. GENERAL

During the progress of the work, the project area and all effected adjacent areas will be kept clean of all rubbish and surplus materials. All unneeded construction equipment will be removed and all damage repaired so as to minimize the inconvenience to the general public and private property owners.

Where rubbish or debris has washed into or been placed into water courses, ditches, gutters, drains, catch basins or elsewhere as a result of the Contractor's operation, such rubbish or debris shall be promptly removed and satisfactorily disposed of during the progress of the work. All water courses, ditches, gutters, drains, etc. shall be kept neat and clean during the progress of the work.

On or before the completion of the work, the Contractor shall, unless otherwise directed or permitted in writing, tear down and remove all temporary buildings and structures built by him; shall remove all temporary works, tools, and machinery or other construction equipment furnished by him; shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses and other buildings used by him; shall remove all rubbish from any ground which he has occupied; and shall leave the roads and all parts of the premises and adjacent property affected by his operations, in a neat and satisfactory condition.

The Contractor shall restore or replace, when and as directed by the Contracting Officer, all public or private property damaged by his work, equipment, or employees, to a condition at least equal to that existing immediately prior to the beginning of operations. The Contractor shall do as required all necessary highway, driveway, sidewalk, and landscaping work, and all other work not otherwise herein provided for, as specified or directed. Suitable materials, equipment, and methods shall be used for such restoration.

B. MEASUREMENT AND PAYMENT

For all work, materials, and incidentals required to accomplish cleaning up, the Contractor shall receive the lump-sum price bid for Item 160. No part of this price shall be paid before the final estimate.

ITEM 165.0000 SHEETING LEFT IN PLACE

A. GENERAL

This work shall consist of furnishing and placing lumber, wood or steel sheeting of the kinds and dimensions required for trench excavation and for structures, complying with these specifications, where indicated on the plans or where directed.

B. MATERIALS

Lumber and wood sheeting shall be sound Spruce, Douglas Fir, white or yellow Lodgepole or Ponderosa Pine, or Western Hemlock planking, planed on one side, tongue and grooved, and shall conform to the thickness shown on the plans. Lumber sheeting shall not be less than nominal 4 inches thick. All lumber and wood sheeting shall be sound, well seasoned and free from defects that will impair its strength.

Steel sheeting shall be an approved standard section whether new or used, weighing not less than 22 pounds per square foot of wall.

C. CONSTRUCTION METHODS

The Contractor shall furnish, put in place, and maintain such sheeting, shoring, bracing, and the like, as may be required to support the sides of excavations and to prevent any movement which could in any way injure the work, diminish the necessary width of trench or other excavation, or otherwise delay the work or endanger

adjacent structures. Sheeting shall be driven and excavation work conducted in such a manner as to prevent the material in back of the sheeting from running under the sheeting and into the trench. Care should be taken to prevent voids outside of the sheeting but if voids are formed they shall be immediately filled and well rammed.

Whenever possible, sheeting shall be driven ahead of excavation to avoid loss of material from behind the sheeting, if necessary to excavate below the sheeting. Care shall be taken to avoid trimming behind the face along which the sheeting will be driven.

Bracing, rangers, and sheeting shall be fastened securely in place so that they can loosen up and fall from position.

The Contractor shall leave in place to be imbedded in the backfill or concrete all sheeting and bracing that is shown on the plans or which the Contracting Officer may direct him in writing to leave in place at any time during the progress of the work, for the purpose of preventing injury to structures or property.

D. *MEASUREMENT AND PAYMENT*

The unit price per thousand feet board measure for lumber and/or wood sheeting shall include furnishing and placing such lumber and/or wood as left in place as specified under Item 165.

The unit price paid per pound for steel sheeting shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in furnishing and placing steel sheeting as shown on the plans, as specified in these specifications and as directed by the Contracting Officer.

No payment will be made for any sheeting not shown on the plans to be left in place or directed by the Contracting Officer in writing to be left in place.

No payment will be made for cut-offs of sheeting and no payment will be made for any waste.

The furnishing and placing of blocking as shown in the plans or as directed by the Contracting Officer shall be considered as incidental to the work and no separate payment will be made therefore.

ITEM 170.0000 COMPLY WITH THE CONSERVATION COMMISSIONS ORDER OF CONDITIONS

A. *GENERAL*

Under this item, the Contractor shall provide all labor, tools, equipment and materials required to comply with the "Order of Conditions" issued by the Worcester Conservation Commission or Massachusetts Department of Environmental Protection enclosed with the Bid Documents of the Contract for Siltation Control.

The Contractor is required to comply with all conditions of this document.

B. *MEASUREMENT AND PAYMENT*

Payment under this item will be as a Lump Sum.

ITEM 171.0000 NSTALLATION AND MAINTENANCE OF EROSION CONTROLS

A. *GENERAL*

The Contractor shall provide all labor, tools, equipment and material required to install, maintain, and remove all siltation control measures shown on the approved plans, or at the direction of the contract officer.

B. *MEASUREMENT AND PAYMENT*

Payment under this item will be by Linear Feet, complete in place.

ITEM 173.0000 SILT SACKS

A. *GENERAL*

The work under this item includes the furnishing, construction, maintenance and removal of a reusable fabric sack to be installed in drainage structures for the protection of wetlands and other resource areas during construction and prevention of silt and sediment from the construction site from entering the storm water collection system. Silt sacks shall be designed to intercept all water, silt and debris entering the catch basin. Silt sacks shall be installed at all catch basins designated by the Engineer.

B. *MATERIALS*

The silt sack shall be Silt Sack® sediment control devices as manufactured by ACF Environmental, Inc. of Richmond, Virginia or approved equal.

C. *CONSTRUCTION METHODS*

The Silt sacks shall be installed in catch basins in place within the project limits and as required by the Engineer. All curb openings shall be blocked to prevent stormwater from bypassing the device.

The silt sack shall be as manufactured to fit the opening of the drainage structure and shall be mounted under the grate. The insert shall be secured from the surface such that the grate can be removed without the insert discharging into the structure. The filter material shall be installed and maintained in accordance with the manufacturer's written recommendations and as directed by the Engineer.

Silt sacks shall remain in place until the placement of all temporary pavement. All materials used for the filter fabric will become the property of the Contractor and shall be removed from the site. The Contractor shall inspect the condition of silt sacks after each rainstorm and during major rain events. Silt sacks shall be cleaned periodically to remove and dispose of accumulated debris as required. Silt sacks, which become damaged during construction operations, shall be repaired or replaced immediately at no additional cost.

When emptying the silt sack, the Contractor shall take all due care to prevent sediment from entering the structure. Any silt or other debris found in the drainage system at the end of construction shall be removed at the Contractor's expense. The silt and sediment from the silt sack shall be legally disposed of offsite. Under no condition shall silt and sediment from the insert be deposited on site and used in construction.

D. *MEASUREMENT AND PAYMENT*

The quantity of silt sacks shall be measured and paid for as each unit installed at a catch basin location and utilized for the duration of the work. Removal and replacement of the silt sack for the replacement of an existing catch basin shall not be considered for payment.

SECTION 200 - TRENCH PIPE WORK

Under Item 210 and 211 the work specified shall consist of cleaning and closed-circuit television inspection of all pipes shown in the contract documents or as directed by the Contracting Officer.

ITEM 210.0800 CLEAN AND CCTV 8" PIPE

ITEM 210.0900 CLEAN AND CCTV 9" PIPE

ITEM 210.1000 CLEAN AND CCTV 10" PIPE

ITEM 210.1200 CLEAN AND CCTV 12" PIPE

ITEM 210.1400 CLEAN AND CCTV 14" PIPE

ITEM 210.1500 CLEAN AND CCTV 15" PIPE

ITEM 210.1600 CLEAN AND CCTV 16" PIPE

ITEM 210.1800 CLEAN AND CCTV 18" PIPE

ITEM 210.2000 CLEAN AND CCTV 20" PIPE

ITEM 210.2100 CLEAN AND CCTV 21" PIPE

ITEM 210.2200 CLEAN AND CCTV 22" PIPE

ITEM 210.2400 CLEAN AND CCTV 24" PIPE

ITEM 210.2600 CLEAN AND CCTV 26" PIPE

ITEM 210.2700 CLEAN AND CCTV 27” PIPE

ITEM 210.2800 CLEAN AND CCTV 28” PIPE

ITEM 210.3000 CLEAN AND CCTV 30” PIPE

ITEM 210.3200 CLEAN AND CCTV 32” PIPE

ITEM 210.3300 CLEAN AND CCTV 33” PIPE

ITEM 210.3400 CLEAN AND CCTV 34” PIPE

ITEM 210.3600 CLEAN AND CCTV 36” PIPE

ITEM 210.3800 CLEAN AND CCTV 38” PIPE

ITEM 210.4000 CLEAN AND CCTV 40” PIPE

ITEM 210.4200 CLEAN AND CCTV 42” PIPE

ITEM 210.4400 CLEAN AND CCTV 44” PIPE

ITEM 210.4500 CLEAN AND CCTV 45” PIPE

ITEM 210.4800 CLEAN AND CCTV 48” PIPE

ITEM 210.5400 CLEAN AND CCTV 54” PIPE

ITEM 210.6000 CLEAN AND CCTV 60” PIPE

ITEM 210.7200 CLEAN AND CCTV 72” PIPE

ITEM 210.8400 CLEAN AND CCTV 84” PIPE

ITEM 210.1624 CLEAN AND CCTV 16x24” PIPE

ITEM 210.2030 CLEAN AND CCTV 20x30” PIPE

ITEM 210.2436 CLEAN AND CCTV 24x36” PIPE

ITEM 210.2842 CLEAN AND CCTV 28x42” PIPE

ITEM 211.0800 HEAVY CLEANING 8” PIPE

ITEM 211.0900 HEAVY CLEANING 9” PIPE

ITEM 211.1000 HEAVY CLEANING 10” PIPE

ITEM 211.1200 HEAVY CLEANING 12” PIPE

ITEM 211.1400 HEAVY CLEANING 14” PIPE

ITEM 211.1500 HEAVY CLEANING 15” PIPE

ITEM 211.1600 HEAVY CLEANING 16” PIPE

ITEM 211.1800 HEAVY CLEANING 18” PIPE

ITEM 211.2000 HEAVY CLEANING 20” PIPE

ITEM 211.2100 HEAVY CLEANING 21" PIPE

ITEM 211.2200 HEAVY CLEANING 22" PIPE

ITEM 211.2400 HEAVY CLEANING 24" PIPE

ITEM 211.2600 HEAVY CLEANING 26" PIPE

ITEM 211.2700 HEAVY CLEANING 27" PIPE

ITEM 211.2800 HEAVY CLEANING 28" PIPE

ITEM 211.3000 HEAVY CLEANING 30" PIPE

ITEM 211.3200 HEAVY CLEANING 32" PIPE

ITEM 211.3300 HEAVY CLEANING 33" PIPE

ITEM 211.3400 HEAVY CLEANING 34" PIPE

ITEM 211.3600 HEAVY CLEANING 36" PIPE

ITEM 211.3800 HEAVY CLEANING 38" PIPE

ITEM 211.4000 HEAVY CLEANING 40" PIPE

ITEM 211.4200 HEAVY CLEANING 42" PIPE

ITEM 211.4400 HEAVY CLEANING 44" PIPE

ITEM 211.4500 HEAVY CLEANING 45" PIPE

ITEM 211.4800 HEAVY CLEANING 48" PIPE

ITEM 211.5400 HEAVY CLEANING 54" PIPE

ITEM 211.6000 HEAVY CLEANING 60" PIPE

ITEM 211.7200 HEAVY CLEANING 72" PIPE

ITEM 211.8400 HEAVY CLEANING 84" PIPE

ITEM 211.1624 HEAVY CLEANING 16x24"

ITEM 211.2030 HEAVY CLEANING 20x30"

ITEM 211.2436 HEAVY CLEANING 24x36"

ITEM 211.2842 HEAVY CLEANING 28x42"

A. *GENERAL REQUIREMENTS*

The contractor shall furnish all materials, equipment, gauges, pumps, etc. for performing work under this item. For sewer construction projects (new or rehabilitation), a sketch will be required to show any deviation from the design drawings.

B. *PIPE CLEANING*

The Contractor may elect to use either high velocity jet, or mechanically powered equipment, as described in the NASSCO Standard Specifications. Selection of equipment shall be based upon field conditions such as

access to manholes, quantity of debris, size of sewer, depth of flow, etc.

All sludge, dirt, sand, rocks, grease, and other solid or semisolid material resulting from the cleaning operation shall be disposed of in accordance with all applicable regulations and in a method acceptable to the Owner. Pipe cleaning shall be performed in advance of pipe television inspection.

The Contractor shall be responsible for the legal disposal of all debris removed from the sewers during the cleaning operation including any costs incurred. The Contractor shall not expect the Owner to provide a dump site.

Acceptance by the Engineer of the cleaning results will be based on the results of television inspection. If the results are unsatisfactory, the Contractor shall repeat the cleaning until accepted by the Engineer at no additional cost to the Owner.

C. *HEAVY CLEANING*

Heavy Cleaning shall be defined as any cleaning done after an initial three passes with a jet flusher as required by Clean and CCTV. All sewer lines with remaining debris, roots, or other obstructions shall be Heavy Cleaned until the line is completely clear and able to be fully inspected by a CCTV camera.

The itemization of Heavy Cleaning is detailed in Items 211.

D. *TELEVISION INSPECTION*

The contractor will submit closed circuit television camera inspection (CCTV) digital files and reports to the Department of Public Works and Parks on an external hard drive for review and approval. The external hard drive will become the property of the City of Worcester, Department of Public Works & Parks.

The Contractor shall maintain printed television inspection logs of sewer segments under this contract. The log sheet(s) at a minimum shall clearly identify:

1. Project Name
2. Street Location, Name, Intersection, Station
3. Date of inspection
4. Total Length of Line Inspected
5. Line Size(s)/Joint Spacing/Type
6. Line and Manhole(s) Condition

Significant observations such as service connections, offset joints, drop joints, broken/cracked pipe, protruding services, roots, collapsed sections, infiltration, presence of scale and corrosion and other discernible features.

The City uses PACP codes to record pipe defects. The City imports the data into Central Square EAM (asset management program) with a PACP database. The final format for delivery to the City shall use NASSCO PACPU7 or greater in a file format that can be directly imported into IT Pipes without further manipulation of any kind by the City.

All observations and defects shall have snapshots taken and the pictures included in the PACP export.

All logs shall be provided to the Engineer in PDF format (one log per PDF file) at the completion of the project.

All television inspection shall be recorded in MPEG2, MP4 (not MP3), or WMV format (minimum) in accordance with NASCCO specifications and shall include a PACP exchange database that holds all inspection results including pictures and video for import to the City's maintenance management software, "Central Square EAM ". Inspections shall be recorded one at a time with each segment recorded as a separate file on the external hard drive.

The contractor shall provide two (2) original and labeled copies of each external hard drive to the Engineer. All external hard drives shall have a typed label with the following:

All cctv inspection work shall be performed by a NASSCO certified PACP inspector. Licenses shall be made available before the start of the contract.

[Date work was performed/Contractor/Contract /]

Filenames shall contain pipe wASSET_ID identification numbers. Stationing shall be recorded at a minimum of every foot and at all points of interest, to allow instant access to any given footage. Each street shall be tested in its entirety, and all associated reports and videos must be submitted on the same external hard drive.

Filenames for television inspection (video and report files) shall be provided as follows:

WASSET_ID_Date_Media_Iteration

Where "wASSET_ID" is the identifying number for the pipe asset, "Date" is in the format "YYYYMMDD", "Media" can be either "Report", "Video", "Picture" or "Sonar", and "Iteration" starts at "1" and increases by one (1) for each subsequent video in the same pipe asset. The "Iteration" does not need to increase if the same wASSET_ID is inspected on a different day. The date provides the distinction. For example, if pipe wASSET_ID SM26765 on Dallas Street was inspected on August 1st, 2013, the video file name would be:

SM26765_20130801_Video_1

and the Report file name would be:

SM26765_20130801_Report_1

In the event of a reverse setup, the next filename would be:

SM26765_20130801_Video_2
SM26765_20130801_Report_2

In the event the pipe segment was inspected on August 2nd, the next filenames would be:

SM26765_20130802_Video_1
SM26765_20130802_Report_1

All video and snapshot files shall be located in a single folder, as opposed to being stored in a separate folder for each asset.

E. *MEASUREMENT AND PAYMENT*

Payment for work under this item shall be by the linear foot for each complete segment as specified in the contract documents. No payment will be given for incomplete segments unless authorized by the Contracting Officer

Under Items 220 - 223 the work specified shall consist of excavation, backfilling and compaction of all materials encountered in the trenching for sewer mains and sewer services and the disposal of any and all surplus material from these excavations, as shown on the plans and specified herein. Unless shown on design plans or specified by the Contracting Officer, excavation and backfill for sanitary and surface sewers will be paid for as a common trench. The pay limits of the trench are those shown on a plan titled Typical Trench.

ITEM 220.0400 FURNISH AND INSTALL 4" PVC

ITEM 220.0600 FURNISH AND INSTALL 6" PVC

ITEM 220.0800 FURNISH AND INSTALL 8" PVC

ITEM 220.1000 FURNISH AND INSTALL 10" PVC

ITEM 220.1200 FURNISH AND INSTALL 12" PVC

ITEM 220.1500 FURNISH AND INSTALL 15" PVC

ITEM 220.1800 FURNISH AND INSTALL 18" PVC

ITEM 220.2100 FURNISH AND INSTALL 21" PVC

ITEM 220.2400 FURNISH AND INSTALL 24" PVC

ITEM 221.0812 FURNISH AND INSTALL 8" PVC & 12" RCP

ITEM 221.0815 FURNISH AND INSTALL 8" PVC & 15" RCP

ITEM 221.0818 FURNISH AND INSTALL 8" PVC & 18" RCP

ITEM 221.0821 FURNISH AND INSTALL 8" PVC & 21" RCP

ITEM 221.0824 FURNISH AND INSTALL 8" PVC & 24" RCP

ITEM 221.0827 FURNISH AND INSTALL 8" PVC & 27" RCP

ITEM 221.0830 FURNISH AND INSTALL 8" PVC & 30" RCP

ITEM 221.0836 FURNISH AND INSTALL 8" PVC & 36" RCP

ITEM 221.0842 FURNISH AND INSTALL 8" PVC & 42" RCP

ITEM 221.1012 FURNISH AND INSTALL 10" PVC & 12" RCP

ITEM 221.1015 FURNISH AND INSTALL 10" PVC & 15" RCP

ITEM 221.1018 FURNISH AND INSTALL 10" PVC & 18" RCP

ITEM 221.1021 FURNISH AND INSTALL 10" PVC & 21" RCP

ITEM 221.1024 FURNISH AND INSTALL 10" PVC & 24" RCP

ITEM 221.1027 FURNISH AND INSTALL 10" PVC & 27" RCP

ITEM 221.1030 FURNISH AND INSTALL 10" PVC & 30" RCP

ITEM 221.1042 FURNISH AND INSTALL 10" PVC & 42" RCP

ITEM 221.1212 FURNISH AND INSTALL 12" PVC & 12" RCP

ITEM 221.1215 FURNISH AND INSTALL 12" PVC & 15" RCP

ITEM 221.1218 FURNISH AND INSTALL 12" PVC & 18" RCP

ITEM 221.1221 FURNISH AND INSTALL 12" PVC & 21" RCP

ITEM 221.1224 FURNISH AND INSTALL 12" PVC & 24" RCP

ITEM 221.1227 FURNISH AND INSTALL 12" PVC & 27" RCP

ITEM 221.1230 FURNISH AND INSTALL 12" PVC & 30" RCP

ITEM 221.1236 FURNISH AND INSTALL 12" PVC & 36" RCP

ITEM 221.1242 FURNISH AND INSTALL 12" PVC & 42" RCP

ITEM 221.1515 FURNISH AND INSTALL 15" PVC & 15" RCP

ITEM 221.1518 FURNISH AND INSTALL 15" PVC & 18" RCP

ITEM 221.1521 FURNISH AND INSTALL 15" PVC & 21" RCP

ITEM 221.1524 FURNISH AND INSTALL 15" PVC & 24" RCP

ITEM 221.1527 FURNISH AND INSTALL 15" PVC & 27" RCP

ITEM 221.1530 FURNISH AND INSTALL 15" PVC & 30" RCP

ITEM 221.1536 FURNISH AND INSTALL 15" PVC & 36" RCP

ITEM 221.1542 FURNISH AND INSTALL 15" PVC & 42" RCP

ITEM 221.1818 FURNISH AND INSTALL 18" PVC & 18" RCP

ITEM 221.1821 FURNISH AND INSTALL 18" PVC & 21" RCP

ITEM 221.1824 FURNISH AND INSTALL 18" PVC & 24" RCP

ITEM 221.1827 FURNISH AND INSTALL 18" PVC & 27" RCP

ITEM 221.1830 FURNISH AND INSTALL 18" PVC & 30" RCP

ITEM 221.1836 FURNISH AND INSTALL 18" PVC & 36" RCP

ITEM 221.1842 FURNISH AND INSTALL 18" PVC & 42" RCP

ITEM 221.2118 FURNISH AND INSTALL 21" PVC & 18" RCP

ITEM 221.2121 FURNISH AND INSTALL 21" PVC & 21" RCP

ITEM 221.2124 FURNISH AND INSTALL 21" PVC & 24" RCP

ITEM 221.2127 FURNISH AND INSTALL 21" PVC & 27" RCP

ITEM 221.2130 FURNISH AND INSTALL 21" PVC & 30" RCP

ITEM 221.2136 FURNISH AND INSTALL 21" PVC & 36" RCP

ITEM 221.2142 FURNISH AND INSTALL 21" PVC & 42" RCP

ITEM 222.1200 FURNISH AND INSTALL 12" RCP

ITEM 222.1500 FURNISH AND INSTALL 15" RCP

ITEM 222.1800 FURNISH AND INSTALL 18" RCP

ITEM 222.2100 FURNISH AND INSTALL 21" RCP

ITEM 222.2400 FURNISH AND INSTALL 24" RCP

ITEM 222.2700 FURNISH AND INSTALL 27" RCP

ITEM 222.3000 FURNISH AND INSTALL 30" RCP

ITEM 222.3600 FURNISH AND INSTALL 36" RCP

ITEM 222.4200 FURNISH AND INSTALL 42" RCP

ITEM 222.6600 FURNISH AND INSTALL 66" RCP

ITEM 222.3600 FURNISH AND INSTALL 36" RCP

ITEM 222.7200 FURNISH AND INSTALL 72" RCP

ITEM 222.8400 FURNISH AND INSTALL 84" RCP

ITEM 223.1800 FURNISH AND INSTALL 18" RCP EPOXY COATED

ITEM 223.2100 FURNISH AND INSTALL 21" RCP EPOXY COATED

ITEM 223.2400 FURNISH AND INSTALL 24" RCP EPOXY COATED

ITEM 223.2700 FURNISH AND INSTALL 27" RCP EPOXY COATED

ITEM 223.3000 FURNISH AND INSTALL 30" RCP EPOXY COATED

ITEM 223.3600 FURNISH AND INSTALL 36" RCP EPOXY COATED

ITEM 223.4200 FURNISH AND INSTALL 42" RCP EPOXY COATED

ITEM 223.4800 FURNISH AND INSTALL 48" RCP EPOXY COATED

ITEM 223.5400 FURNISH AND INSTALL 54" RCP EPOXY COATED

A. *DESCRIPTION*

It is the responsibility of the Contractor to furnish and install all pipe segments and associated structures per the design plans. All excavations, except as otherwise specified or permitted shall be made in the open. No tunneling or lining will be permitted except by order or permission obtained from the Contracting Officer in writing. If permitted, all lining will be completed by the contractor at no additional cost above the unit bid price for the pipe installation.

The Contractor shall make excavations in such manner and of such widths as will give suitable room for building the structures or laying and jointing pipe; shall furnish and place all sheeting, bracing and supports; shall do all coffer-damming, pumping and draining; and shall render the bottom of the excavation firm and dry and in all respects acceptable. In no case shall the earth be plowed, scraped, or dug by machinery so near to the finished subgrade as to result in disturbance of material below said subgrade.

SEPARATION OF SURFACE MATERIALS

From areas where excavations are to be made, loam and topsoil shall be carefully removed and separately stored to be used again as directed, or if the Contractor prefers not to separate surface materials he shall furnish, as directed, and at no additional cost to the City, loam and topsoil at least equal in quantity and quality to that excavated.

PREPARATION OF SUBGRADE

From areas upon which embankments are to be built or material is to be placed for grading, the Contractor shall remove loam and topsoil, loose vegetable matter, stumps, large roots, etc. The subgrade shall be shaped as indicated on the drawings and shall be so prepared that the first layer or new material to be placed, on the subgrade, shall be firmly bonded thereto.

CUTTING THROUGH PAVEMENT – IN STREETS

Where existing bituminous concrete pavement is to be removed to allow for excavation, the pavement shall be pre-cut in a neat, clean straight line with a pavement breaker or saw. The minimum width of any excavation shall be 24 inches. Pavement edges shall be trimmed to a vertical face and neatly aligned parallel and perpendicular to the centerline of the trench. Pulverization of a trench will be considered an acceptable procedure provided that the trench is cut in a neat, straight line with a pavement breaker or saw prior to permanent restoration. The City may prohibit heavy-duty pavement breakers when their use endangers existing substructures or other property. Unstable pavement shall be removed over cave-ins and breaks and the subgrade shall be treated as the main trench. The Contractor shall not be required to pay for the repair of any pavement damage existing prior to the excavation unless the Contractor's cut results in small floating sections that may be unstable. If this occurs, the Contractor shall remove the unstable portion and the area shall be treated as part of the excavation. The maximum length of open trench permissible at any time shall be two hundred (200) feet. No greater length shall be opened for pavement removal, excavation, construction, backfilling, patching or any other operation without written permission of the City.

CUTTING THROUGH PAVEMENT - IN SIDEWALKS

All provisions of CUTTING THROUGH PAVEMENT – IN STREETS above shall also apply to sidewalks. On cement concrete sidewalks, individual concrete panels will be replaced to the nearest joint or score line the full width of the sidewalk.

SHEETING AND BRACING

The Contractor shall furnish, put in place, and maintain such sheeting and bracing, etc., as may be required to support the sides of the excavation and to prevent any pavement of earth which would in any way diminish the width of the excavation below that is necessary for proper construction, or otherwise injure or delay the work or endanger adjacent structures.

Whenever possible, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled with sand and compacted.

The Contractor shall leave in place to be embedded in the backfill or concrete all sheeting, bracing, etc., which is shown on the drawings to be left in place, and shall also leave in place any and all other sheeting, bracing, etc., not shown on the drawings which the Contracting Officer may direct him in writing to leave in place at any time during the progress of the work, for the purpose of preventing injury to structures or property. Sheeting to be left in place shall be cut off at an elevation as specified or as directed by the Contracting Officer.

All sheeting and bracing not to be left in place shall be carefully removed in such a manner as not to endanger the construction or other structures. All voids left or caused by withdrawal of sheeting shall be immediately backfilled with approved material and compacted by ramming with tools especially adapted to that purpose, by watering, or otherwise as may be directed. As specified under Sheeting Left in Place, the Contractor shall be paid only for sheeting left in place.

DRAINAGE

The Contractor shall at all times during construction provide and maintain ample means and devices with which to remove promptly and dispose properly of all water entering trenches and other excavations and keep said excavations dry until the structures, pipes and appurtenances to be built therein are completed. All water pumped or drained from the work shall be disposed of in a suitable manner without undue interference with other work or damage to pavements or other surfaces. Suitable temporary channels shall be provided for water that may flow along or across the site of the work.

DRAINAGE WELLPOINT SYSTEM

The Contractor shall, if required, dewater the excavation by means of an efficient dewatering system to drain the soil and prevent saturated soil from flowing into the excavation. The dewatering system shall be designed for this type of service and the pumping unit used shall be adequately designed and capable of dewatering the excavation.

If required, the installation of the dewatering system shall be done under the supervision of a competent representative of the manufacturer. Any special work shall be done, such as surrounding the system with sand or gravel, to ensure that the system shall operate as herein intended for the unwatering excavation.

TRENCH HAND EXCAVATION

When approaching underground pipes, conduits, or other structures, digging by machinery shall be discontinued and the excavation shall be done by hand. Such hand excavation when incidental to normal excavation shall be done at no expense to the City.

DEPTH OF TRENCH

Trenches shall be excavated to such depths as will permit the pipe to be laid to the elevations or slopes indicated on the drawings, and to uniform slope between indicated elevations.

PROTECTION OF EXISTING STRUCTURES

All existing pipes, conduits, poles, wires, fences, curbing, property line markers, and other structures which in the opinion of the Contracting Officer, are not required to be changed in location shall be carefully supported and protected from damage by the Contractor, and in case of damage, they shall be restored by him, without compensation therefore, to as good condition as that in which they were found.

Attention is called to the fact that there are water pipes, gas pipes, drain, and other utilities located throughout the project limits. The Contractor shall make himself fully aware of the location of these utilities prior to beginning the new work.

RELOCATING EXISTING STRUCTURES

Whenever it becomes necessary, in the opinion of the Contracting Officer, to change the location of any existing pipe, or other structures not otherwise provided for in these specifications, the Contractor, if ordered, shall do the whole or such portions of the work of making such changes as the Contracting Officer may require, and the work shall be paid for as extra work.

CARE AND RESTORATION OF PROPERTY

The Contractor shall enclose the trunks of shade trees adjacent to this work with tree fence of such height as is required to protect them from injury from piled materials or from equipment, or from his operations, or otherwise due to his work. Excavation machinery and cranes shall be handled with care to prevent damage to shade trees, particularly to overhanging branches and limbs.

Branches, limbs, and roots shall not be cut, except by permission of the Contracting Officer. Any cutting shall be smoothly and neatly done without splitting or crushing. In case of cutting or unavoidable damage to branches, limbs, and trunks of trees, the cut or damaged portions shall be nearly trimmed and covered with an application of grafting wax or tree healing paint as directed.

Cultivated hedges, shrubs, and plants that might be damaged by the Contractor's operations shall be protected by suitable means, or shall be dug up and temporarily replanted and cared for. After the construction operations have been substantially completed, they shall be replanted in their original positions and cared for until growth is re-established. If cultivated hedges, shrubs, and plants are injured to such degree as to

affect their growth or diminish their beauty or usefulness, they shall be replaced by items of kind and quality at least equal to kind and quality existing at the start of the work.

On paved surfaces the Contractor shall not use or operate tractors, bulldozers, or other power operated equipment, the treads or wheels of which are so shaped to cut or otherwise damage such surfaces.

Any surfaces that have been damaged by the Contractor's operations shall be restored to the condition at least equal to that in which they were found immediately prior to the beginning of operations. Suitable materials and methods shall be used for such restoration.

The restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the completion of the contract.

PUBLIC CONVENIENCE AND BRIDGING TRENCHES

The Contractor shall so conduct his operation as to offer the least possible obstruction and inconvenience to the public and he shall have under construction no greater length or amount of work than he can prosecute with due regard to the rights of the public.

Vehicular and pedestrian traffic will be maintained on all streets located within the project unless permission is received in writing from the Contracting Officer or his representative to close the street.

The Contractor shall give one weeks' notice to the Contracting Officer and to the DPW Construction Engineer of his desire for street closings and detours. Contractor shall notify City of Worcester Emergency Services of any proposed traffic adjustments before any work begins.

Where construction operations are such that an open ditch must be maintained until all of the work is completed therein, the Contractor must provide safe bridging of the trench so that vehicular and pedestrian traffic will be maintained over the trench until all construction is completed in that section of the ditch. Also, the Contractor shall provide suitable and safe bridges and other crossings where required to provide access to private property during construction and shall remove said structures thereafter.

Full compensation for conforming to the requirements of this section shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefore.

DISPOSAL OF MATERIALS

The most suitable material from excavations shall be used for backfilling around structures and for backfilling in open trenches as specified below.

All surplus excavated material and all unsuitable material shall be removed from the site of the work and be disposed of by the Contractor without additional compensation.

AMOUNT OF OPEN EXCAVATION

The amount of excavation open at any one time will be controlled by project conditions, but shall always be confined to the limits as approved by the Contracting Officer.

UNAUTHORIZED EXCAVATIONS

If the bottom of any excavation is being taken out beyond the limits shown on the drawings, or approved by the Contracting Officer, it shall be backfilled at the Contractor's expense with crushed stone as required by the Contracting Officer.

ELIMINATION OF UNSUITABLE MATERIAL

If, in the opinion of the Contracting Officer, the material at or below the point to which excavation would normally be carried is unsuitable for foundation, it shall be removed to such widths and depths as he may direct and be replaced with crushed stone of approved size under Items 130 - 132.

BACKFILLING AROUND STRUCTURES AND UTILITIES

As soon as practical after the pipes and masonry have been installed and the concrete has acquired a suitable degree of hardness, special leakage tests, if required, shall be made after which backfilling procedures shall begin and shall thereafter be prosecuted expeditiously. Approved Select Common Fill, in compliance with Item #124, shall be used to backfill around structures. Backfilling procedures shall conform to all applicable provisions of this section. JETTING MAY BE CONSIDERED AS A FORM OF COMPACTION AS DIRECTED BY THE CONTRACTING OFFICER.

In the event that 95% compaction cannot be achieved due to the location of existing utilities, the Contractor may be required to use excavatable Controlled Density Fill (CDF) to backfill around utilities. CDF shall conform to Item #446.3 and be paid for by the cubic yard complete in place.

BACKFILLING IN OPEN TRENCH

Pipelines shall be installed as shown on the Typical Trench Details above. Single sanitary pipelines shall be installed in an envelope of stone from 6 inches below the pipeline to 6 inches above the pipeline. Single surface pipelines shall be installed in an envelope of stone from 6 inches below the pipeline to the spring- line of the pipe. In typical trenches containing two (2) pipe lines, the limits of the stone shall be from 6 inches below the lowest pipe line to the center elevation of the higher pipeline. Select common fill shall be placed and thoroughly compacted by means of mechanical or pneumatic tamping up to a level of one (1) foot above the top of the pipe.

The backfilling of the trench shall follow immediately after construction of the pipeline and appurtenances.

The backfilling of the trench shall be made with selected common fill from the excavation and conform to Item #124, Ordinary Borrow/Selected Common Fill.

Prior to beginning backfill operations, the contractor shall be responsible for contacting the Contracting Officer to obtain a soil sample. The soil sample will then be forwarded to an approved material-testing agency to insure its compliance with the project's specifications. A maximum laboratory dry density of the soil will be determined in accordance with ASTM D698. It will benefit the contractor to provide a soil sample prior to the beginning of the project. This will allow field density test values to be calculated, as the excavation is being backfilled and allow for additional passes with compaction equipment, if necessary. It will also be the responsibility of the contractor to notify the Contracting Officer if any change in soil characteristics occurs.

Approved backfill material shall be placed in lifts not to exceed ten (10) to twelve (12) inches and thoroughly compacted by mechanical or pneumatic compactors to at least ninety-five per cent (95%) of the soil's maximum laboratory dry density.

Adequate moisture content in a backfill material is essential to achieve effective compaction. It will be the Contractor's responsibility to adjust the moisture content of the soil as necessary to achieve the specified compaction.

An approved material testing agency or Contracting Officer will then perform field density testing. Density testing will be performed at intervals of one (1) test per one hundred (100) linear feet of the compacted lift. In the event that the project is of a short duration or begins prior to obtaining the soil's maximum laboratory dry density (which is necessary in determining field density test results), the contractor shall assume full responsibility for re-excavating and re-compacting areas of failed field density tests.

Due to the hazardous nature of performing field density testing in deep excavations (6 feet or deeper), the contractor shall be responsible for establishing a method of compaction using mechanical or pneumatic compactors that assures each lift is compacted to at least 95% of the soil's maximum laboratory dry density.

As the excavation is brought to grade and field density tests are taken, the Contracting Officer, along with the contractor, shall establish a sufficient compaction method necessary to achieve at least ninety-five per cent (95%) of the material's maximum laboratory dry density based on the type of compaction equipment, number of passes and existing soil type and moisture content.

BUCKET WHACKING WILL NOT BE PERMITTED AS A MEANS OF COMPACTION.

In public or private streets excavated for sewer mains or sewer services, the top of the selected common fill shall be left one (1) foot below the bottom of the existing pavement surface. The remainder of the trench shall be backfilled with gravel borrow, conforming to MHD Standard, Section M1.03.0, Type b. this layer of gravel borrow shall form the sub-base of the road. This shall be a subsidiary obligation of the Contractor at no additional cost to the City of Worcester.

On Private Streets, the Contracting Officer may require that additional gravel borrow be placed on the surface of the backfilled trench to a reasonable depth and width. This will be done to cover part of, or even the entire, traveled way to eliminate impassable traffic conditions. This shall be in effect for one (1) year after completion of the work.

EXCAVATING AND BACKFILLING TRENCHES IN NEW STREETS LESS THAN FIVE (5) YEARS OLD

All applicable provisions of CUTTING THROUGH PAVEMENT – IN STREETS shall apply to new streets less than five (5) years old. The date used to determine the age of a street shall be the date of final paving. When excavating trenches in new streets less than five (5) years old, all material excavated shall be removed from the project site. No material shall be placed on the roadway. All excavated material shall be loaded directly into a dump truck for disposal off site. Upon completion of water, sewer and/or utility work, a one- (1) foot envelope of approved pipe bedding material shall be placed over installed lines. The trench shall then be backfilled using excavatable Controlled Density Fill (CDF), Type 2E. For rigid base roads, the trench shall be filled with CDF to the bottom of the rigid base. Prior to backfilling with CDF, the Contractor

may be required to notify the Contracting Officer for the purpose of obtaining a sample for compressive strength testing.

B. *SANITARY SEWERS*

GENERAL

Under this item the Contractor shall furnish all labor, tools, equipment, pipe and fittings, adapters, couplings, stoppers and/or plugs, jointing materials and screened gravel required to handle, lay and joint pipe for sanitary sewers, including tee connections, Y-branches and pipe for chimneys. All house and/or building connections shall be required to maintain any flows in existing sewer lines that are affected by his work. The Contractor is responsible for locating, maintaining and connecting all existing connections that are affected by his work. The Contractor shall not discharge sewage onto roadways or into surface sewers during the progress of his work. Where applicable the connection shall be Kor-N-Tee as manufactured by NPC Systems, Inc., Milford N.H., or equal.

PIPES AND FITTINGS

The type of pipe and fittings to be used for sanitary sewers shall be as specified in the proposal and shall be made of (1) cast and ductile iron; (2) poly (vinyl chloride) plastic; and (3) pre-cast, reinforced concrete. Each type of pipe and fitting shall meet the standards specified herein. Other types of pipe and fittings may be used for sanitary sewers and will be designated under appropriate items in the specifications and proposal. Where specific standards are referred to in the specifications, it is understood and agreed that they shall include all the revisions and amendments thereto. The class and type of pipe and fittings shall be shown on the plans.

CAST AND DUCTILE IRON PIPE

Cast and ductile iron pipe and fittings shall conform to the following standards:

1. American National Standard ANSI A 21.1 (AWWA HI) for thickness design of Cast-Iron Pipe.
2. American National Standard ANSI 21.50 (AWWA H3) for thickness design of Ductile Iron Pipe.
3. American National Standard ANSI A 21.6 (AWWA C 106) for Cast-Iron Pipe centrifugally cast in Metal Molds, for water and other liquids with push-on, mechanical and/or bell-and-spigot joints.
4. American National Standard ANSI A 21.8 (AWWA C 108) for Cast-Iron Pipe centrifugally cast in Sand-lined Molds, for water and other liquids with push-on, mechanical and/or bell-and spigot joints.
5. American National Standard ANSI A 21.10 (AWWA C 111) for Gray-Iron and Ductile - Iron Fittings, 2 inches through 48 inches, for water and other liquids with mechanical, push-on, bell-and-spigot and flanged joints.
6. American National Standard ANSI A 21.11 (AWWA C 111) for Rubber Gasket Joints for

Cast-Iron and Ductile-Iron Pressure Pipe and Fittings for push-on and mechanical joints.

7. American National Standard ANSI A 21.51 (AWWA C 151) for Ductile-Iron Pipe centrifugally cast in Metal Molds or Sand-lined molds for water or other liquids with push-on and mechanical joints.
8. Federal Specifications WW-P-421 c for pipe, Cast Iron and Ductile iron, pressure (for water and other liquids).
9. CIPRA Standard for Flanged Pipe with threaded flanges.
10. CIPRA - Special type of pipe and fittings. POLY (VINYL CHLORIDE) PLASTIC PIPE

Poly (Vinyl Chloride) plastic pipe and fittings shall conform to the following standards:

1. ASTM Standard Specification for Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Schedules 40, 80 and 120 for Water and Force Mains, Designation D 1785
2. ASTM Standard Specification for Socket-Type Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40, Designation D 2466.
3. ASTM Standard Specification for Socket-Type Poly (Vinyl Chloride) (PVC) and Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80, Designation D 2467.
4. ASTM Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe Fittings, Designation D 2729.
5. ASTM Standard Specification for Filled Poly (Vinyl Chloride) (PVC) Sewer Pipe, Designation D 2836.
6. ASTM Standard Specification for Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings, Designation D 3033.
7. ASTM Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings for Gravity Sewers.

PRECAST REINFORCED CONCRETE PIPE

Pre-cast, reinforced concrete pipe and fittings for sanitary sewers shall be epoxy coated. The pipe shall conform to the requirements of ASTM Standard Specifications for Reinforced Concrete Culvert. Storm Drain and Sewer, Designation C 76 and to ASTM Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe, Designation C 655.

The epoxy coating shall conform to the specifications listed herewith. Class and Wall Designations will be shown on the plans.

The groove of all tongue-and-groove pipes and the bell of all bell-and-spigot pipes shall contain circumferential reinforcement equal in area to that of a single line within the barrel of the pipe. Reinforcement for bell-and-spigot pipe, 12 to 24 inches in diameter, shall be extended into the bell.

The interior of pre-cast, reinforced concrete pipe for sanitary sewers shall be coated with two (2) coats of a green epoxy resin, specified as follows.

Internal coating of each piece of concrete sewer pipe shall be performed at the plant and under the control of the concrete pipe manufacturer in accordance with these specifications. A rigid inspection shall be maintained by the manufacturer of each length of pipe to determine that a thorough coating has been applied. If any portion of the coating is found to be thin or holidays are found, a second coat shall be applied to the deficient area. If bond between the pipe and coating is inadequate, the coating shall be thoroughly removed and a new application properly made.

PREPARATION OF PIPE

At the time the protective inner coating is applied, the pipe shall have a high, uniformly distributed moisture content (essentially saturated and surface damp) but shall be free of glistening or dripping water. The pipe may be prepared to meet this condition by one of the following methods:

1. For Pipe to be Prepared after Initial Kiln Curing.

Pipe, after initial kiln curing and removal of forms, shall be placed in an enclosure and shall be subjected to an atmosphere of approximately 100% relative humidity at a temperature of not less than 90 degrees

F. for a period of not less than 12 hours.

2. For Pipe from Yard Storage.

Pipe from yard storage shall be placed in an enclosure and shall be subjected to an atmosphere of approximately 100% relative humidity at a temperature of not less than 90 degrees F. for a period of not less than 12 hours.

Dust, weak laitance, rich cement films not firmly bonded, irregular aggregate protuberances, and other objectionable conditions shall be removed from the inner surface of the pipe to a depth sufficient to assure firm bond of crating. This shall be accomplished by mechanical grinding or other approved method, followed by a strong air blast, wire brushing and/or generous water flushing to remove all detritus. This inner surface preparation may precede or follow the moisture conditioning of the pipe herein before described.

COATING APPLICATION

After the pipe has been properly prepared as specified, the pipe shall be coated immediately before any appreciable loss of moisture by evaporation takes place and before a significant change in color of the pipe takes place due to drying.

The coating shall be catalytic - setting modified type epoxy coating consisting of two approximately equal volume components of type J-151-75 as manufactured by the George W. Whitesides Company, Inc. Louisville, Kentucky or approved equal. The coating shall be distinctively pigmented to aid in inspection. Application must be made in full compliance with instructions of the manufacturer. The coating shall be applied as a uniform with no holidays or thin spots. Application shall be at a rate to produce a cured film thickness of not less than 5 mils, and shall be made by suitable proportioning in temperature-controlled spray equipment, in which intimate mixing is done in the nozzle. Alternate application at the same rate may be made by approved hand methods, but in this case, no more epoxy material than is necessary to coat one pipe shall be attained by mechanical stirring.

In addition to coating the entire internal surface of the pipe, the inside groove (bell) and the extreme end of the tongue or spigot face shall also be coated.

MISCELLANEOUS CONTROLS

Temperature of concrete shall be 60 degrees F. to 90 degrees F. at the time of coating application. The pipe, after coating, shall be promptly stored and protected at an initial curing temperature of 60 degrees F. to 90 degrees F. until the film attains set-hardness before stockpiling, shipping, etc. Forced curing, at temperatures not to exceed 115 degrees F. will be permitted.

Any damage or discontinuities in the coating film prior to installation may be repaired by spot brush application of the same material used in the original coating. The proper timing of spot application in relation to original application of coating shall be determined from the manufacturer of the epoxy material and shall be rigidly adhered to in order to prevent lamination at overlaps of coats.

Sealing materials shall conform to the following requirements:

Rubber gaskets for joints shall conform to the requirements of ASTM Standard Specification for circular concrete sewer and culvert for pipe, using rubber gaskets, Designation C 443 and shall be flexible and able to withstand expansion, contraction, and settlement.

Resilient joint materials shall consist of poly vinyl chloride, or fiberglass impregnated with epoxy resin, or other approved resilient joint materials.

Joint material for reinforced concrete sanitary sewer pipe shall be the rubber gasketed type.

LAYING AND JOINTING PIPE

Before being laid each pipe length shall be inspected and tested to verify that it is not cracked, permanently dented or deformed. Pipe of the required size shall be laid to conform to the lines and grades indicated on the drawings or given by the Contracting Officer. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and bring the inverts continuously to required grade. Each pipe shall be supported with compacted crushed stone, graded in size from 1/4 inch to 3/4 inch, to obtain a substantially unyielding bed.

Unless recommended by the ASTM standards and by the manufacturers of the various kinds and types of pipe, the Contractor shall not joint pairs of pipe before laying them.

The factory instructions for unloading, handling, and laying and jointing the various kinds and types of pipes and fittings shall be followed explicitly and shall also follow the standards below, providing that the listed standards do not conflict with the manufacturer's recommendations:

1. ASTM Standard Recommended Practice for Installing Vitrified Clay Pipe Sewers, Designation C

12.

2. ASTM Standard Specifications for Rubber Rings for Asbestos Cement Pipe, Designation D 1869.
3. AWWA Standard for Installation of Cast Iron Water Mains C 600.
4. ASTM Standard Specifications for the Underground Installation of Flexible Thermoplastic Sewer Pipe, Designation D 2321.
5. ASTM Standard Specifications for Butt Fusion of Polyethylene (PE) Plastic Pipe Fittings, Schedule 40, Designation D 2610.
6. ASTM Standard Specifications for Butt Fusion of Polyethylene (PE) Plastic Pipe Fittings, Schedule 80, Designation D 2611.
7. ASTM Recommended Practice for the Underground Installation of Thermoplastic Pressure Piping, Designation D 2774.
8. ASTM Standard Specifications for Plastic Pressure Pipe using Flexible Elastomeric Seals, Designation D 3139.
9. Tentative Specifications for Joints for Drain and Sewer Plastic Pipe using Flexible Elastomeric Seal, Designation D 3212-73T.
10. Standard Specifications for Butt Heat Fusion of Polyethylene (PE) Plastic Pipe and Tubing, Designation D 3261.

Where a concrete cradle is used, the pipe shall be laid on concrete saddles so constructed as to provide lateral support for the pipe while the cradle is being placed. The location, dimensions, and class concrete required for cradles are given on the drawings.

Branches and fittings shall be laid by the Contractor as and where directed. Open ends of pipe and branches shall be closed with the appropriate stoppers and/or plugs secured in place in an acceptable manner using an approved gasket for the stopper and/or plug. No walking on or working over the pipes after they are laid, except when necessary in tamping the earth and backfilling, will be permitted until they are covered with earth to a depth of one (1) foot. All openings to the pipe line shall be satisfactorily protected from the entrance of earth, water, or other material, and all necessary precautions shall be taken to prevent flotation of the pipe.

LEAKAGE

The sewers and appurtenant structures connected thereto shall be made as nearly watertight as practicable and leakage measurements shall be made wherever possible.

The leakage into the sewers, including manholes, constructed under contract shall not exceed an average of 500 gallons per twenty-four (24) hour per inch-diameter per mile of sewer pipeline. There shall be no gushing or spurting streams entering the sewer or manholes.

Where practicable, the leakage tests shall be made at a time when a head of water can be maintained at least one (1) foot above the top of the pipe of the highest section of work being tested.

The sewers will be tested before any building connections are made.

The Contractor shall construct such weirs or other means or measurement as may be required and shall do all necessary pumping to enable the tests to be properly made.

Testing will be required.

SPECIFICATION FOR FLEXIBLE WATERTIGHT PIPE-TO-PIPE TEE CONNECTORS

A flexible watertight pipe-to-pipe connector shall be employed when connecting laterals into trunk and other sanitary sewer pipelines.

The connector shall be Kor-N-Tee as manufactured by NPC Systems, Inc., Milford N.H. or approved equal.

The connector shall be the sole element relied on to assure a flexible watertight seal at the location where the two (2) pipes are connected. No adhesives or lubricants shall be employed in the installation of the connector. The rubber for the connector shall comply with ASTM C 443, be of molded one-piece construction, shall be 3/8" (9.4 mm) thick or greater and consist of EPDM and Neoprene or elastomers designed to be resistant to ozone, weather elements, chemicals including acids, alkalis, animal and vegetable fats, oils and petroleum products from spills.

The connector shall be installed in the wall of the pipe by activating the expanding mechanism in strict accordance with the recommendation of the connector manufacturer.

All stainless steel elements of the connector shall be totally non-magnetic Series 304 stainless including the worm screw assembly for tightening the steel band around the pipe. The worm screw for tightening the stainless steel band shall be torqued by a break-away torque wrench available from the pre-cast manhole supplies, and set for 60-70 inch/lbs.

The connector shall be a size specifically designed so as not to protrude more than 1/8" inside the pipe. The connector shall also contain an internal shoulder that shall act as a stop for the incoming lateral.

Actual laboratory test results show that our material meets the requirements given in ASTM Specification C923, which covers rubber seals used in concrete sewer pipe and culvert joints.

PHYSICAL PROPERTIES	***ASTM C-923***	***ACTUAL***
I. Original		
Tensile, psi., min.	***1200***	***1550***
Elongation, % min.	***350%***	***910***
Shore A. Durometer	***35-65***	***40***
II. Comp. Set, % max.	***19.6***	***25***
III. Oven Aging: 96 hrs. @ 158 degrees F.		
Tensile Change, % max.	***-15***	***10.40%***
Elongation Change, % max.	***-20***	***-14.00%***
IV. Water Absorption: 48 hrs. @ 158 degrees F.	***10***	***3.50%***
Weight increase, % max.		
V. Ozone Resistance		
120 hrs. @ 100 degrees (+-) 02 degrees F.	***0***	***0***

TESTING

1. GENERAL REQUIREMENTS

All sanitary and surface sewer lines shall be subject to the applicable tests described in this section and also subject to CCTV work as described under Item 210. The contractor shall furnish all materials, equipment, gauges, pumps, special temporary tapings in line and water or other things required for making the tests. He shall include in his price for furnishing and laying pipe an allowance for the costs of such tests. The pipes installed under this contract will be tested as specified by the contracting officer and according to the contract documents.

2. TELEVISION INSPECTION

On all City of Worcester pipe installation projects, including sanitary and surface sewer lines, new or replacement projects, the contractor will adhere to the work specified in Item 210.

3. PIPE DEFLECTION MEASUREMENT

In accordance with ASTM D3034, no less than 30 days after completion of the PVC sewer pipe installation, the contractor shall test the pipeline for deflection using a “go/no-go” deflection mandrel having a minimum of nine evenly spaced arms or prongs. The “go/no-go” gauge shall be hand pulled through all sections of the pipeline by the contractor. The contractor shall submit drawings of the “go/no- go” gauge to the engineer for approval prior to testing. Complete dimensions of the gauge for each diameter of pipe to be tested shall be in accordance with ASTM D3034.

Any section of pipe found to exceed 7.5 percent deflection shall be deemed a failed pipe and shall be excavated and replaced by the contractor at his own expense.

4. LOW PRESSURE AIR TESTING

Unless otherwise approved, the section shall be tested using low-pressure air test procedures. If circumstances permit; the Engineer may allow testing in infiltration or exfiltration in lieu of air testing.

The air test procedures shall conform to the Uni-Bell Recommended Practice for Low pressure Air Testing of Installed Sewer Pipe, UNI-B-6. The starting air pressure for the test shall be 4 psi. The minimum duration permitted for the prescribed low pressure air exfiltration pressure drop between two consecutive manholes

shall not be less than provided in Table I or Table II of UNI-B-6.

The two tables are reproduced on the following sages

TABLE 1

SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSUER DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

PIPE DIAMETER (INCHES)	MINIMUM TIME (MIN:SEC)	LENGTH FOR MINIMUM TIME (FT)	LENGHT FOR LONGER LENGTH (SEC)	100 FEET	150 FEET	200 FEET	250 FEET	300 FEET	350 FEET	400 FEET	450 FEET
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.52L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15.49	17.48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22.47	25.38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	31:09	35:36
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.673L	22:47	34:11	45:34	56:58	68:22	79.46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172.21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179.29	205:07	230:46

SEPTEMBER 25, 2009		DEPARTMENT OF PUBLIC WORKS AND PARKS Engineering Division 20 East Worcester St, Worcester MA 01604	NO.	DATE	DESCRIPTION	BY
TABLE 1						
NOT TO SCALE						
SHEET 1 OF 1						

TABLE 2

SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSUER DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

PIPE DIAMETER (INCHES)	MINIMUM TIME (MIN:SEC)	LENGTH FOR MINIMUM TIME (FT)	LENGHT FOR LONGER LENGTH (SEC)	100 FEET	150 FEET	200 FEET	250 FEET	300 FEET	350 FEET	400 FEET	450 FEET
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	26:26	25:38	28:51
21	9:55	114	5.235L	9:55	13.00	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17.57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	46:54
30	14:10	80	10.683L	17:48	38:28	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926L	21:33	64:38	43:56	53:25	64:28	75:24	86:10	96:57
36	17:00	66	15.384L	25:39	76:55	51:17	64:06	76:55	89.44	102:34	115:23

SEPTEMBER 25, 2009		DEPARTMENT OF PUBLIC WORKS AND PARKS Engineering Division 20 East Worcester St, Worcester MA 01604				
TABLE 2						
NOT TO SCALE						
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

If either infiltration or exfiltration is permitted by the Contracting Officer, the test shall be conducted for at least 24 hours. The amount of infiltration or exfiltration shall not exceed 100 gallons per inch-diameter per mile of sewer per 24 hours.

The infiltration test measures leakage into a section of sewer and may be used only where the groundwater level is one foot or more above the crown of the section of sewer pipe at its upper end and at least one foot above the top of building connections and chimneys. For making the infiltration tests, under drains, if used, shall be plugged and other groundwater drainage shall be stopped to permit the groundwater to return to its normal level insofar as practicable. Allowances shall be made for water, which may enter the sewer through pipe connections and inlets during the infiltration test.

Where the groundwater level is less than 1 foot above the top of the pipe at its upper end, the exfiltration test may be used. The sewers shall be subjected to an internal pressure by plugging the pipe at the lower end and

then filling the pipelines and manholes with clean water to a height of 2 feet above the highest point in the system to be tested, including main pipeline, service connections and chimneys.

When slopes between manholes are steep, the contractor shall insure that this test can be accomplished without danger of forcing stoppers from wyes or tee branches.

The rate of exfiltration from the sewers shall be determined by measuring the amount of water required to maintain the water level at the elevation established at the beginning of the test.

The contractor shall construct such weirs or other means of measurements as may be required, shall furnish water and shall do all necessary pumping to enable the test to be properly made.

The contractor shall be responsible for the satisfactory water tightness of the entire section of sewer. Should the sections under test fail to meet the requirements, the contractor shall do all work of locating and repairing leaks and retesting as the Contracting Officer may require without additional compensation. A plan of the method of repairing any leaks that are found shall be submitted to the Engineer for review.

Portions of sewers that fail to meet tests shall be repaired and retested as necessary until test requirements are compiled. All said tapes/DVD's shall be submitted to the Contracting Officer.

C. *SURFACE SEWERS*

GENERAL

Under this item, the Contractor shall furnish all labor, tools, equipment, pipe, fittings, stoppers and/or plugs, jointing materials and screened gravel required to handle, lay and joint pipe for surface sewers (storm drains), including tee connections, Y-branches, and pipe for chimneys. Where applicable the connector shall be Kor-N-Tee as manufactured by NPC Systems, Inc., N.H. or equal.

MATERIALS

The kinds of pipe and fittings to be used for surface sewers shall be specified in the contract and they shall be made of (1) pre-cast, reinforced concrete and (2) cast and ductile iron. Each make of pipe and fittings shall meet the standards specified herein. Other kinds of pipe and fittings may be used for surface sewers and will be designated under appropriate items in the specifications and proposal. Where specific standards are referred to in the specifications, it is understood and agreed that they shall include all the revisions and amendments thereto. The class and type of each kind of pipe and fittings shall be shown on the plans.

PRE-CAST, REINFORCED CONCRETE PIPE

Pre-cast, reinforced concrete pipe for surface sewers shall conform to the requirements of ASTM Standard Specifications for Reinforced Concrete Culvert, Storm Drains and Sewer Pipe, Designation C 76 and to ASTM Standard Specifications for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, Designation C 655.

CAST AND DUCTILE IRON

Cast and ductile iron pipe for surface sewers shall be the same as for cast and ductile iron pipe for sanitary sewers.

LAYING AND JOINTING PIPE (See Item 220-223, subsection entitled "LAYING & JOINTING PIPE") Same as for sanitary sewers.

LEAKAGE (See Item 220-223, subsection entitled "LEAKAGE") Same as for sanitary sewers.

SPECIFICATION FOR FLEXIBLE WATERTIGHT PIPE-TO-PIPE TEE CONNECTORS

Same as for sanitary sewers. TESTING

Same as for sanitary sewers.

D. *MEASUREMENT AND PAYMENT*

The unit prices for Items 220 - 223 shall include compensation for trench excavation and backfill, furnishing, handling, laying and jointing the pipe and fittings, including setting stoppers and/or plugs and connecting to existing stubs and/or stoppers where required, furnishing gaskets, jointing material, crushed stone, all required testing, and all work incidental thereto.

Payment for trench excavation, backfill and sewer pipe under Items 220 - 223 shall be based upon measurements projected on a horizontal scale of the completed pipelines taken along their center lines, including Y or T branches. The length of manhole inverts (as measured between inside walls of the manholes)

will be deducted from said measurements.

The cost of excavation and backfill, furnishing and handling, laying and jointing the various sized pipe for connections shall be paid for under Item 224 in the proposal.

Payment for trench rock excavation and disposal shall be made under Item 121.

Payment for trench excavation and backfill, furnish and install pipe shall be paid for by the linear foot.

ITEM 224.0000 CONNECTIONS

A. GENERAL

Where indicated on the drawings or directed by the Contracting Officer, the Contractor shall furnish, handle, lay and joint 6-inch or larger sized ductile iron pipe and stoppers; 6-inch or larger sized PVC pipe and plugs for existing or future house or building connections.

B. MEASUREMENT AND PAYMENT

Payment for connections under this item shall be by the linear foot, and based upon measurements of completed connections taken along their centerlines. The unit price for this item shall include compensation for furnishing, handling, laying and jointing the pipe and plugs. The unit price shall also include furnishing rubber rings and lubricants for the various kinds of pipe, crushed stone envelope and making all excavations required for the connections above that are normally required under items and all work incidental thereto.

ITEM 225.0800 8 INCH CATCH BASIN CONNECTION

ITEM 225.1200 12" CATCH BASIN CONNECTION

A. GENERAL

Under these items the Contractor shall furnish and install the 8 inch or 12 inch DR18, Class 150 pipe complete in place, including excavation and gravel backfill and make connections to the new or existing manholes or catch basins. Gravel to be power tamped in 6-inch layers as directed by the Contracting Officer.

B. MEASUREMENT AND PAYMENT

This item shall be paid for by the sum bid per linear foot.

LOW PRESSURE FORCE MAIN

ITEM 226.0150 TRENCH EXCAVATION & BACKFILL, FURNISH AND INSTALL1.5" PVC FORCE MAIN

ITEM 226.0200 TRENCH EXCAVATION & BACKFILL, FURNISH AND INSTALL 2" PVC FORCE MAIN

ITEM 226.0250 TRENCH EXCAVATION & BACKFILL, FURNISH AND INSTALL 2.5" PVC FORCE MAIN

ITEM 226.0300 TRENCH EXCAVATION & BACKFILL, FURNISH AND INSTALL 3" PVC FORCE MAIN

A. GENERAL

Polyvinyl Chloride (PVC) pipe for low-pressure sewers shall be of the size indicated on the Drawings and shall be PVC, Type 1120, ASTM 2241, Class 200 (DR-21). Joints shall use elastomeric gaskets conforming to ASTM D1869.

The standard laying length shall not exceed 20 feet. All pipe and fittings shall be clearly marked on the outside indicating the name of the manufacturer, ASTM designation and the nominal diameter. PVC pipe shall be laid in a 6" envelope of sand borrow at a minimum depth of 5 feet. Sand Borrow shall conform to Item #125 of these specifications. Sewer Warning Tape shall be required with all force main installations. The magnetic tape shall be a minimum of 6" in width, green in color and shall be placed 1 foot above the pipes bedding. Installation of the sewer warning tape shall be a subsidiary obligation of the contractor at no additional cost to the City of Worcester.

Service connections to the low-pressure sewer shall use tees. Tees shall be of the same class and size as a mainline pipe for the location to be installed and shall have a branch of 1-1/4" in size. The run of the tee shall use elastomeric joints. A Corporation Stop placed at the tee or saddle, suitable for withstanding line test pressure shall be supplied and installed.

B. PRESSURE AND LEAKAGE TESTS

Unless otherwise approved, all pipelines shall be given combined pressure and leakage tests between line valves. The Contractor shall furnish and install suitable temporary testing plugs or caps; all necessary pressure pumps, pipe connections, meters, gates, and other necessary equipment; and all labor required.

Test the service lateral by disconnecting the hose and valve assembly at the union, filling lateral with water, and using positive displacement pump to raise the pressure to 100 psi for one (1) hour. No loss of pressure will be permitted. The Owner and Engineer shall have the privilege of using their own gages. Subject to approval and provided that the tests are made within a reasonable time considering the progress of the project as a whole, and the need to put the section into service, the Contractor may make the tests when he desires. However, pipelines in excavations or embedded in concrete shall be tested prior to backfilling of the excavation or placing of the concrete, and exposed piping shall be tested prior to field painting.

Unless it has already been done, the section of pipe to be tested shall be filled with water and all air shall be expelled from the pipe. The Contractor shall follow established procedures for filling the pipe and expelling trapped air to avoid exposing the piping system to water hammer. If blowoffs are not available at high points for releasing air, the Contractor shall make the necessary excavations and install the necessary taps. If directed, he shall plug the holes after completion of the test and backfill as necessary.

The section under this test shall be maintained full of water for a period of 24 hours prior to the combined pressure and leakage test being applied.

The pressure test shall consist of first raising the water pressure (based on the elevation of the lowest point of the section under the test corrected to the gage location) to the pressure rating of the pipe. If the Contractor cannot achieve the specified pressure and maintain it for a period of one (1) hour, the section shall be considered as having failed to pass the pressure test.

If the pressure test fails, the Contractor shall make a leakage test by metering the flow of water into the pipe while maintaining the specified pressure in the section being tested. If the average leakage during a two- hour period exceeds 11.6 gallons per day, per inch of diameter, per mile of pipe, the section shall be considered as having failed the leakage test. For example, if 1,000 feet of 4-inch pipe is to be tested, the allowed leakage is 0.73 gallons over a two (2) hour period as calculated as follows:

$$L = \frac{(11.6 \text{ Gallons})(4")(2 \text{ Hr.})}{(1")(24 \text{ Hr.})(5.280')(1{,}000')} = 0.7$$

If the section fails to pass the pressure and leakage test, the Contractor shall do everything necessary to locate, uncover, and repair or replace the defective pipe, fitting, or joint, all at his own expense and without extension of time for completion of the work. Additional tests and repairs shall be made until the section passes the specified test.

Pressure and leakage tests shall be a subsidiary obligation of the Contractor at no additional cost to the City.

C. *MEASUREMENT AND PAYMENT*

The unit prices for Item 226.0150 thru 226.0300 shall include compensation for trench excavation and backfill, furnishing, handling, laying and jointing the pipe and fittings. This will include setting stoppers and/or plugs and connecting to existing stubs and/or stoppers where required. It shall also include furnishing gaskets, jointing material, sand borrow, making leakage tests and all work incidental thereto.

Payment for trench excavation, backfill and sewer pump under Item 226.015 and 226.02 shall be based upon measurements projected on a horizontal scale of the completed pipelines taken along their centerlines, including Y or T branches.

The cost of excavation and backfill, furnishing and handling, laying and jointing the various sized pipe for connections shall be paid for under Item 227.125 in the proposal.

Payment for trench rock excavation and disposal shall be made under Item Payment for trench excavation and backfill, furnish and install pipe shall be paid for by the linear foot.

ITEM 227.0000 SERVICE CURB STOP AND ROD BOX FOR LOW PRESSURE SEWER FORCE MAINS

A. *GENERAL*

A curb stop valve shall be installed on each sewer lateral. The curb stop shall be a 1-1/4" brass ball-type with full port, pack joint (compression). Valves shall be Ford Meter Box Company or approved equal. Curb stops

shall NOT be of the stop/waste type.

The curb stop service box shall be rod type. Quality Water Products or equal. The service box shall adjust one

(1) foot for proper height. The bottom shall be arch pattern with the use of a curb box base that fits over a 1-1/4" curb stop. The 36-inch rod shall be offset for centering in the pipe and must be a minimum 5/8" diameter. A brass cotter pin must be supplied with each rod. The rod shall be permanently attached to the end yoke. The plug cover shall have a deep slot for the release of water and the removal of debris. The brass pentagon plug shall have a coarse thread. All boxes will be coated with asphalt-based paint and shall be labeled "Sewer" on the lid.

As a general rule, a curb stop and box shall be installed within the City right-of-way at or near the property line behind the sidewalk, usually in the grass area. Curb stops and boxes shall not be location within the sidewalk unless directed by the Contracting Officer because of special or unique conditions.

B. *MEASUREMENT AND PAYMENT*

Curb stop and rod box for force sewer services will be paid for per each complete in place.

ITEM 227.1250 LOW PRESSURE SEWER LATERAL HOUSE CONNECTIONS AND VALVES

A. *GENERAL*

Low-pressure sewer connections from each sewage grinder pump station shall be PVC Type 11, ASTM 2241, Class 200 (DR 21). Joints shall use elastomeric gaskets conforming to ASTM D1869.

All pipe and fittings shall be clearly marked on the outside indicating the name of the manufacturer, ASTM designation and the nominal diameter.

Service connections to the low-pressure sewer shall use "tees". Tees shall be of the same class and size as the mainline pipe for the location to be installed and shall have a branch of 1-1/4" in size. The run of the tee shall use elastomeric joints.

Forced sewer house lateral lines are to be installed at a minimum of five (5) feet of cover and a maximum of eight (8) feet from the pipe to the finished grade.

Forced sewer lines shall be installed a minimum of ten (10) feet away from any potable water service.

B. *MEASUREMENT AND PAYMENT*

Low-pressure service connections shall be paid for by the linear foot complete in place. This unit price shall include trench excavation and backfill, furnishing, handling, laying and joining the pipes and fittings. It shall also include furnishing gaskets, joining material, sand borrow and making leakage tests and all work incidental thereto.

The work to be done under Items 230 and 232 shall include furnishing and installing complete manhole bases and sections including hauling, excavation, placement of structures, backfilling and all labor, equipment and incidentals necessary to complete the work. All pre-cast manhole bases and sections shall conform to ASTM Specifications C 478. Installation of pre-cast manholes shall be as shown on a plan titled Typical Manhole and Step Manhole.

ITEM 230.4000 4' MANHOLE BASE

ITEM 230.5000 5' MANHOLE BASE

ITEM 230.6000 6' MANHOLE BASE

ITEM 230.7000 7' MANHOLE BASE

ITEM 230.8000 8' MANHOLE BASE

ITEM 231.4000 4' MANHOLE SECTION

ITEM 231.5000 5' MANHOLE SECTION

ITEM 231.6000 6' MANHOLE SECTION

ITEM 231.7000 7' MANHOLE SECTION

ITEM 231.8000 8' MANHOLE SECTION

ITEM 232.1000 MITER BEND MANHOLE TEE

ITEM 232.2000 FLAT MANHOLE TEE

MANHOLES

A. DESCRIPTION

Manholes shall conform in shape, size, dimensions, and in other respects to the details indicated on the drawings, or as ordered by the Contracting Officer. Manholes shall be two types: (1) manholes built over existing sewer pipes and (2) pre-cast reinforced concrete manholes to be installed along with sanitary and surface sewers. A minimum of 12 inches of red sewer brick, grade MS only, shall be used under the frame.

1. The base of manholes built over existing sewer pipes shall be reinforced Class A concrete on screened gravel bed with sewer brick masonry built up to the spring line of the existing sewer pipe, as shown on the drawings or as directed by the Contracting Officer. The walls and cones of the manholes shall be pre-cast manhole sections as specified on (2) below. The joint between the manhole base and the first wall section shall be completely mortared by buttering the groove end of the wall section immediately prior to setting the section assuring a water tight joint. Type I cement is to be used. Kent Seal, or equivalent, can be used as an alternative if appropriate. The remaining joints of the wall and cone sections of the manhole as well as the rubber gaskets for the pipe opening and riser sections and the aluminum manhole steps or approved equal shall be described in (2) below.

The location of manhole bases to be built over existing sewers pipes shall be indicated on the drawings.

2. Pre-cast reinforced concrete manholes shall consist of pre-cast reinforced riser sections, a concentric or eccentric top and a base section conforming to the typical manhole details.

Pre-cast manhole sections shall be manufactured in accordance with ASTM Standard Specifications for Pre-cast Reinforced Concrete Manhole Sections, Designation C 478. The minimum compressive strength of the concrete for 4-foot diameter and for 5-foot diameter manholes for all sections shall be 4,000 psi. The minimum compressive strength of the concrete for 6-foot diameter manholes for all sections shall be 5,000 psi. The circumferential steel reinforcement for riser pipe, cone sections and base walls for the various sized manholes shall be as required by ASTM Standard Specifications for Welded Steel Fabric for Concrete Reinforcement, Designation A 185 and shall be as follows:

a. For 4-foot diameter manholes - An area of 0.12 square inch per vertical foot reinforcement in both bell and spigot.
b. For 5-foot diameter manholes - An area of 0.12 square inch per vertical foot reinforcement for the 4-foot diameter portion and an area of 0.15 square inch per vertical foot reinforcement for the 5- foot diameter portion of the manhole in both bell and spigot.
c. For 6-foot diameter manholes

An area of 0.12 square inch per vertical foot reinforcement for the 4-foot diameter portion and an area of

0.17 square inch reinforcement of the 6-foot diameter portion of the manhole in both bell and spigot.

d. For 7 & 8-foot diameter manholes See ASTM Specification C 478.

Reinforcing in the bottoms of bases shall be of the same design as that required for the various sized manholes. Reinforcing shall extend into the tongue and groove of each manhole section.

Manhole steps shall be epoxy coated steel ladder type (or approved equal). All steps shall be cast into walls of the pre-cast sections so as to form a continuous ladder with a distance of twelve (12") inches between steps.

Each section of the pre-cast manhole shall have two holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with hydraulic cement after installation.

Monolithically pressure cast base sections shall be as shown on the drawings or as ordered by the Contracting Officer. Holes for pipes shall be cased in the base section so that there is a clear distance of four (4) inches

minimum between the inside bottom of the base section and the pipe invert.

The joint at the base section between the manhole and the pipe shall be (1) "A-Lok" Seal Joint as manufactured by L and L Concrete Products Incorporated, Webster, Massachusetts (or an approved equal).

The "A-Lok" rubber gasket is a pipe to manhole seal cast integrally into the pipe opening of the manhole base to provide a water tight joint and 10 degree of omni directional deflection. The "A-Lok" rubber gasket is to be manufactured in accordance with ASTM Rubber Joint Specifications Designation C 425 for Compression Joints.

The Contractor shall furnish all the material required for the construction of the manholes, including bricks, cement, sand, concrete, lime, hydraulic cement, and all other materials required.

3. Manhole Tees shall comply with the following:

Pipe and class shall be in accordance with ASTM C76 Steel shall be grade 60 steel per ASTM A615 and Design to resist HS20-44 live loads.

B. *CLASS OF CONCRETE*

The following are alternate designations for the various cement concrete mixtures on the Contract Plans and Standards.

Class A = 4,000 p.s.i., 1-1/2",565

Class B = 3,500 p.s.i., 1-1/2", 520

Class C = 3,000 p.s.i., 1-1/2", 470

Class D = 4,000 p.s.i., 3/4", 610

Class DE = 5,000 p.s.i., 3/4", 705

Class F = 5,000 p.s.i., 1-1/2", 660

C. *PORTLAND CEMENT*

Cement shall be a single brand of approved American made Portland Cement conforming to current specifications of ASTM Standard Specifications for Portland Cement, Designation C 150, Type II, or where required. Type III high early-strength cement.

When used in the work, cement shall be free from lumps and partially or wholly set cement.

D. *ADMIXTURES*

The use of admixtures to improve workability, facilitation hardening of waterproofing, will not be permitted.

E. *WATER*

Clean, fresh water shall be used for mixing concrete.

F. *FINE AGGREGATE*

Concrete sand shall be clean, sound, sharp, screened, and well graded with no grain larger than will pass a 3/8-inch sieve. Not more that 30 percent by weight shall pass a No. 50 sieve.

No sand shall be used which shows a color darker than Fig. 2 when tested according to the standard method of test for Organic Impurities in Sands for Concrete, ASTM Standard Specifications, Designation C 40.

G. *COARSE AGGREGATE*

Coarse aggregate shall be washed screened gravel or crushed stone, hard, tough, durable, and having not more than 5 percent by weight of deleterious substances and soft fragments. Aggregate shall be well graded from the largest, which shall pass a 1-1/2 inch mesh, to the smallest, which shall pass a 3/8 inch mesh and not over 5 percent passing a 1/4 inch mesh.

H. *SAMPLES OF AGGREGATE*

If required, the Contractor shall submit clearly labeled samples of sand and coarse aggregate to the Contracting Officer as directed. No aggregates shall be delivered or used before the samples have been approved and aggregates as delivered shall in all respects be equal to the approved samples.

I. *CONCRETE QUALITY AND PROPORTIONING*

Class A (4,000 p.s.i., 1-1/2", 565) concrete shall be proportioned to produce the thoroughly workable mix resulting in a dense, watertight concrete and meeting the following limitations:

Maximum net water content over bag of cement (decrease possible).6-1/2 gallons

Minimum amount of cement per cubic yard of concrete (increase if necessary to meet other requirements)...5-1/2 bags

The volume of sand and stone shall be measured separately and loose in approved boxes, but may be varied

as required so that the sum of their volumes does not exceed six (6) times the volume of cement, and so that the volume of coarse aggregate approximates but does not exceed twice the volume of fine aggregate. Allowance for bulking of fine aggregate shall be made as directed. No caked or lumpy materials shall be used.

When high-early strength cement is used, the above limitations shall also apply except that the minimum compressive strength of 4,000 psi shall be attached in seven (7) days.

Class B (3,500 p.s.i., 1-1/2", 520) concrete shall meet the following limitations: Maximum net water content over bag of cement (decrease possible). - 8 gallons

Minimum amount of cement per cubic yard of concrete (increase if necessary to meet other requirements). - 5-1/2 bags

The sum of the volumes of fine and coarse aggregates shall not exceed nine (9) times the volume of cement.

J. *CONCRETE MIXING*

The concrete shall be mixed by a batch mixer having at least 1/2 cubic yard rated capacity, which capacity shall not be exceeded by the mixed material. Adequate facilities shall be provided for accurate measurement of water and control of materials entering the drum. The mixer shall revolve at a uniform peripheral speed of about 200 rpm, and the mixer shall be at least 1-1/2 minutes after all materials are in the drum.

K. *READY MIXED CONCRETE*

Ready mixed concrete will be permitted provided that the Contracting Officer shall have the right to inspect the plant of the manufacturer and the proportioning and mixing of the concrete and shall be given every facility therefore, and that the materials and methods of portioning, mixing, and delivering are satisfactory and generally in accordance with the above specifications.

The manufacturer shall furnish, through the Contractor, appropriate certificates of tests, materials, proportions, mixing, and strengths from an independent testing laboratory, to such extent as such certificates are available from previous work. Such certificates shall have an effective date not more than six (6) months prior to the time when the concrete will be used and shall be furnished to the Contracting Officer at least seven (7) days before that time. No ready mixed concrete shall be ordered before the Contracting Officer has given the approval.

The quantity of concrete to be mixed or delivered in any one batch shall not exceed the rated capacity of the mixer or agitator, as stated on the nameplate.

Attention is called to the importance of dispatching trucks from the batching plant so that they shall arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.

L. *CONCRETE FORMS*

Forms shall be constructed of sound lumber, plywood or metal and shall conform accurately to the dimensions, shapes, and elevations shown on the drawings. They shall be mortar-tight, rigid and unyielding during the placing and ramming of concrete.

The Contractor shall be entirely responsible for their adequacy. Forms for manhole inverts shall be smooth, carefully built to true size and shape, and accurately set.

Form ties to be encased in concrete shall not be made of through-bolts or common wire, but shall be an approved well-established type manufactured for the purpose.

Form surfaces to be in contact with concrete shall be oiled, and if re-used, shall first be cleaned, repaired and re-oiled.

No part of any form shall be struck without the consent of the Contracting Officer.

M. *PLACING CONCRETE*

No concrete shall be poured before foundations, forms, embedded materials, and all preliminary work have been inspected and approved. No concrete shall be laid in water. If chutes are used they shall be of metal or metal lined.

All laitance shall be removed from construction joints and surfaces of previous poured concrete that shall then be roughened and cleaned with a stream of water or compressed air and thoroughly saturated with water. Horizontal joints and surfaces shall receive a layer of mortar 1/4 inch thick of the same cement-sand ration used in the concrete immediately before the new concrete is deposited.

Concrete shall be deposited in suitable layers, one layer quickly following another, until the pour is completed. While being deposited the concrete shall be thoroughly compacted by rodding and spading or by mechanical vibration. If mechanical vibration is used, it shall be done by experienced operators under close supervision, the concrete consistency as measured by slump shall not exceed three (3) inches and the duration shall be held to the minimum necessary to produce thorough compaction without segregation. Hand spading shall always be used adjacent to forms to produce a smooth dense surface. The concrete shall be thoroughly and carefully rodded about embedded materials.

N. *CURING AND PROTECTION*

All concrete work shall be protected against damage from the elements and defacement of any nature during construction operations.

Water shall not be permitted to rise on concrete within twenty-four (24) hours after it is placed, or shall running water be allowed to flow over completed concrete within four (4) days after it has been placed.

O. *CONCRETE REINFORCEMENT*

The steel shall be newly rolled stock, substantially free from mill scale, rust, dirt, grease, or other foreign matter.

P. *PLACING REINFORCEMENT*

Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings, including ice, that reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be reinforced and cleaned when necessary.

Reinforcement shall be accurately positioned as indicated on the drawings, and secured against displacement by using annealed iron wire ties or suitable clips at intersections. Reinforcement shall be supported by concrete or metal supports, spacers, or hangers. Wood blocks, stones, brick, chips, etc., shall not be used.

Reinforcement that is to be exposed for a considerable length of time after having been placed shall be painted with a heavy coat of cement grout.

Q. *KIND OF BRICK*

The brick shall be good, sound, hard, and uniformly burned brick, regular and uniformly burned brick, regular and uniform in shape and size, of compact texture and satisfactory to the Contracting Officer.

Brick shall be Grade MS conforming to the ASTM Standard Specifications for Sewer Brick (made from clay or shale), Designation C 32 for use under the frame and for all other uses with the exception of the invert and shelf.

Brick shall be Grade SS conforming to the ASTM Standard Specification for Sewer Brick (made from clay or shale), Designation C 32 for invert and shelf.

In case the Contracting Officer rejects any brick, the same shall be immediately removed from the work site and brick satisfactory to the Contracting Officer substituted. Brick shall be culled and completely piled as soon as possible.

R. *LAYING BRICK*

Bricks shall be clean when laid. For best results, bricks should have a section rate, when laid, not in excess of 40 gpm., in accordance with the NBS test procedure.

Except in cold weather, all brick shall be set as directed by the Contracting Officer to approximate this condition.

Each brick shall be laid in full bed and joint of mortar without requiring subsequent grouting, flushing or filling and shall be thoroughly bonded as directed.

Brick work shall be protected against weather and frost as approved or required by the Contracting Officer.

S. *PLASTERING*

Outside faces of brick masonry shall be plastered with mortar 1/2 inch thick. The masonry shall be properly wetted as above specified, before the plaster is applied.

The plaster shall be carefully spread and troweled so that all cracks are thoroughly worked out. After hardening, the plaster shall be carefully checked, by being tapped, for bond and soundness. Two coats of bituminous

waterproofing material shall then be applied to the hardened plaster. The material shall be "Minimax Fibrous Brush Coat" made by the Minimax Company, New York, N.Y.; "Tremco 121 Foundation Coating" made by the Tremco Manufacturing Company, Cleveland, Ohio; "Inertol No. 7" made by Inertol Company, Newark, N.J.; or approval equal. The material shall be applied by brush or spray (using a primer if necessary) in

accordance with the direction of the manufacturer.

The Contracting Officer, at his discretion, may require that two (2) coats of the above described bituminous waterproofing material be applied to the outside of pre-cast manholes installed in wet area.

T. *STUBS IN MANHOLES*

The stubs shall be short pieces cut from the bell end of the pipe, sealed as specified under Items 230-232. The stubs shall be set to the required line and elevation and encased in the manhole masonry as shown on the drawings or as directed by the Contracting Officer.

U. *MANHOLE VACUUM TESTING*

Vacuum Test: The work under this section shall be for new construction only, unless otherwise specified by the Contracting Officer. Testing required in this section shall be a subsidiary obligation of the contractor at no additional cost to the City of Worcester.

Vacuum Test: The vacuum test shall be conducted in accordance with ASTM C1244. Test results will be judged by the length of time it takes for the applied vacuum to drop from 10 inches of mercury to 9 inches. If the time is less than that listed in Table 1 of ASTM C1244, the manhole will have failed the test. Test times from Table 1 are excerpted below.

TABLE 1 - Minimum test times for various manhole diameters.

Diameter (Inches)	***48***	***60***	***72***
Depth (Feet)		***Times (Seconds)***	
0 - 12	***30***	***39***	***49***
12 - 16	***40***	***52***	***67***
16 - 20	***50***	***65***	***81***
20 - 24	***59***	***78***	***97***
26 - 30	***74***	***98***	***121***

If the manhole fails the initial test, the Contractor shall locate the leaks and make proper repairs. Leaks may be filled with wet slurry of accepted quick setting material. If the manhole should again fail the vacuum test, additional repairs shall be made, and the manhole water tested as specified below.

Water Exfiltration Test: After the manhole has been assembled in place, all lifting holes shall be filled and pointed with an approved non-shrinking mortar. All pipes and other openings into the manhole shall be suitably plugged and the plugs braced to prevent blow out. The test shall be made prior to placing the shelf and invert. If the groundwater table has been allowed to rise above the bottom of the manhole, it shall be lowered for the duration of the test.

The manhole shall be filled with water to the top of the cone section. If the excavation has not been backfilled and observation indicates no visible leakage, that is, no water visibly moving down the surface of the manhole, the manhole may be considered to be satisfactorily watertight. If the test, as described above, is unsatisfactory as determined by the Contracting Officer or if the manhole excavation had been backfilled, the test shall be continued. A period of time may be permitted if the Contractor so wishes, to allow for absorption by the manhole. At the end of this period, the manhole shall be refilled to the top of the cone, if necessary, and a measuring time of at least 8 hours begun. At the end of the test period, the manhole shall be refilled to the top of the cone, measuring the volume of water added. This amount shall be extrapolated to a 24-hour loss rate and the leakage determined on the basis of depth. The leakage for each manhole shall not exceed one gallon per vertical foot for a 24-hour period. If the manhole fails this requirement, but the leakage does not exceed 3 gallons per vertical foot per day, repairs by approved methods may be made as directed by the Contracting Officer to bring the leakage within the allowable rate of one gallon per foot per day. Leakage due to a defective section or joint or exceeding the 3-gallon per vertical foot per day shall be cause for rejection of the manhole. It shall be the Contractor’s responsibility to uncover the rejected manhole as necessary and to disassemble,

reconstruct or replace it as directed by the Contracting Officer. The manhole shall then be retested and, if satisfactory, interior joints shall be filled and pointed. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc. It shall be assumed that all loss of water during the test is a result of leaks through joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the Engineer that the water table is below the bottom of the manhole throughout the test.

If the groundwater table is above the highest joint in the manhole, and there is no leakage into the manhole, as determined by the Contracting Officer, such a test can serve to evaluate watertightness of the manhole. However, if the Engineer is not satisfied with the results, the Contractor shall lower the water table and

carry out the test as described hereinbefore.

Cleaning: All new manholes shall be thoroughly cleaned of all silt, debris and foreign matter of any kind, prior to final inspection.

V. *MEASUREMENT AND PAYMENT*

Manholes bases including excavation and disposal, crushed stone bed, backfill reinforced Class A (4,000 p.s.i., 1-1/2", 565) concrete base and/or pre-cast, reinforced concrete base, brick invert and that portion of the manhole wall from the manhole base to the top of the invert shelf shall be considered as one unit and shall be paid for under the appropriately lettered portion of 230.

Manhole walls and cones will be paid for by the vertical foot including excavation and gravel, disposal, under the appropriately lettered portion of Item 231, measured from the bottom of the frame to the highest point of the manhole base, including the installed manhole steps.

GRAVEL BACKFILL SHALL BE FURNISHED BY THE CONTRACTOR AT NO ADDITIONAL COST, AND SHALL BE POWER TAMPED IN 12 INCH LIFTS, JETTED, OR CDF MAY BE USED AS DIRECTED BY THE CONTRACTING OFFICER.

Hauling, handling, and installing of standard cast-iron manhole frames and covers will be paid for under the appropriately lettered portion of Item 236. The stubs and stoppers in the manholes shall be installed and sealed without additional compensation.

Where manholes are installed over existing sewer pipes, the portion of the sewer pipe within the manhole above the installed brick shelf shall be removed by appropriate means so as to conform accurately with the shelf and no additional compensation shall be paid for the removal and disposal of the portion of the pipe above the shelf.

Rock excavation and disposal for manholes shall be measured and paid for under Item 121, Trench Rock Excavation, in addition to the installation price of manhole bases and manhole sections. The limits of payment for trench rock excavation will be those shown on the detail titled “Typical Trench Section in Rock” in this book.

ITEM 233.0000 REMODEL EXISTING MANHOLE

A. *GENERAL*

The work to be done under this item shall include furnishing all labor, materials and equipment required to break into existing manholes, re-shape and re-build existing inverts.

B. *MEASUREMENT AND PAYMENT*

This item shall be paid per each.

ITEM 233.1000 REMODEL EXISTING MANHOLES FOR LOW PRESSURE SEWER FORCE MAIN

INSTALLATION

A. *GENERAL*

This work shall include furnishing all labor, material and equipment required to break in the existing manhole.

It shall also include installation of the inside drop in accordance with Inside Chimney.

B. *MEARUREMENT AND PAYMENT*

The method of payment for this Item is per each complete in place.

The work to be done under Items 235 thru 236 shall include the furnishing, handling and installation to finish grade of Worcester standard castings as specified. This includes removal and disposal of

deficient castings, where these items replacements, at the contractor's expense.

ITEM 235.0000 CATCH BASIN FRAME & GRATE

ITEM 236.0000 MANHOLE FRAME & COVER

A. *INSTALLATION OF CASTING FRAMES*

Casting frames shall be set on a full bed of mortar, set to finish grade and concentric with the masonry. All voids beneath the bottom flange shall be completely filled to make a watertight fit. A ring of mortar at least 1 inch thick shall be placed around the outside of the bottom flange extending to the outer edge of the masonry all around the frame. A minimum 12 inches of red sewer brick, grade MS only, shall be used under casting.

B. *TECHNICAL SPECIFICATIONS*

All construction castings shall meet the requirements of AASHTO M306 and shall be supplied by East Jordan Iron Works, Inc. – LeBaron Foundry or approved Equal. All manufacturers will need their drawings and weights reviewed by Worcester DPW – Engineering to determine if the proposed item is equal.

Catch Basin grate shall be EJIW 7288M or LeBaron L28SG1. Catch basin inlet frame shall be EJIW 7288Z (4-Flange), EJIW 7288Z1 (3-Flange) or LeBaron LF288, Type E.

Manhole frame and cover shall be EJIW 1056Z frame and EJIW 1056A cover or LeBaron LC239/L23C-1. Non-bolted casting manhole covers shall be supplied with a closed pick hole and shall show the wording 'Worcester, A Town June 14, 1722: A City February 29, 1848" cast into said cover. Castings that are supplied bolted and watertight may have alternate lettering.

C. *MEASUREMENT AND PAYMENT*

Catch basin frame and grate or manhole frame and cover shall be paid per each complete in place, and set to finish grade as per instructed by the Contracting Officer.

The work to be done under Item 237 shall include the construction of outside drops for sanitary manholes) Outside drops are to be constructed where shown on the design drawing or as specified by the Contracting Officer. This item shall include all labor, materials, and equipment required to furnish and install all piping, fittings, and masonry.

ITEM 237.0800 8" OUTSIDE MANHOLE DROP

ITEM 237.1000 10" OUTSIDE MANHOLE DROP

ITEM 237.1200 12" OUTSIDE MANHOLE DROP

ITEM 237.1500 15" OUTSIDE MANHOLE DROP

ITEM 237.1800 18" OUTSIDE MANHOLE DROP

A. *MEASUREMENT AND PAYMENT*

The unit price for outside manhole drops shall be per vertical foot complete. Measurement shall be made from the invert at the manhole to the invert at the inlet pipe.

ITEM 239.0000 TYPICAL TERMINAL CLEANOUT MANHOLE

ITEM 239.1000 TYPICAL CLEANOUT MANHOLE

A. *GENERAL*

This work to be done under Item 239 shall include furnishing and installing complete manhole bases and sections including hauling, excavation, placement of structures, backfilling and all labor, equipment and incidentals necessary to complete the work. All pre-cast manhole bases and sections shall conform to ASTM

Specifications C 478. Installation of pre-cast manholes shall be as shown on a plan titled Typical Terminal Cleanout for Pressure sewers and in accordance with Item 230.4 and 231.4.

B. MEASUREMENT AND PAYMENT

Payment of the bid price for each low pressure sewer terminal cleanout manhole shall be full compensation for all clearing, excavation, backfill and compaction required for the installation of the manhole and for furnishing and installing the pre-cast manhole, piping within the manhole to one (1) foot outside of the manhole, fittings, valves, pipe insulation and all labor, equipment and materials required or incidental to the work.

ITEM 240.0000 WORCESTER STANDARD CATCH BASIN (5 FOOT DIAMETER)

A. GENERAL

Catch basins shall be constructed of the materials, size, form thickness and in the manner shown in detail on a plan titled Typical Pre-Cast Catch Basin and shall conform to the applicable provisions of Section 201, (MSSHB).

Pre-cast concrete basins shall consist of pre-cast reinforced riser sections, a flat slab top and top ring, and a base section conforming to the typical catch basin details.

Pre-cast catch basin sections shall be manufactured in accordance with ASTM Designation C478. The minimum compressive strength of the concrete for all sections shall be 4,000 PSI on a 28 Day Test. The circumferential steel reinforcement for riser sections and base walls shall be 0.15 square inch per lineal foot. Reinforcing in the bottoms of bases shall be of the same design. Reinforcing in top slabs to be as given on the standard catch basin detail. Reinforcing shall extend into the tongue and groove of each catch basin section wall.

Each section of the pre-cast manhole shall have two holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with hydraulic cement after installation.

Type II cement to be used. Sections shall be set so as to be vertical and in true alignment. Joints shall be completely mortared by buttering the groove and immediately prior to setting a section, or approved alternative sealant, assuring a watertight sump.

Catch basin connection to the catch basin shall be made prior to constructing the catch basin above the invert grade of the trap.

Red sewer brick shall be used in the catch basins. Limits of Class B rock excavation will be six (6) inches below and twelve (12) inches outside the base.

GRAVEL BACKFILL SHALL BE FURNISHED BY THE CONTRACTOR AT NO ADDITIONAL COST, AND SHALL BE POWER TAMPED IN TWELVE (12) INCH LIFTS, JETTED OR CDF MAY BE USED AS DIRECTED BY THE CONTRACTING OFFICER.

All excavated material, except as directed by the Contracting Officer, shall be removed from the site 3/4" crushed stone foundation six (6) inches in depth is required under the pre-cast base at no additional cost.

Traps, frames, grates and inlets shall be furnished and installed as specified under their respective items. A minimum of 12 inches of red sewer brick shall be used under the frame. The grates shall fit so as to prevent rocking or unnecessary space at the joints.

B. MEASUREMENT AND PAYMENT

Pay item 240 shall be catch basins (each) complete in place. The cost for Class B rock, frames and grates, inlet stones, and green traps will be paid under Items 120, 235, 245 and 246.

ITEM 241.0000 CATCH BASIN ALTERNATE TYPE

ITEM 241.1000 DROP INLET

A. GENERAL

The work to be done under Item 241 shall conform to the details shown on a plan titled Catch Basin Alternate Type and shall conform to the applicable provisions of Section 220, (MSSHB).

The work to be done under Item 241.1 shall conform to the detail shown on a plan titled Drop Inlet Detail and shall conform to the applicable provisions of Section 220, (MSSHB). The cost for frames and grates and inlet stones, will be paid under Items 235 and 245.

B. MEASUREMENT AND PAYMENT

Pay item 241 shall be catch basin (each) and catch basin inlet box (including drop inlet if used), complete in place. The cost for Class B rock, frames and grates, frames and covers, inlet stones, and green traps will be paid under Items 120, 235, 236, 245 and 246.

Pay item 241.1 shall be drop inlet, connection piping, and catch basin alteration complete in place. The cost, frames and grates, frames and covers, inlet stones, and green traps will be paid those appropriate items.

The work to be done under Items 242 and 243 shall conform to the applicable provisions of Section 220, (MSSHB) and shall consist of the removal and rebuilding of existing brick work in the basin walls to line and grade to receive the Worcester standard frame, grate, and inlet stone. The existing trap shall be removed (if not a green trap) and a new green trap shall be installed. The Contractor will be required to return the old grates, frames, and traps to the Department of Public Works and Parks at 1065 Millbury Street Yard, unless otherwise directed by the Contracting Officer. All excavation, gravel backfill, replacing Superpave Bituminous Concrete, or cutting of existing granite curb required shall be included at no additional cost to the City.

ITEM 242.0000 CATCH BASIN REBUILD "D" FRAME TO SQUARE FRAME

ITEM 243.0000 CATCH BASIN REBUILD BORDERSTONE TO SQUARE FRAME

A. MEASUREMENT AND PAYMENT

Payment for this item will be paid for under the contract unit price (each). Frame and grate, green trap and inlet stone shall be furnished and installed under Items 235, 245, 246, complete in place.

ITEM 244.0000 REBUILD EXISTING CATCH BASINS TO ALTERNATE TYPE

A. GENERAL

The work under this item shall include the removal of the catch basin frame and grate and top ring, to a depth sufficient to accommodate the new 6" manhole top ring. The work to be done under this item shall conform to the detail, Catch Basin Alternate Type (ITEM 241), and shall conform to the applicable provisions of Section 220, (MSSHB).

B. MEASUREMENT AND PAYMENT

Pay item 244 shall be paid for per each installed complete in place. The cost for frames and grates removal and replacement, frames and covers, and inlet stone removal and replacement will be paid under Items 254.1, 236, and 245.1. The trap shall be inspected as part of this work and be replaced as directed by the Contracting Officer.

ITEM 244.1000 REBUILD EXISTING CATCH BASINS

A. GENERAL

A Catch Basin that has been damaged to the point that it will not properly support the frame and grate (This is usually found in older brick Catch Basins), will be reconstructed. The unsuitable portions of the structure shall be removed, as directed by the Contracting Officer, and rebuilt with brick. The work to be done under this item shall conform to the applicable provisions of Section 220, (MSSHB).

B. MEASUREMENT AND PAYMENT

Pay item 244.1 shall be paid for per vertical foot installed, complete in place. The cost for frames and grates removal and replacement and inlet stone removal and replacement will be paid under Items 254.1 and 245.1. The trap shall be inspected as part of this work and be replaced as directed by the Contracting Officer.

ITEM 244.2000 REMOVE AND DISPOSE OF EXISTING CATCH BASIN

A. GENERAL

The Contractor shall furnish all additional labor, materials and equipment required to remove and dispose of existing manholes as directed by the Contracting Officer. The work to be done under this item shall conform to the applicable provisions of Section 140, (MSSHB).

B. MEASUREMENT AND PAYMENT

The unit bid price per each shall be full compensation for all work required including salvage and delivery to the City's Department of Public Works and Parks – 1065 Millbury Street Yard of any castings as directed by the Contracting Officer.

ITEM 245.0000 GRANITE INLET STONE

ITEM 245.1000 EXISTING GRANITE INLET STONE REMOVE & RESET

A. GENERAL

The work done under these items shall include furnishing, handling and installing Worcester standard granite inlet stone for catch basins. Granite inlet stone shall be as supplied by H.E. Fletcher Company of Westford, MA, or approved equal. New or existing inlet stones are to be set level with berms or curbs and pitched to follow roadway profile. Installation of inlet stones shall be as shown on the detail titled "Typical Inlet Stone for Catch Basin".

B. MEASUREMENT AND PAYMENT

The unit of payment for granite inlet stones will be per each installed complete in place.

ITEM 246.0000 8" GREEN TRAPS

ITEM 247.0000 12" GREEN TRAPS

A. GENERAL

The work to be done under this item shall include furnishing, handling and installing Worcester standard green traps in catch basins. Green traps shall be as supplied by Tolman Manufacturing Company of Boston, MA., or approved equal. Green traps are to be installed as shown on a plan titled Body and Collar for 8" Trap.

B. MEASUREMENT AND PAYMENT

The unit of payment for green traps will be per each installed complete in place.

ITEM 249.0000 CATCH BASIN CLEANING

A. GENERAL

The work specified in this item shall include furnishing equipment and labor necessary to clean Worcester standard catch basins and the jetting of the catch basin connection. Catch basins are to be cleaned as thoroughly as possible and to the bottom of each catch basin by means of a truck mounted vacuum catch basin cleaner which uses a high-velocity pressure jet for removing sludge and debris from drainage lines, and simultaneously vacuum the sludge and debris from the catch basin or manhole. Said machine must be approved by the Contracting Officer. Care shall be taken not to damage any portions of the basin particularly that of the headstone, pre-cast structure, brick work or green trap. Any damage to the catch basin or immediate area of roadway or sidewalk shall be restored to its original condition by the Contractor at no expense to the City of Worcester. Non-conforming traps are to be replaced with City standard traps. Any broken connections are to be replaced with City standard pipe. Waste contents from the catch basin will become the property of the Contractor.

Catch Basin cleaning, when part of roadway resurfacing, shall be conducted once the street has been paved to the binder course and prior to placement of the top course.

B. MEASUREMENT AND PAYMENT

The unit payment for catch basin cleaning will be per each complete in place.

ITEM 250.0000 MANHOLE FRAMES, REMOVE, PLATE & RETAIN

A. GENERAL

Under Item 250 the Contractor will remove and plate manhole frames where designated by the Contracting Officer. Each manhole frame shall be removed by the Contractor and retained so that each is stored in a manner as to prevent either theft or breakage. Also, it will be the Contractor's responsibility to remove the grade ring or the first 6 inches of sewer brick (whichever is applicable) so that a minimum of 14 inches clearance exists for pulverizing equipment to pass over said structure. It will also be the Contractor's responsibility to supply a plate that covers the structure completely and which is also strong enough to support construction equipment and to preserve its location for use after the SUPERPAVE base has been laid. Any debris

found in the invert will be assumed to be caused by the Contractor and all liabilities including that of cleanup of such debris will be considered a subsidiary obligation of the Contractor. Also it will be the Contractor's responsibility to preserve the manhole frame and grade ring so that it may be reset as indicated under Items 252.1, 252.2, 253.1 & 253.2. Any broken manholes or grade rings caused by the Contractor shall be replaced by same. All excavated areas shall be suitably backfilled by approved compaction methods and the work site shall be left in a neat and clean state.

B. *MEASUREMENT AND PAYMENT*

The pay item for this work shall be Manhole Frames - Removed, Plated and Retained, paid per each complete in place.

ITEM 252.1000 MANHOLE ADJUSTMENT 12" OR LESS GRAVEL

ITEM 252.2000 MANHOLE ADJUSTMENT 12" OR LESS RIGID

ITEM 253.1000 MANHOLE ADJUSTMENT OVER 12" GRAVEL

ITEM 253.2000 MANHOLE ADJUSTMENT OVER 12" RIGID

A. *GENERAL*

Work to be done under these items shall consist of the adjustment of structures to line and grade and will be paid for under contract unit price for manhole adjustment (12" or less vertical) or (over 12" vertical). Work shall conform to the applicable provisions of Section 220.

When the line or grade of the structure requires change, the Contractor will excavate around manhole structures a minimum 6-foot diameter donut (allowing a minimum width of 20 inches, from the casting. Compaction shall be completed using a compactor weighing a minimum of 250 pounds) to a depth of 8 inches, the masonry shall be removed to such depth as directed by the Contracting Officer and new masonry shall be constructed to conform to the proposed design**.** Material from this excavation will be satisfactorily disposed of by the Contractor. The excavated area will then be filled with SUPERPAVE 12.5 mm Level 2 bituminous concrete binder course placed in two lifts and thoroughly compacted with a plate compactor. Payment for this work shall be covered under the contract price bid for Item 424

Adjusted structures will have ramped protection (i.e. asphalt "doughnuts") if the street is not paved within 10 days from the date of adjustment. This work will be conducted at no cost to the City.

Contractor shall be responsible for ensuring all catch basins cleaned as part of the work remain free of construction related debris from the time of cleaning through paving of the top course of asphalt. If any catch basins require additional cleaning due to the accumulation of construction related debris within the catch basin, the Contractor shall perform an additional cleaning at no additional cost to the City.

B. *MORTAR MIX*

Conproco mortar mix will be used when adjusting manholes. It shall conform to or exceed ASTM C-270 and C-387 specifications. The mortar mix can be supplied by Camosse Masonry Supply of Worcester, MA (or approved equal).

C. *KIND OF BRICK*

(See Items 230-232, Q. KIND OF BRICK)

D. *MANHOLE SAFETY RAMPS*

The Contractor shall utilize manhole safety ramps as manufactured by American Highway Products (www.ahp1.com) or approved equal at no additional compensation. Said safety ramps must fit snuggly around manhole frame and at the appropriate elevation. Safety ramps shall be removed just prior to the placement of the final surface layer and removed subsequently from the job site.

E. *MEASUREMENT AND PAYMENT*

There shall be no additional payment for the handling of pre-cast sections during adjustment of manhole.

The respective item bid shall constitute full payment for the removal, protecting and installing of any castings to be adjusted on the project; the removal of old masonry and the construction of new masonry, all materials,

equipment, safety ramps, tools and labor and all other incidental work including excavation, gravel backfilling necessary for the final completion of the item specified. The adjustment for frames for structures built by the Contractor shall be considered a subsidiary obligation of the Contractor and the contract unit price bid for the installation of the structure shall include the cost of adjusting the frames to line and grade. 95% compaction must be achieved around all manholes by mechanical or vibratory equipment.

Payment for the SUPERPAVE bituminous concrete will be paid under Item 424 Various Areas (.8 ton per manhole).

The work to be done under Items 254 thru 255 shall consist of the adjustment of structures to line and grade and will be paid for under contract unit price for catch basin adjustment (12" or less vertical) or (over 12" vertical). Work shall conform to applicable provisions of Section 201, 220.

ITEM 254.1000 CATCH BASIN ADJUST TO LINE AND/OR GRADE 12" OR LESS, GRAVEL

ITEM 254.2000 CATCH BASIN ADJUST TO LINE AND/OR GRADE 12" OR LESS, RIGID

ITEM 255.1000 CATCH BASIN ADJUST TO LINE AND/OR GRADE 12" OR OVER, GRAVEL

ITEM 255.2000 CATCH BASIN ADJUST TO LINE AND/OR GRADE 12" OR OVER, RIGID

A. *GENERAL*

When the line or grade of the structure requires change, the Contractor will excavate around catch basins a minimum of 18" wide to a depth of 8 inches, the masonry shall be removed to such a depth as directed by the Contracting Officer and new masonry shall be constructed to conform to the proposed design. Material from this excavation will be satisfactorily disposed of by the Contractor. The excavated area will then be filled with SUPERPAVE 12.5 mm Level 2 bituminous concrete binder course placed in two lifts and thoroughly compacted with a plate compactor. Payment for this work shall be covered under the contract price bid for Item 424. There shall be no additional payment for the handling of pre-cast sections during adjustment of catch basins.

Adjusted structures will have ramped protection (i.e. asphalt "doughnuts") if the street is not paved within 10 days from the date of adjustment. This work will be conducted at no cost to the City.

B. *MORTAR MIX*

Conproco mortar mix will be used when adjusting manholes. It shall conform to or exceed ASTM C-270 and C-387 specifications. The mortar mix can be supplied by Camosse Masonry Supply of Worcester, MA (or approved equal).

C. *KIND OF BRICK*

Use ASTM Grade MS only.

D. *MEASUREMENT AND PAYMENT*

The unit price shall constitute full payment for the removal, protecting and installing of any castings to be adjusted on the project; the removal of old masonry and the construction of new masonry, all materials, equipment, concrete tools and labor and all other incidental work including excavation and gravel backfilling necessary for the final completion of the item specified. The adjustment for catch basin frames for structures built by the Contractor shall be considered a subsidiary obligation of the Contractor and the contract unit price bid for the installation of the structures shall include the cost of adjusting the frames. 95% compaction must be achieved around all catch basins by mechanical or vibratory equipment.

Payment for the SUPERPAVE bituminous concrete will be paid under Item 424 Various Areas (1 ton per catch basin).

ITEM 256.0000 GREASE TRAP / INTERCEPTOR

A. *GENERAL*

Contractors for any project requiring grease traps / interceptors should design and construction traps by size, type, and location in accordance with the grease trap manufacturer and Massachusetts Plumbing Code. These requirements are applicable to all commercial food service establishments, including those that are undergoing:

New Construction

Interior remodeling to accommodate expansion or operational modifications Changes of ownership/occupancy

Facilities which may be having trouble in achieving compliance with maintenance and/or wastewater discharge limitations.

Waste discharge in establishments from fixtures and equipment which contain grease, including but not limited to, scullery sinks, pot and pan sinks, dishwashers, soup kettles, and floor drains located in areas where grease-containing materials exist, shall be permitted to be drained into the sanitary waste through the grease trap.

B. *CONSTRUCTION / INSTLATION*

Grease trap/grease interceptor shall be so installed and connected that it shall be at all times easily accessible for inspection, cleaning, and removal of the intercepted grease. All permitting, construction, design and inspection activities must be completed in accordance with the manufacturer's instructions, and the Massachusetts Plumbing Code, Additionally, the following specifications must be incorporated into grease trap design.

The grease trap/grease interceptor shall be constructed with a minimum of two baffles.

Grease traps/grease interceptors are to be installed at a minimum distance of 10 ft. from sinks and dishwashers to allow for adequate cooling of the wastewater. Water temperatures must be less than 120 degrees prior to entering grease trap.

All grease bearing waste streams should be routed through an appropriate grease traps/grease interceptor, including: three-compartment sinks, pot/pan sinks, soup kettles, hand-washing sinks, dishwashers, mop sinks and floor drains. Notable Exceptions: Drains that receive "clear waste" only, such as from ice machines, condensate from coils and drink stations, may be plumbed to the sanitary system without passing through the grease trap.

All exterior or recessed grease traps/grease interceptors are to be installed with an Effluent Sampling Well.

C. *CUSTOMER (GENERATOR) RESPONSIBILITIES*

It is the responsibility of the customer (waste generator) to ensure compliance with the Massachusetts discharge limitations specified in Massachusetts Plumbing code.

Hazardous wastes, such as acids, strong cleaners, pesticides, herbicides, paint, solvents, or gasoline should not be disposed of where they would go through grease traps, interceptors or separators. If commercial dishwashers are discharged through a grease trap, care must be taken in system design. Dishwashers use detergents and elevated water temperatures that will melt grease. If the grease trap is either too small or

too close to the commercial dishwasher, grease may pass through the grease trap and into the collection system.

Generators are responsible for maintaining grease traps, interceptors and separators in continuous proper working condition. Further, generators are responsible for inspecting, repairing, replacing, or installing apparatus and equipment as necessary to ensure proper operation and function of grease traps, interceptors and separators, and compliance with discharge limitations at all times.

Enzymes, solvents, and emulsifiers are not permitted as they will only change the form of grease, allowing it to be carried out of the grease trap with the wastewater and deposited in the collection system.

D. *GREASE INTERCEPTORS OR TRAPS INSTALLED OUTSIDE OF THE BUILDINGS*

General Requirements: When authorities or agencies require the installation of an outside grease interceptor/trap, the entire installation within the property line shall comply Massachusetts Plumbing code. Where required, the design of said systems shall be specified by the authority or agency requiring the installation, however, said requirements shall not be deemed to supersede the requirements of 248 CMR Massachusetts Plumbing code.

This installation shall require a chamber vent which shall:

i. be piped to the inside of the building in compliance with 248 CMR 10.16; and

ii. shall be not less than four-inch minimum pipe diameter.

iii. The chamber vent may connect into the buildings sanitary venting system.

ITEM 258.0000 TREE BOX FILTER TREATMENT DEVICE

A. *GENERAL*

The treatment device shall be a precast 4'x 6' Filterra Unit Curb Inlet Configuration by Filterra Bioretention Systems or approved equal. Each unit shall consist of a precast concrete container together with an under drain system, filter media, grate, and appropriate landscape cover where applicable.

B. *CONSTRUCTION / INSTALLATION*

The treatment device shall be installed in accordance with the manufacturer's printed recommendations, as shown on the DETAILS on file at the City of Worcester

i. The MANUFACTURER shall deliver the prefabricated unit to the project site. The unit shall remain on the bed of the delivery truck until lifted and set by CONTRACTOR.

ii. The CONTRACTOR shall dig a trench to design subgrade, lay and compact base material. Base material shall be 6" of class 2 aggregate base compacted to 95% relative compaction.

iii. The CONTRACTOR shall lift the unit and place in the trench so that the inlet and outlet connections meet the alignment as shown on the DRAWINGS.

iv. Once the unit is set, the CONTRACTOR shall backfill in a careful manner, bringing the appropriate fill material up in 5" lifts on all sides. In all instances, installation of unit shall conform to ASTM Specification C891 "Standard Practice for Installation of Underground Precast Utility Structures".

v. The MANUFACTURER shall activate the unit including installation of tree(s) and mulch layers once installation of the unit is complete. Tree species are to be selected by the CONTRACTING OFFICER.

Connections to the unit and storm drain catch basins shall be made by installing pipe sections into the structure wall using non-shrink grout as specified herein. A water stop shall also be installed on all plastic pipes.

i. Non-shrink grout shall be Class A non-shrinking grouts shall have a minimum 28-day compressive strength of 5000 psi; shall have no shrinkage (zero percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C 827; and shall have no shrinkage (zero percent) and a maximum of 0.2-percent expansion in the hardened state when tested in accordance with CRD C 621.

C. MAINTAINANCE

The MANUFACTURER shall maintain the treatment unit for a minimum period of one year. The cost of this service is to be included in the price of the system.

Annual maintenance consists of a maximum of one scheduled visit.

Each maintenance visit consists of the following:

i. System Inspection
ii. Foreign Debris, silt, plant material and trash removal.
iii. Filter media evaluation.
iv. Plant health evaluation and pruning.
v. Replacement of tree if necessary.
vi. Disposal of all maintenance refuse items.
vii. Maintenance records updated and stored.

D. *MEASURMENT AND PAYMENT*

Payment for the unit shall be per unit and include all aspects of delivery, excavation, placement and appurtenances necessary to complete installation including pipe work and drainage connections.

ITEM 258.0100 TREEBOX FILTER GRATE SPECIFICATION

A. GENERAL

Tree box filter grates shall be 36" X 36" square, two-piece items, and include a perforated cover. A 16" diameter circular cutout shall be included in the center when the two pieces are together. The grate shall match EJ product number 00895321C01 or equal and be ASTM A48 and ADA certified. All manufacturers will need their drawings reviewed by Worcester DPW – Engineering to determine if the proposed item is equal.

ITEM 258.0200 TREEBOX FILTER CLEANING AND INSPECTION

A. GENERAL

The Contractor shall remove all materials from inside the existing tree boxes and coordinate with City of Worcester inspectors to ensure that all parts of the tree box are clean and functional.

B. REMOVAL OF CONTENTS

The Contractor shall remove all material contents of the tree box filters, including but not limited to the mulch layer, the filter media, the stone underdrain layer, the tree, and the root ball. Care shall be taken to ensure that functional portions of the filter (perforated underdrain, inlet, etc.) are not damaged by the removal of the materials.

C. TRANSPORT/DISPOSAL OF CONTENTS

All materials removed from the tree box filter shall be transported to a location of the City's choosing (within City limits). Materials shall be stored in two piles/locations, one pile/location for the tree and root ball, and one pile/location for all other materials (stone, media, mulch, etc.). The City shall be responsible for disposal of all materials.

D. INSPECTION OF STRUCTURAL UNITS

The Contractor shall coordinate with the City of Worcester DPW&P inspector to confirm the structural integrity of the unit. The Contractor shall be responsible for hydraulically flushing the perforated underdrain system to confirm function and cleanliness. The inspector may request additional hydraulic cleaning of the unit to confirm integrity of the walls and inlet. Tree box filter grates shall be 36" X 36" square, two-piece items, and include a perforated cover. A 16" diameter circular cutout shall be included in the center when the two pieces are together. The grate shall match EJ product number 00895321C01 or equal and be ASTM A48 and ADA certified. All manufacturers will need their drawings reviewed by Worcester DPW – Engineering to determine if the proposed item is equal.

ITEM 258.0300 BIO-UPTAKE TREE REPLACEMENT

A. GENERAL

The Contractor shall provide all containerized trees, all necessary hardware, materials, labor, tools, and equipment required to properly complete the work.

B. METHOD OF PLANTING

All trees shall be transported, moved, and installed with the fibrous root system as a solid mass of earth.

The diameter and depth of the earth mass must be sufficient to encompass the fibrous and feeding root systems necessary for the healthy development of the new trees, but not larger than the treebox unit. All standard treebox units are to have the following minimum dimensions: 4' x 6' internal treebox area with a height of 3' 6" from the invert to the top of the grate. The Contractor shall conduct due diligence of nonstandard treebox units. If not previously done, the entire treebox shall be excavated to a depth of 2' 6" over the entire 4' by 6' area for tree planting. The unit shall then be filled with approved treebox filter media (*ITEM 258.04 BIORETENTION FILTER MEDIA*). The filter media will be paid for at contract price.

The Contractor shall provide at least one (1) person who shall be present at all times during the execution of the work and who shall be thoroughly familiar and knowledgeable with the type of trees being handled in reference to the best methods for the proper delivery, handling, and installation.

C. PLANT MATERIALS

Tree type shall be Yoshino Cherry (pink or white), shall be nursery grown, containerized (not to be ball and burlapped) in a container not to exceed 15 gallons, and have a caliper of 0.5-1.0 inches (measured 6 inches above the soil line).

D. GUARANTEE PERIOD

At the end of the establishment period of 120 days, formal written acceptance from the City Director of Sewer Operations stating that tree plantings and their care and maintenance has been completed by the Contractor in all respects and in accordance with the tree specification shall be required.

After the establishment period, the Contractor shall guarantee that all trees shall be in good health and flourishing condition two (2) years from date of acceptance.

The Contractor shall note that the guarantee period of two (2) years begins at the end of the establishment period after acceptance from the City Director of Sewer Operations.

E. SPECIAL CONDITIONS

All newly planted trees shall be watered in by the Contractor within twenty-four (24) hours after planting.

During the establishment period of 120 days, the Contractor shall be required to water trees adequately. An adequate supply of water is estimated to be the equivalent of one (1) inch of water per week, delivered at weekly intervals in the form of natural rain or augmented as required by the Contractor.

F. MEASUREMENT AND PAYMENT

The work under *ITEM 258.03 BIO-UPTAKE TREE REPLACEMENT* will be paid per each installed, complete in place.

ITEM 258.0400 BIORETENTION FILTER MEDIA

A MATERIALS

Internal components including engineered biofiltration media, underdrain stone, PVC underdrain piping, and mulch must be included as part of the bioretention system. Note that vegetation is an essential component of bioretention systems and shall be provided at the time of Activation by the Contractor.

Engineered biofiltration media shall consist of both organic and inorganic components. Stormwater shall be directed to flow vertically though the media profile, saturating the full media profile without downstream flow control.

Underdrain stone shall be of the size and shape to provide adequate bridging between the media and stone for the prevention of migration of fine particles. Underdrain stone must also be able to convey the design flow rate of the system without restriction (see Part B for design flow rate).

Mulch shall be double shredded wood or bark mulch and shall be installed in accordance with *ITEM 110 PINE BARK MULCH* of the 2024 Standard Specifications.

Vegetation shall comply with the type and size specified by the City and shall be alive and free of obvious signs of disease. Vegetation shall conform to *ITEM 258.03 BIO-UPTAKE TREE REPLACEMENT*. Vegetation shall be supplied by Contractor prior to Activation (See Part D).

B. PERFORMANCE

Treatment capabilities of the engineered biofiltration media shall be verified via third-party report following either TAPE or TARP protocols.

Engineered biofiltration media minimum treatment flow rate shall be 140” per hour. The system shall be designed to ensure that high flow events shall bypass the engineered biofiltration media preventing erosion and resuspension of pollutants.

The system shall remove a minimum of 85% Total Suspended Solids (TSS).

The system shall remove a minimum of 62% Total Phosphorus (TP).

The system shall remove a minimum of 34% Total Nitrogen (TN).

C. QUALITY ASSURANCE

Quality assurance and quality control procedures shall be followed for all batches of engineered biofiltration

media produced. Engineered biofiltration media shall be certified by the Manufacturer for performance and composition.

Media particle size distribution and composition shall be verified as per relevant ASTM standards.

Media pollutant removal performance shall be verified as per relevant ASTM standards as well as a minimum of one scientific method approved by USEPA.

Media hydraulic performance shall be verified as per relevant ASTM standards.

Media fertility shall be verified as per a minimum of one published scientific method.

D. ACTIVATION

The treebox filter system shall not be placed in operation (activated) until the project site is clean and stabilized (construction erosion control measures are no longer required) in accordance with ITEM 160 CLEANING UP of the 2024 Standard Specifications. Activation shall be provided by Manufacturer of authorized supplier and includes planting of the vegetation by the Contractor

ITEM 260.0600 6" SUBDRAIN COMPLETE

ITEM 260.0800 8" SUBDRAIN COMPLETE

A. *GENERAL*

This work shall consist of constructing sub-drains using fabric wrapped pipe, crushed stone, and filter fabric material, in accordance with the plans and these specifications and in close conformity with the lines and grades shown on the plans or established by the Contracting Officer. The drain trench shall be excavated to the depth designated on the plans, or, if directed, to a stratum of impervious material.

Where no structure is to be placed at the ends of the sub-drain pipe, the trench shall be excavated a distance of three feet beyond the end of the pipe. The excavation shall proceed in advance of the actual drain construction only to the extent the Contracting Officer directs. The width of the trench for pipe of more than 12 inches in diameter shall be 1 foot greater than the nominal diameter of the pipe. The width of the trench for pipe 12 inches or less in diameter shall be 2 feet. Filter fabric shall be continuously placed around the perimeter of the crushed stone envelope.

Where rock is encountered in the excavation, no part of any rock remaining in the trench shall come within 6 inches of any portion of the pipe.

The pipe shall be laid in accordance with a plan titled Typical Sub-Drain Detail. Pipes used shall be round, perforated PVC pipe, or equal.

Inlets and open outlets of sub-drains shall be covered with a #23 gauge galvanized wire screen of 1/4-inch mesh satisfactorily fastened to the pipe.

Sub-drain pipe shall be measured in place and the quantity to be paid for shall be the length of pipe actually constructed, plus an allowance of three (3) feet for open ends.

The sub-drain is to be connected into an existing catch basin above the trap. The connection is to be made by breaking into the catch basin, inserting the PVC into the hole, and mortaring the pipe into the catch basin.

B. *MEASUREMENT AND PAYMENT*

The above work will be paid for at the contract unit price per linear foot under the appropriate item for sub-drains with the specified size and kind of pipe, complete in place.

ITEM 261.0000 REPAIR, REPLACE OR RELOCATE EXISTING DRAINS

A. *GENERAL*

The work to be done under this item shall conform to the applicable provision of Section 230, (MSSHB). Payment for repairing or replacing existing drains will be made only when authorized by the Contracting Officer.

No payment to the Contractor will be made for repairs due to damage caused by his men or machines.

Drains that do not have sufficient cover (4' minimum) when the final grade is determined shall be lowered and if necessary relocated as directed by the Contracting Officer.

B. *MEASUREMENT AND PAYMENT*

Payment under this item shall be complete in place by the linear foot, including supplying of all pipe, fittings and materials, including gravel backfill and labor, also handling of water and/or raw sewage.

ITEM 265.0000 REMOVE AND DISPOSE OF EXISTING MANHOLE

A. *GENERAL*

The Contractor shall furnish all additional labor, materials and equipment required to remove and dispose of existing manholes as directed by the Contracting Officer. The work to be done under this item shall conform to the applicable provisions of Section 140, (MSSHB).

B. *MEASUREMENT AND PAYMENT*

The unit bid price per each shall be full compensation for all work required including salvage and delivery to the City's Department of Public Works and Parks – 1065 Millbury Street Yard of any castings as directed by the Contracting Officer.

ITEM 270.0000 RODENT CONTROL

A. *GENERAL*

This section specifies requirements for rodent control activities by the Contractor at all work and laydown (or staging) areas in connection with this Contract.

The Contractor shall retain the services of a licensed rodent exterminator to conduct an inspection of the work and laydown areas and report on the presence of rodents and take any necessary measures to eliminate existing rodent populations prior to start of work.

The Contractor shall begin rodent elimination methods at a minimum of one (1) week in advance of normal construction operations in each area. Rodent elimination methods shall consist of as many treatments as deemed necessary to control the rodents, as deemed necessary by the Engineer and City of Worcester Division of Public Health.

B. *SUBMITTALS*

Incidental to this item, within ten days after Notice to Proceed, submit to the Engineer and City of Worcester Division of Public Health a written description of rodent control measures to be used and the areas to be included in the program and a complete plan showing the locations of the rodent control measures for approval.

Provide the name and background of the licensed rodent exterminator retained to provide any necessary rodent eradication measures prior to start of work.

C. *PRODUCTS*

CONTAINERS:

Use metal or heavy-duty plastic refuse containers with tight-fitting lids for disposal of all garbage, or trash associated with food. These containers shall not have openings that allow access by rodents. Rodents containers for above and below grade applications shall allow rodents entrance but pets and children cannot access.

D. *EXECUTION*

1. WORK AND LAYDOWN AREAS WITHIN THE CONTRACT AREA:

A minimum of one week in advance of normal construction operations, rodent control boxes shall be placed within the project area. Rodent control boxes shall be placed above ground with a spacing of approximately 250 feet, as well as below ground with a spacing of approximately 250 feet. Above ground locations shall

be visible to the public whenever possible. Rodent control box placements shall extend one block radius outside of construction limits.

Before mobilization begins, obtain written verification from the rodent exterminator that rodent populations have been effectively controlled in areas to be occupied and provide to Engineer.

Before excavation, or construction, inspect work and laydown areas and remove all trash, debris, and weeds.

Maintain work and laydown areas free of trash, garbage, weeds, and debris. Provide and enforce proper use of refuse containers to ensure that rodents and other pests are not harbored or attracted.

Designate specific locations as lunch and coffee break areas to prevent random disposal of garbage and trash. Keep those areas free of litter and garbage, and provide refuse containers as described in C, PRODUCTS of this

section. Keep refuse containers upright with their lids shut tight.

Have all refuse containers emptied daily to maintain site sanitation.

Notify the Engineer within 24 hours whenever rodents (rats or mice) or signs of rodent activity (burrows or droppings) are observed in work or laydown areas. Take appropriate action to locate and control the rodents.

2. LAYDOWN AREAS OUTSIDE THE CONTRACT AREA:

A minimum of one week in advance of normal construction operations, rodent control boxes shall be placed within a one block radius outside of the area in all directions. Rodent control boxes shall be placed above ground with a spacing of approximately 250 feet, as well as below ground with a spacing of approximately 250 feet. Above ground locations shall be visible to the public whenever possible.

Implement pest control at all laydown areas that are not areas of this Contract, but that are used by the Contractor in connection with this Contract. Undertake rodent control at least one week prior to use of the area and with time to ensure that the site is free of rodent populations (rats and mice) prior to site occupancy. Maintain the site free of rodents throughout the duration of its use.

Clear laydown areas of trash, debris, and weeds prior to occupancy. Initiate those actions only after rodent populations have been effectively controlled.

Maintain laydown areas free of trash, garbage, weeds, and debris. Provide and enforce proper use of refuse containers to ensure that rodents and other pests are not harbored or attracted.

Dispose of all garbage or trash associated with food in refuse containers with tight-fitting lids as described in C, PRODUCTS of this Section. Have refuse containers emptied daily to maintain site sanitation.

E. *MEASUREMENT AND PAYMENT*

Rodent control within the project area shall be measured via lump sum and shall be paid at the contract unit price under the provisions of Item 270 Rodent Control, as listed under this Section. Payment shall constitute full compensation for hiring a licensed rodent exterminator, inspections, furnishing materials and labor for rodent elimination methods, and all work incidental thereto and not specifically included for payment under other items.

SECTION 300 – WATER

ITEM 301.0100 1" POLYETHYLENE TUBING

ITEM 301.0150 1" COPPER TUBING

ITEM 301.0200 2" COPPER TUBING

ITEM 301.0400 4" ZINC COATED CLDI PIPE

ITEM 301.0600 6" ZINC COATED CLDI PIPE

ITEM 301.0800 8" ZINC COATED CLDI PIPE

ITEM 301.1000 10" ZINC COATED CLDI PIPE

ITEM 301.1200 12" ZINC COATED CLDI PIPE

ITEM 301.1400 14" ZINC COATED CLDI PIPE

ITEM 301.1600 16" ZINC COATED CLDI PIPE

ITEM 301.1800 18" ZINC COATED CLDI PIPE

ITEM 301.2000 20" ZINC COATED CLDI PIPE

ITEM 301.2400 24" ZINC COATED CLDI PIPE

ITEM 301.3000 30" ZINC COATED CLDI PIPE

ITEM 301.3600 36" ZINC COATED CLDI PIPE

ITEM 301.4200 42" ZINC COATED CLDI PIPE

ITEM 301.4800 48" ZINC COATED CLDI PIPE

ITEM 301.5000 POLYETHYLENE WRAP FOR DI PIPE

A. *SCOPE OF WORK*

The work under this section shall consist of furnishing and installing new water pipe of various sizes, complete with gaskets, accessories, appurtenances, coatings for installing or making alterations in existing water main systems. The work shall also include excavating, backfilling, chlorinating, testing for leakage and other steps as may be necessary for the construction of new sections of existing water main systems as specified herein, as shown on the plans, or as directed by the Contracting Officer.

B. *MATERIALS*

Ductile Iron Pipe:

1. Ductile Iron Pipe shall be zinc coated, cement lined; coal tar enamel double coated and shall conform to the latest revisions of the following ANSI / AWWA Standards as follows:

a. **Pipe:** ANSI / AWWA C151/A21.51

b. **Cement Lining:** ANSI / AWWA C104/A21.4

c. **Push-On** (Tyton Joint by McWane or Fast-Tite by American) **and Mechanical Joints:** ANSI / AWWA C111/A21.11

d. **Flanges:** ANSI / AWWA C115/A21.15

2. Thickness design of the ductile iron pipe as described herein shall be in accordance with the latest revisions of ANSI/AWWA C150/A21.50. The design shall be based on a minimum internal hydrostatic pressure (rated working water pressure) of 150 psi and a transient or surge pressure allowance of 100 psi. The design shall incorporate a 2 to 1 factor of safety based on the sum of the working pressure plus surge pressure.

3. Ductile Iron Pipe shall be Class 52 for sizes three (3) inch and greater and Class 53 for all sizes of flanged pipe with threaded flanges.

4. The exterior of the ductile iron pipe shall be coated with a layer of arc-sprayed zinc per ISO 8179. The mass of zinc applied shall be 200g/m^2 of pipe surface area. The finishing asphaltic topcoat layer shall be applied to the zinc. The mean dry film thickness of the finishing layer shall not be less than 3 mils with a local minimum not less than 2 mils. The zinc coating system shall conform to ISO 8179-1 "Ductile iron pipes – External zinc-based coating – Part 1: Metallic zinc with finishing layer; Second edition 2004-06-01."

5. Pipe shall be gage full length for field cutting.

6. Bolts for all flanged and mechanical joints shall be high strength, low alloy steel bolts only, conforming to ANSI / AWWA C111/A21.11 as latest revised. Bolt manufacturers certification of compliance shall accompany each shipment.

7. All pipes shall be manufactured in the United States of America by a Ductile Iron Pipe Research Association (DIPRA) member company in good standing and permanently marked with the following information:

a. Manufacturer, date

b. Size, type, class or wall thickness

c. Standard produced to (ANSI / AWWA, ASTM, etc.)

8. Inspection of the pipe shall be made by a representative of the owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification's requirements. Pipe rejected after delivery shall be marked for identification and shall be removed from the site.

Polyethylene Wrap: All ductile iron pipe shall be encased in a Polyethylene sleeve (polywrap) that shall meet all the requirements for ANSI/AWWA C105/A21.5, *Polyethylene Encasement for Ductile Iron Pipe Systems*. Each pipe joint shall be covered with an 8 mil thick polyethylene sleeve that is 2 feet longer than the pipe joint. The sleeve shall cover the full length of the pipe joint, lap over 1 foot on each end of the adjoining pipe joints, and be secured with a minimum of two circumferential turns of pressure sensitive polyvinyl tape. Excess material should be neatly drawn up around the pipe barrel, folded into an overlap on top of the pipe, and held in place by means of pieces of pressure sensitive tape at approximately 5 foot intervals. After assembling the joint, the polywrap tube from the previously installed pipe shall be pulled over the joint and secured by the Contractor. The polywrap tube from the new joint shall be pulled over the first tube and secured by the Contractor to provide a double seal. This polyethylene wrap shall also be used for all point repairs or cut-in valves and shall include all couplings used for this work

Cast iron and ductile iron fittings and valves shall be completely wrapped in 8 mil thick polyethylene film with a minimum of a 1 foot overlap on each end and appropriately taped. Laps shall cover joints of adjoining pipe or fittings when installed. Also, the fire hydrant barrel, from the surface to the valve, shall be wrapped as specified herein. Any damaged areas in the polyethylene film shall be repaired by covering the area with a sheet of polyethylene film large enough to lap over the damaged area 1 foot minimum in any direction and appropriately taped. Extreme care shall be taken at service tap locations to insure that the tape extends beyond the corporation and onto the service line pipe by a minimum of 1 foot.

Prior to placing pipe in the trench, a cushion of approved materials shall be placed in the trench as required by, "Excavation, Trenching and Backfill." Backfill material shall be carefully placed on the pipe so as to avoid any damage to the polyethylene sleeve.

The Contractor shall use care to protect and preserve the polyethylene wrap around ductile iron water mains when installing service corporations. The required method is to wrap pipe tape around the pipe over the polywrap in the area to be tapped. The tap is to be made through the tape and polywrap. It is not necessary to remove and replace poly wrap. All exposed pipe, the corporation, and the first 3 feet of the service shall be wrapped and taped to achieve a complete seal. In addition, a sand envelope shall extend over and around the connection to a depth of 12 inches above the main.

Proper Installation of Polyethylene Encasement – Appurtenances:

Pipe-Shaped Appurtenances

Cover bends, reducers, offsets, and other pipe-shaped appurtenances in the same manner as the pipe.

Odd-Shaped Appurtenances

Wrap odd-shaped appurtenances such as valves, tees, and crosses with a flat sheet or split length of polyethylene tube by passing the sheet under and then over the appurtenance and bringing it together around the body of the appurtenance. Make seams by bringing the edges of the polyethylene together, folding over twice, and taping them down.

Joints

Overlap joints as in normal installation; then tape the polyethylene securely in place at valve stems and other penetrations. When bolted-type joints are used, care should always be taken to prevent bolts or other sharp edges of the joint configuration from penetrating the wrap.

Branches, Blowoffs, Air Valves

To provide openings for branches, blowoffs, air valves, and similar appurtenances, make an

X-shaped cut in the polyethylene and temporarily fold back the film. After installing the appurtenance, tape the slack securely to the appurtenance and repair the cut and any other damaged areas in the polyethylene with tape.

Service Taps

The preferred method of tapping polyethylene-encased Ductile Iron Pipe involves wrapping two or three layers of polyethylene adhesive tape completely around the pipe to cover the area where the tapping machine and chain will be mounted. Then install the corporation stop directly through the tape and polyethylene. After the tap is made inspect the entire circumferential area for damage and make any necessary repairs.

Source: Corrosion Control: Polyethylene Encasement (English) | DIPRA

a. Polyethylene Tubing:

Polyethylene tubing shall conform to the latest revision of AWWA Standard C901, have a working pressure of 250 psi and shall meet the nominal size as shown on the plan. All tubing shall be copper tube size, meeting ASTM specifications D-1248, D-2239, and D-2737 and shall meet PE 4710 requirements.

b. Copper Tubing:

Copper tubing shall conform to the requirements of ASTM-B88, Type K, “Annealed” (soft).

c. Inspection:

All pipe and tubing shall be thoroughly inspected before being installed. All cracked or otherwise defective pipe shall not be laid but shall be removed immediately from the work, and new materials of acceptable quality shall be furnished at the contractor's expense.

d. Bolts:

Bolts for all Flexible Couplings, Flanged and Mechanical Joints shall be high strength; low alloy steel bolts only, conforming to the latest revision of AWWA C111. Bolt manufacturers certification of compliance shall accompany each shipment.

C. *DESIGN AND CONSTRUCTION*

1. The minimum allowable size of any public water main shall be eight (8) inches in diameter unless otherwise approved by the Department of Public Works and Parks - Water Operations.
2. All water mains shall have a five (5) foot minimum and an eight (8) foot maximum depth of cover as measured from the top of the pipe to finish grade. Any depth of cover greater than five (5) feet requires prior approval from the Department and will only be permitted to avoid conflicts with existing utilities.
3. All pipes shall be thoroughly cleaned before being installed, and shall be kept clean until accepted in the finished work. The ends of all uncompleted lines shall be tightly closed with temporary plugs at all times when the pipe laying is not in progress, and no trench water or debris shall be permitted to enter the pipe.
4. The contractor shall furnish the necessary pumps and tools to handle any water encountered in the pipe trench, and shall maintain the trench in a satisfactory condition, free from water, during the laying of the pipe. The pipe, after being laid in place, shall not, under any circumstances, be used as a drainpipe for the trench. Pipe shall be set in accordance with manufacturer's recommendations. Pipe or fittings requiring

cutting shall be beveled so that the cut end does not damage the gasket. Joint ends of pipe shall especially be kept clean.

5. All tees shall be three (3) way gated and all crosses shall be four (4) way gated, unless otherwise directed by the Contracting Officer.
6. Small depressions shall be excavated in the trench bottom to accommodate the pipe bells and to assure continuous support of the pipe.
7. When new mains are installed, the corporation stops shall be installed (dry tap) prior to the hydrostatic pressure test or as the Contracting Officer directs.
8. All work shall conform to Typical Trench Detail W-5 which is part of these specifications.

D. *EXCAVATION, TRENCING AND BACKFLIING*

1. Excavation for water main and water service trenches shall be wide enough to permit the pipe to be properly installed and the backfill to be placed and compacted. Depth of the trench shall be such as to provide five (5) feet minimum cover from the top of the pipe to finished grade. The City may prohibit heavy-duty pavement breakers when their use endangers existing substructures or other property. Unstable pavement shall be removed over cave-ins and breaks and the sub-grade shall be treated as the main trench. The contractor shall not be required to pay for the repair of any pavement damage existing prior to the excavation unless the contractor's cut results in small floating sections that may be unstable. If this occurs, the contractor shall remove the unstable portion and the area shall be treated as part of the excavation. The maximum length of open trench permissible in the street or sidewalk, at any time, shall be two hundred (200) feet. No greater length shall be opened for pavement removal, excavation, construction, backfilling, patching or any other operation without written permission of the City.
2. The extent of excavation necessary to make tie-ins or taps between new and existing pipes shall be kept to a minimum consistent with room needed to accomplish the work.
3. Where existing bituminous concrete pavement is to be removed to allow for excavation, the pavement shall be precut in a neat, clean straight line with a pavement breaker or saw. The minimum width of any excavation shall be twenty four (24) inches. Pavement edges shall be trimmed to a vertical face and neatly aligned parallel and perpendicular to the center line of the trench. Pulverization of a trench shall be considered an acceptable procedure to remove the existing bituminous concrete pavement provided that the trench is cut in a neat, straight line with a pavement breaker or saw prior to permanent restoration.
4. Backfilling of trenches shall follow as soon as possible and/or practical after the installation of water mains and water service pipes. The purpose of the backfill material which shall be placed under, around and over the pipe is to:

a. Provide support for the pipe
b. Provide lateral stability between the pipe and the trench walls
c. Form a cushioning layer over the pipe to prevent damage
d. The first layer of backfill shall be placed under and around both sides of the pipe, joints, valves and fittings, up to the center line of the pipe, and thoroughly compacted with hand tampers or approved mechanical rammers which shall not come in contact with the pipe.
e. All water mains and/or water service pipes shall be properly bedded in a pipe envelop consisting of moist sand borrow. The pipe shall be set on six (6) inches of moist sand borrow and backfilled with such sand, well compacted to a level of one (1) foot above the pipe.
f. The backfill between the top of the pipe envelope and a point one (1) foot below the bottom of the existing or proposed pavement surface shall be selected common fill from the excavation suitable for proper compaction as the Field Engineer directs. It shall be the contractor's responsibility to adjust the moisture content of the soil in the field as necessary to achieve the specified compaction. If the excavation material

is not suitable in the opinion of the Field Engineer, then gravel borrow, conforming to MHD Standard, Section M1.03.0, Type B shall be used.

g. In public streets, the top of the compacted backfill shall be left one (1) foot below the bottom of the existing pavement surface and the remainder of the trench backfilled with gravel borrow conforming to MHD Standard, Section M1.03.0, Type B. This layer of gravel borrow shall form the sub-base of the road.

h. All sand and gravel borrow shall be as specified in Section 100.

5. Prior to beginning backfill operations, the contractor shall be responsible for contacting the Field Engineer to obtain a soil sample. The soil sample will then be forwarded to an approved material testing agency to insure its compliance with the project's specifications. A maximum laboratory dry density of the soil will be determined in accordance with ASTM D698. It will benefit the contractor to provide a soil sample prior to the beginning of the project. This will allow field density test values to be calculated, as the excavation is being backfilled and allow for additional passes with compaction equipment, if necessary. It will also be the responsibility of the contractor to notify the Contracting Officer if any change in soil characteristics occurs. Approved backfill material shall be placed in lifts not to exceed ten (10) to twelve (12) inches and thoroughly compacted by mechanical or pneumatic compactors to at least ninety-five per cent (95%) of the soil's maximum laboratory dry density. Adequate moisture content in a backfill material is essential to achieve effective compaction. It will be the Contractor's responsibility to adjust the moisture content of the soil as necessary to achieve the specified compaction. An approved material testing agency or certified City Engineer will then perform field density testing. Density testing will be performed at intervals of one (1) test per one hundred (100) linear feet of the compacted lift. In the event that the project is of a short duration or begins prior to obtaining the soil's maximum laboratory dry density (which is necessary in determining field density test results), the contractor shall assume full responsibility for re-excavating and re-compacting areas of failed field density tests. Due to the hazardous nature of performing field density testing in deep excavations (6 feet or deeper), the contractor shall be responsible for establishing a method of compaction using mechanical or pneumatic compactors that assures each lift is compacted to at least 95% of the soil's maximum laboratory dry density. As the excavation is brought to grade and field density tests are taken, the Field Engineer, along with the contractor, shall establish a sufficient compaction method necessary to achieve at least ninety-five per cent (95%) of the material's maximum laboratory dry density based on the type of compaction equipment, number of passes and existing soil type and moisture content.

BUCKET WHACKING AND WATER JETTING WILL NOT BE PERMITTED.

6. Hand excavation may be required when mechanical equipment cannot gain access, or in the opinion of the Field Engineer is required, due to conflicts with underground structures.

7. When excavation of rock is necessary, all rock shall be removed to provide a clearance below and on each side of all pipe, valves and fittings of at least six (6) inches for nominal pipe sizes up to twenty four (24) inch. When excavation is completed, a minimum of six (6) inches of gravel borrow shall be placed between the rock and the bottom of the pipe envelope. This layer of gravel borrow shall be placed leveled and compacted prior to the installation of any pipe. This gravel borrow shall be **"Type B"** as specified in Section 100. These clearances and bedding procedures shall also be followed for pieces of concrete or masonry and other debris or subterranean structures, such as masonry walls, piers or foundations that may be encountered during excavation. In all cases, the specified clearances shall be maintained between the bottom of all pipe and appurtenances and any part, projection or point of rock, boulder or stone of sufficient size and placement that could cause a fulcrum point or point load.

8. The Contractor will have adequate equipment, such as magnetic or electronic pipe locators so that he may pinpoint locations of water services in the event City personnel cannot furnish timely information on locations.

9. Streetcar rails will be occasionally encountered on some City streets. When they are, the Contractor may be directed by the Field Engineer to cut them with an acetylene torch or some other means, and dispose of them satisfactorily.

10. If tree roots are encountered and must be removed in order to facilitate the installation of the water pipe, the Contractor shall satisfactorily remove them. Care shall be taken so to minimize the damage to the trees.

11. Materials from all classes of excavation which are unsuitable and any surplus suitable materials remaining after the completion of backfilling shall be known as **waste** and shall be disposed of by the

Contractor at no additional cost to the City.

12. Calcium Chloride shall be applied to any backfilled trench for dust control. The calcium chloride shall be placed at the discretion and direction of the Field Engineer. Calcium Chloride shall be uniformly applied at the rate of 1-1/2 pounds per square yard or at any other rate as directed by means of a mechanical spreader, or other approved means.

13. Whenever additional information is required regarding the location of existing sub-surface structures, the Field Engineer may direct the Contractor to excavate test pits of such dimensions as may be required. If the Field Engineer deems it necessary to dig a test pit, the Contractor shall cut the pavement, excavate and properly backfill the test hole as outlined in this section.

EXCAVATING AND BACKFILLING TRENCHES IN NEW STREETS LESS THAN FIVE (5) YEARS OLD

14. All applicable provisions of section 3.03 above shall apply to cutting through the existing pavement. The date used to determine the age of a street shall be the date of final paving. When excavating trenches in new streets less than five (5) years old, all material excavated shall be removed from the project site. No material shall be placed on the roadway. All excavated material shall be loaded directly into a dump truck for disposal off site. Upon completion of water, sewer and/or utility work, a one- (1) foot envelope of approved pipe bedding material shall be placed over installed lines. The trench shall then be backfilled using excavatable Controlled Density Fill (CDF), Type 2E. For rigid base roads, the trench shall be filled with CDF to the bottom of the rigid base. Prior to backfilling with CDF, the Contractor may be required to notify the Contracting Officer for the purpose of obtaining a sample for compressive strength testing.

E. *DISINFECTION*

1. Disinfection shall be in accordance with the latest revision of AWWA Standard 651 Disinfecting Water Mains. Precautions shall be taken to protect pipe interiors, fittings, and valves against contamination during construction. The water main shall be flushed prior to disinfection except when the tablet method is used.

2. The disinfection shall be accomplished by pumping a chlorine solution into the pipes by using the continuous feed method of disinfection. The initial chlorine dose concentration shall be 25 mg/l with a free chlorine residual of not less than 10 mg/l after a 24-hour holding period. After the retention period, the chlorinated water shall be flushed from the main until chlorine concentrations in the water leaving the main are no higher than that generally prevailing in the distribution system.

3. The tablet method of disinfection shall not be used without the expressed approval of the Contracting Officer.

4. After final flushing and before the new water main is placed in service, two (2) consecutive sets of acceptable samples, taken at least 24 hours apart, and shall show the absence of coliform bacteria. At least one (1) set of samples shall be collected from the new main. All samples shall be tested for bacteriological quality and be collected from every 1,200 feet of new water main plus one (1) set from the end of the line and at least one (1) set from each branch. All samples shall be collected by DPW&P at no charge to the contractor. All plastic pipe and hose for bacteria sampling shall bear the imprint of the National Sanitary Foundation (NSF) approval for potable water, NSF-PW or shall be capable of meeting the standards established by the NSF for its use and shall have no threaded ends unless otherwise directed by the Field Engineer.

5. If initial disinfection fails to produce satisfactory bacteriological results, the new main shall be re- flushed and shall be re-sampled. If these check samples also fail to produce acceptable results, the main shall be re-chlorinated until satisfactory results are obtained. When check samples are taken, it is advisable to sample water entering the new main also.

6. The environment to which the chlorinated water is to be discharged shall be inspected. If there is any question that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water. Where necessary, Federal, State and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water. The contractor shall be responsible for the proper disposal of all heavily chlorinated water at no cost to the City. Any

temporary connection to the main or other facilities required to accomplish the chlorination as just described shall be at the contractor's expense. Any temporary connections shall be properly abandoned as determined by the Contracting Officer at no cost to the City.

F. *HYDROSTATIC TESTING*

1. Hydrostatic Testing shall be in accordance with the latest revision of AWWA Standard C600, Installation of Ductile-Iron Water Mains and their Appurtenances and NFPA24 for fire protection systems as combined approach.
2. Hydrostatic pressure test shall be made at 1.5 times the working pressure but not less than 200 psi for a period of not less than 2 hours to meet minimum requirements of NFPA24. The working pressure shall be based on the static pressure at the lowest point of the line or section under test. The test pressure shall not vary by more than 5 psi plus or minus for the duration of the test.
3. If permanent air release valves are not located at all high points, the contractor shall install temporary connections as necessary to expel any air in the line. All temporary connections shall be removed and plugged as directed by the Contracting Officer at no cost to the City. When hydrants are in the test section, the test shall be made against the closed hydrant.
4. A leakage test shall be conducted concurrently with the pressure test. No pipe installation will be acceptable if the leakage is greater than the allowable leakage as determined by the formula listed in the above-referenced AWWA Standard. Leakage shall not be measured by a drop in pressure in a test section over a period of time.
5. If any test of laid pipe discloses leakage greater than that specified, the contractor shall, at no cost to the City, locate and repair defective material until leakage is within the specified allowance.

G. *SPECIAL CONDITIONS*

1. If requested by the contracting officer the contractor shall return all existing valves and valve boxes removed under normal excavation to the Millbury Street Yard (formerly Ballard Street Yard) at no additional cost to the City.
2. Unless otherwise specified the existing pipe shall be removed and the new pipe installed within the same trench. The existing water pipe to be removed shall become the property of the contractor and shall be properly disposed of at **no** additional cost to the City.
3. Where a main is going to be abandoned in place, as specified on the plans, the service and valve boxes shall be removed and stacked at the 1065 Millbury Street at no cost to the City if requested by the contracting officer.
4. During the cutting of tees, crosses, valves; the installation of tapping sleeves and the repair of leaks and breaks, sanitary construction practices shall be followed so there is no contamination of the new or existing water main with foreign material or groundwater. Any and all pipe, valves, couplings, and fittings used as listed above shall be disinfected as outlined in the latest revision of ANSI/AWWA Standard C651 for Disinfecting Water Mains.

All dedicated fire protection/fire sprinkler pipes shall be hydrostatically pressure tested in accordance with the latest revision of National Fire Protection Association standard, NFPA 24. Hydrostatic test shall be made at not less than 200 psi for two(2) hours and conform to requirements as specified in Section F above. A typical “Contractor’s Material and Test Certificate for Private Fire Service Mains” shall be submitted to the Worcester Fire Department upon successful completion of all work, inspections and tests.

Where CDF (controlled density fill) is used, care shall be taken to avoid any contact between the CDF and pipe or fitting surfaces either by the use of approved polywrap around the pipe, gravel fill encasing all metallic surfaces to a depth of at least 6” above pipe surfaces or a combination of these methods as directed by the contracting officer.

When unpaved or private streets are excavated for water main or water service installations, the Field Engineer may require that additional gravel borrow be placed on the surface of the backfilled trench to a reasonable depth and width to cover part of or even the entire traveled way to eliminate impassable traffic conditions.

This shall be in effect for one (1) year after completion of the work. The gravel borrow shall conform to MHD Standard Section M1.03.0, Type B.

H. *MEASUREMENT AND PAYMENT*

Water Mains, Copper and Polyethylene Tubing shall be measured complete in place along the axis of the pipe excluding the length occupied by valves and fittings.

Water Mains, Copper and Polyethylene Tubing including fittings, shall be paid for at the Contract Unit Price under the respective items for the kind of work involved, as set forth in the Proposal, which price shall include all pipe, excavation less than 7 feet in depth, backfill, compaction, disposal of all waste material from the excavation, tools, materials, disinfection, sheeting, shoring, successful hydrostatic and leakage tests, labor and equipment necessary to complete the work as specified herein.

Any excavation beyond the standard trench (see detail W-5) shall be compensated under excavation pay item "122 Earth Excavation below normal grade". Likewise any excavation, as directed by the Contracting Officer, which results in a "dry" hole, also referred to as "outside excavation" shall also be compensated under item 122.

Polyethylene wrap for ductile iron pipe shall be paid per linear foot of water main installed where needed, in addition to the price per foot for the ductile iron pipe.

ITEMS 302.0000 and 303.0000 CAST OR DUCTILE IRON FITTINGS

ITEM 302.1000 CAST OR DUCTILE FITTINGS

ITEM 302.0804 8"X4" CUT-IN TEE

ITEM 302.0806 8"X6" CUT-IN TEE

ITEM 302.0808 8"X8" CUT-IN TEE

ITEM 302.1208 12"X8" CUT-IN TEE

ITEM 302.1212 12"X12" CUT-IN TEE

ITEM 302.1408 14"X8" CUT-IN TEE

ITEM 302.1608 16"X8" CUT-IN TEE

ITEM 302.1612 16"X12" CUT-IN TEE

ITEM 303.0808 8"X8" CUT-IN CROSS

ITEM 303.1208 12"X8" CUT-IN CROSS

A. *SCOPE OF WORK*

The work under this section shall consist of furnishing and installing cast iron or ductile iron fittings including bends, elbows, tees, plugs, reducers, flexible couplings where required, sleeves and other accessories in new or existing water mains, as shown on the plans, or as directed by the Contracting Officer.

B. *MATERIALS*

All fittings for use with cast iron or ductile iron pipe shall conform to the latest revisions of AWWA C110 (gray and ductile iron standard fittings) or AWWA C153 (ductile iron compact fittings). All fittings shall be cement lined in accordance with the latest revision of AWWA C104 and shall have mechanical joints in accordance with the latest revision of AWWA C111. The ductile iron compact fittings shall be marked in accordance with Sec. 53-10 which states that the fittings shall have distinctly cast on them the identity of this standard, C153; the pressure rating, 350 psi; nominal diameter of openings; manufacturer's identification; the country where cast; the letters "DI" or word "Ductile;" and the number of degrees or fraction of the circle on all bends.

Coatings: The exterior of all cast iron or ductile iron fittings shall be coated with a zinc-rich primer layer complying with ISO 8179-2:1991 to protect against corrosion of the exterior surfaces. The zinc-rich primer layer shall be applied on the blast cleaned (free from rust or any non-adhering particles or foreign matter such as oil or grease) exterior surface of the fitting. The coating material shall be zinc-rich paint with an inorganic binder and zinc content of at least 85% in dry film and shall be asphalt paint compatible. The zinc-rich paint shall have a solid by volume of 67±2%, a flash point of 14°C (ISO 3679 method 1) and a density of 2.63 kg/liter. PVC attachments shall be used to close the fitting openings to avoid zinc contamination of the internal surfaces. The zinc-rich paint shall cover the entire outside diameter of the fitting and shall be free from bare patches and lack of adhesion.

A finishing layer of asphaltic topcoat shall be applied to the internal and external surfaces of the fitting.

All fittings shall be thoroughly inspected before being installed; all cracked or otherwise defective fittings shall not be laid but shall be removed immediately from work and new materials of acceptable quality shall be furnished at no cost to the City.

Mechanical joint restraint shall be incorporated in the design of the follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. This fitting shall be “Mega lug” or equal.

Flexible couplings shall be Dresser style or an approved equal. An approved tar coating shall be applied on the entire outer surface of such couplings including bolts when installed. **Bolts shall have factory- applied epoxy coating.**

Bolts for all Flexible Couplings, Flanged and Mechanical Joints shall be high strength; low alloy steel bolts only, conforming to the latest revision of AWWA C111. Bolt manufacturer’s certification of compliance shall accompany each shipment.

C. *DESIGN AND CONSTRUCTION*

Fittings, which are furnished and installed in the normal course of constructing new water mains, shall conform to all applicable provisions of these specifications.

Tees, which are to be furnished and installed in existing water mains, will be known as Cut-in Tees, and construction shall also conform to all the applicable provisions of these specifications. In addition, the work of Cut-in Tees shall include the cutting of the existing pipe to be connected to the run and the branch and furnishing and installing all necessary items to successfully accomplish the work including the tee, nipples, couplings, sleeves, and accessories as required. When cutting in a tee to a water main, measurements must be taken to ensure close tolerances between existing pipe and pipe nipple. If the tolerance is, in the opinion of the Contracting Officer, too large, a ring section shall be cut and installed on one side to make up the difference in length.

The contractor shall install permanent blocking under any cut-in tee or cross and under any valve or fitting installed to prevent any movement or settlement of the valve or fitting during backfilling and compaction.

D. *MEASUREMENT AND PAYMENT*

Fittings will be measured by the pound and the quantity to be paid for shall be the cast iron weight stated in latest revision of AWWA Specification C110, or the manufacturer’s rated weight, as listed in the catalog, whichever is the lesser. The Contractor shall furnish a copy of the manufacturer’s catalog at the start of the work.

The weight of glands, bolts, gaskets, restraints and other iron fitting accessories will not be included for measurement and payment.

Cut-in Tees and Crosses will be measured per Each completely installed and in place.

Fittings will be paid for at the Contract Unit Price as set forth in the Proposal which price shall include full compensation for furnishing all labor, materials, restraint fittings or rodding, tools, equipment, and incidentals for doing all the work involved in furnishing and installing iron fittings complete in place as specified herein.

The work necessary to install a Cut-in Tee or Cross on an existing water main shall include all pipes, nipples, couplings, sleeves, accessories, the tee or cross, excavation less than 6 feet in depth, backfilling, compaction, sheeting, shoring, tools, equipment and labor. This work shall be paid for only under the item of Cut-in Tee or Cross. Under no circumstances will any of the work under this item be compensated by other pay items.

ITEMS 304 through 308 VALVES AND VALVE BOXES

The work under this section shall consist of furnishing and installing new valves in new water lines, new valves in existing water lines, furnishing and installing new or removing and stacking valve boxes in water lines, adjusting gate boxes in street, adjusting service boxes (curb stops) in sidewalk area as specified herein, as shown on the plans, or as directed by the Contracting Officer.

ITEM 304.0100 VALVE BOX

ITEM 304.0200 SERVICE BOX

ITEM 304.0300 ADJUST CURB STOP TO GRADE

IMPORTANT: SPECIFICS OF VALVE BOX SIZES AND CONFIGURATIONS as well as VALVE BOX CASTINGS SPECIFICATIONS are included in VALVES SECTION Items 305-308.

A. *MEASUREMENT AND PAYMENT*

Adjusting curb stops will only be considered for payment when an extension rod is furnished and installed by the Contractor or if a repair is requested by the Contracting Officer.

ITEM 304.0400 REPLACING 4" - 12" GATE VALVE BOX, GRAVEL BASE

ITEM 304.0500 REPLACING 4" - 12" GATE VALVE BOX, RIGID BASE

A. *SCOPE OF WORK*

The work to be done under Items 304.04 and 304.05 shall conform to the applicable provisions of MHD, Section 301 and Items 304.08 and 304.09 of the contract.

The work shall consist of the supply and replacement of existing 4" through 12" gate valve boxes with a three-piece slip type gate valve box either EJIW 8555 series or Tyler Union 6855 series with flange at bottom of the top section and the cover with the word “WATER”. This work shall include furnishing all necessary labor, materials and equipment, backfilling with bituminous concrete, power tamped in 6" layers, set to designated line and grade, operating the gate nut to the satisfaction of the Contracting Officer and patching the base course with SUPERPAVE binder course without extra cost to the City. The contractor will also be required to return all old water castings to the Department of Public Works and Parks, 1065 Millbury Street, unless otherwise directed by the Contracting Officer. All valve boxes shall be set in bituminous concrete. The bituminous concrete shall extend a minimum 18" beyond the outside of the valve box to a depth of 12" so the area can be packed with a plate compactor.

As part of this work, each valve box and riser will be cleaned of soil and debris with an “air-lance” or equivalent, to accommodate the proper access to the valve. This work will be completed at no additional cost to the City.

B. *MEASUREMENT AND PAYMENT*

Measurement shall be at the number of units furnished and installed in place and paid for at the unit price for each bid therefore in the proposal. No additional payment will be made for bituminous concrete used in this item (only when the City of Worcester cannot supply said boxes, will this item be used).

ITEM 304.0600 REMOVE AND RETAIN WATER BOX

ITEM 304.0700 RETURN AND RESET WATER BOX

A. *SCOPE OF WORK*

The work to be done under Items 304.06 and 304.07 shall conform to the applicable provisions of MHD, Section 301 and Items 304.08 and 304.09 of the contract.

Under Item 304.06 the contractor will remove all top boxes from the roadway prior to the excavation and store such boxes in a manner to insure their safe keeping from theft or damage. Also, it will be the Contractor's responsibility to protect the bottom box from clogging, misalignment and damage and to preserve its location for use after the SUPERPAVE bituminous concrete binder course base has been laid. Any bottom boxes that are within 15 inches of finish grade shall be trimmed down by hand to ensure that the excavation equipment will not contact any part of said box or any buried covers. All excavated areas shall be suitably backfilled by approved compaction methods, and the work site shall be left in a neat and clean state.

Under Item 304.07 the Contractor shall return to the job site all undamaged top boxes and covers previously removed under Item 304.06. It will be the contractor's responsibility to then reset the top boxes as indicated in the specifications of Items 304.08 & 304.09 of the contract, taking care as to the clearing of all debris from the bottom box and to successfully operate each gate valve to the satisfaction of the Contracting Officer. It will be the Contractor's responsibility to neatly trim or cut the new binder course, excavate, compact and repave the excavated area with SUPERPAVE bituminous concrete binder. Water boxes shall

be adjusted to specific line and grade given by the Contracting Officer and shall be set prior to the laying of the top course. Contractor shall provide gate risers if necessary at no additional cost to the city

As part of this work, each valve box and riser will be cleaned of soil and debris with an “air-lance” or equivalent, to accommodate the proper access to the valve. This work will be completed at no additional cost to the City.

B. *MEASUREMENT AND PAYMENT*

Measurement shall be at the actual number of water boxes removed and retained and returned and reset as applicable. Payment shall be at the respective item bid for each in the proposal.

ITEM 304.0800 WATER BOX ADJUST TO GRADE, GRAVEL BASE

ITEM 304.0900 WATER BOX ADJUST TO GRADE, RIGID BASE

ITEM 304.1000 LOWER STREET SERVICE BOX

A. *SCOPE OF WORK*

The work under Items 304.08 and 304.09 shall conform to the relevant provisions of MHD, Section 301 supplemented by the Materials section below.

B. *CONSTRUCTION METHODS*

The pay item for this work shall be Water Boxes Adjust to Grade and shall be full payment for all excavation, trimming or cutting of existing box, bituminous concrete backfill, and placing SUPERPAVE bituminous concrete binder course collar for all labor, equipment, tools and incidental expenses required to locate, maintain in proper working order, and set to finished grade complete in place.

Water boxes shall be adjusted to line and grade before the top course has been laid. The bituminous concrete binder course shall be thoroughly compacted with a plate compactor.

It shall be the Contractor's responsibility to mark locations of each box and to maintain each and every box in proper working order, free of all dirt and/or debris and in true alignment at all times.

The Contractor shall notify the Contracting Officer immediately of any boxes found in poor, broken or leaking condition. The locations given at start of work in each street shall be preserved by the contractor for use in establishing water box locations after SUPERPAVE base course has been laid. The Contractor shall be responsible for location of all water boxes at all times during the construction period.

All valve boxes shall be set in bituminous concrete binder. The bituminous concrete shall extend a minimum of 18" beyond the outside of the valve box to a depth of 12" and compacted in two 6" lifts with a plate compactor.

Gate boxes and service boxes shall be carefully fitted together and to the valve with minimum overlap of six (6) inches between the box sections when in the most extended position. The soil shall be firmly compacted around bonnet of the valve to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve. The valve box shall be securely held vertical and plumbed straight during backfilling. Covers shall be set to the specified line or grade as directed by the Contracting Officer.

Gate boxes and service boxes that are removed and stacked shall remain the property of the City of Worcester, DPW&P, Water Operations. The Contractor shall deliver, unload and store said gate and service boxes at the 1065 Millbury Street.

The Contractor shall adjust all existing gate and service boxes where indicated on the drawings and detail sheets. When adjusting a water box, the Contractor shall be responsible to clear all debris from the bottom box and to successfully operate each gate and valve to the satisfaction of the Contracting Officer.

Some gate and service boxes that are called out to be adjusted may not be able to be adjusted as described above. There may be grade changes that exceed the range of adjustment within the existing box; or the top and bottom sections of the existing box have been fused together due to age and corrosion and cannot be

separated or there may be damage to the box sections that is not visible from the surface. If one or more of these conditions exists, the Contracting Officer may deem it necessary to remove and stack the existing box and a new gate or service box will be installed. The contractor shall make every effort to separate the sections of the existing box to be adjusted prior to the Contracting Officer allowing the removal and stacking of the existing box.

Valve and service boxes shall be trimmed and/or cut with an abrasive pipe saw only. The use of hammers and wrenches to hand trim the boxes shall not be allowed.

On all water services that have an existing curb stop or have a curb stop and service box installed without the changing of the service pipe the 4 inch service box over the corporation stop shall be adjusted as follows:

The 4 inch service box shall be adjusted to 18 inches below finish grade unless a cement concrete road base exists, in which case the service box shall be set in the finished grade of the cement concrete road base. If the Contracting Officer determines that the 4 inch service box to be adjusted is not suitable for re-use, the contractor will remove and stack the existing gate box and a new gate box will be set.

C. *MEASUREMENT AND PAYMENT*

Gate boxes and service boxes that are set, removed and stacked or adjusted shall be paid for at the contract unit price per each complete in place. All equipment, tools, Superpave bituminous concrete binder course materials, labor and transportation required to complete all of the above items as specified shall be considered as incidental to the construction and be included in the contract price per each item.

Under Items 304.10 payment will exclude the cost of a casting. The City of Worcester, DPW&P, Water Operations will furnish the new 4 inch service box when necessary and the contractor shall pick up said boxes at the 1065 Millbury Street at no additional cost to the City.

Measurement shall be for work completed in place and paid for at the unit price each bid therefore in the proposal. No additional payment will be made for bituminous concrete used in this time.

ITEM 305.0200 2" BALL VALVE

ITEM 305.0400 4" GATE VALVE

ITEM 305.0600 6" GATE VALVE

ITEM 305.0800 8" GATE VALVE

ITEM 305.1000 10" GATE VALVE

ITEM 305.1200 12" GATE VALVE

ITEM 305.1600 16" GATE VALVE

ITEM 305.2000 20" GATE VALVE

ITEM 305.2400 24" GATE VALVE

ITEM 305.3000 30" GATE VALVE

ITEM 305.3600 36" GATE VALVE

ITEM 305.4200 42" GATE VALVE

ITEM 305.4800 48" GATE VALVE

ITEM 306.0600 6" CUT-IN GATE VALVE

ITEM 306.0800 8" CUT-IN GATE VALVE

ITEM 306.1200 12" CUT-IN GATE VALVE

ITEM 307.1400 14" BUTTERFLY VALVE

ITEM 307.1600 16" BUTTERFLY VALVE

ITEM 307.1800 18" BUTTERFLY VALVE

ITEM 307.2000 20" BUTTERFLY VALVE

ITEM 307.2400 24" BUTTERFLY VALVE

ITEM 307.3000 30" BUTTERFLY VALVE

ITEM 307.3600 36" BUTTERFLY VALVE

ITEM 307.4000 40" BUTTERFLY VALVE

ITEM 307.4200 42" BUTTERFLY VALVE

ITEM 307.4800 48" BUTTERFLY VALVE

ITEM 308.1600 16" CUT-IN BUTTERFLY VALVE

A. *MATERIALS*

All gate valves and all tapping valves shall be gate type resilient-seated style and shall meet or exceed the minimum materials and performance requirements of the latest revisions of the applicable AWWA StandardsC-509 and C515 for resilient-seated. Both ends shall be mechanical joint in accordance with the latest revisions of AWWA C-111 except tapping valves where the outlet end will be mechanical joint.

Design Pressure: The design of the water gate valves as described below shall be based on an internal hydrostatic pressure (working water pressure) of 200 psi.

Stem: Resilient-seated gate valve stems shall be non-rising design, grade E bronze with a yield strength of not less than 32,000 psi. and an elongation of not less than 10 percent in 2 inches, or stainless steel AISI Type 420, 304, or 316. The 300 series stainless steel shall be strain-hardened to meet the physical requirements referenced above.

Resilient-Seated Disc Wedge: The resilient-seated disc wedge shall be fully (100%) encapsulated in rubber. The rubber shall be securely bonded to the wedge, including the part which houses the stem nut. The stem hole through the wedge shall be full opening top to bottom and shall also be covered with rubber. Disc wedges that are not 100% fully encapsulated shall not be acceptable.

Bolting: All resilient-seated gate bonnet bolts, seal or gland plate bolts, stuffing box bolts or any other bolts with threads exposed to the environment shall be type either 304 stainless steel, everdur bronze, cadmium-plated (ASTM B766), or zinc-coated (ASTM A153 or ASTM B633).

Tapping Valves: Tapping valves shall be furnished with the tapping flange on the inlet side shall have a raised face or lip designed to engage the corresponding recess in the tapping sleeve flange in accordance with MSS-SP60. Flanged tapping valves without the raised face shall not be allowed because they do not assure the proper alignment required to prevent damage by a misaligned shell cutter. The interior of the waterway in the valve body shall be a full opening capable of passing a full- sized shell cutter equal to the nominal diameter of the valve.

Country of Origin: To insure compliance with AWWA and other applicable standards, and access to manufacturing facilities for inspection purposes, and assure timely shipment and delivery, all gate type valves shall be manufactured, assembled, and tested in plants located within the continental United States.

All butterfly type valves 16 inches and over, shall be ***CLASS 250B*** and shall meet or exceed AWWA Standard C504 as latest revised, and shall comply with the specific requirements and design standards that follow.

Design Pressure: The design of the water butterfly valves as described below shall be based on an internal hydrostatic pressure (working water pressure) of 200 psi.

Body Type: All butterfly valves shall be of the rubber seated tight-closing type. Both ends shall be mechanical joint per AWWA Standard C111 as latest revised. All accessories (bolts, glands, and gaskets) required to make up two (2) mechanical joints shall be supplied in boxes by the vendor. The rubber seat shall be a full circle 360

degrees seat not penetrated by the valve shaft.

Valve: Bodies of all valves shall be either of cast iron conforming to ASTM A126, Class B, or ASTM A48, Class 40; of ductile iron conforming to ASTM A536, Grade 65-45-12; or of alloy cast iron conforming to ASTM A436, Type 1 and 2, or ASTM A439, Type D2, with a maximum lead content of 0.003%.

Valve Seat: The valve seat rubber shall be Buna-N rubber. If the valve seat rubber is on the disk it shall be held mechanically in place with a stainless steel clamp ring and mate with a stainless steel body ring mechanically held in place. If the valve seat rubber is on the valve body, it shall not be glued in place but it shall be held in place without hardware.

Actuator: The actuator is essentially an integral part of a butterfly valve. Actuator shall be totally enclosed and fully greased-packed for buried, submerged service up to 25 feet of head. It shall be capable of withstanding an overload input torque of 450 ft. lbs. at full-open or full-closed position, without damage to the valve or valve operator. Number of turns to operate valve shall closely resemble conventional distribution valve practices and to minimize water hammer. Actuators shall be built in full conformance with AWWA Standard C504, Class 250B as latest revised.

Testing: Shall be in compliance with AWWA C504 Section 5 as latest revised.

Performance Testing: Each valve with the actuator mounted directly on the valve shall be shop-operated three (3) times from the fully closed to the fully opened position and the reverse under a no-flow condition to demonstrate that the complete assembly is workable.

Leakage Tests: Each valve shall be shop-tested for leaks with the disc in the closed position at 250 psi.

Hydrostatic Test: All valve bodies shall be subjected to an internal hydrostatic pressure equivalent to two (2) times the rated pressure.

All gates (including tapping valves) and butterfly type valves shall be spray coated with a two-component epoxy to cover all interior ferrous surfaces that come in contact with water. The constituents of the cured film shall be non-hygroscopic, non-water soluble, and FDA approved for exposure to fluids for human consumption. Surface preparation shall be blast cleaned or other approved method to near white metal. All metal surfaces shall be cleaned to remove all dirt, dust, mill grade, rust, corrosion products, oxides, paint or any other foreign matter. Blast cleaned surface shall be protected from conditions of high humidity, rainfall or surface moisture. No surface shall be allowed to flash rust before coating. The coating shall be applied to a minimum thickness of 8 mils. All holidays in the coating shall be repaired by the application of another coat of epoxy over the area. The body and ferrous vane shall then be 100% checked on the water-wetted surfaces to be electronically void-free.

All resilient gate valves (including tapping valves) shall have a fusion-bonded epoxy coating applied to and fully cured on all interior and exterior ferrous surfaces that are in constant contact with water. Coating shall meet or exceed the minimum materials and performance requirements in AWWA C550 latest revisions. The coating shall be a minimum of 10 mils thickness, and shall be shown to be holiday-free when tested with a low-voltage holiday detector, using a sponge saturated with a 1/2 percent by weight sodium chloride solution.

Certificates of Compliance: A certificate of compliance from the manufacturer stating that the valve, stem, operator and coating meets all criteria set forth in this specification shall be submitted and approved before installation of any valve. The certificate must be signed by an authorized company official and notarized by a notary public.

All valves, except 2 inch, shall be fitted with a standard 2 inch square operating nut and shall **open right (clockwise)**.

VALVE BOX CASTINGS SPECIFICATIONS

A GENERAL REQUIREMENTS

This specification shall apply to 5-1/4" shaft, slip type cast iron valve boxes. All valve boxes furnished as part of this particular specifications shall comply the Build America, Buy America, ("BABA") provisions of the Infrastructure Investments and Jobs Act. All iron used in the valve boxes is produced in the United States—this means all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States. This specification is applicable for the gray iron castings. All casting

manufacturers shall be approved suppliers of cast iron products for the City of Worcester, MA. All manufacturers shall be able to demonstrate that there is an acceptable quality control program at the producing foundry, and upon request, shall furnish a quality control manual. As part of the quality control program, the producing foundry shall be made available for the purpose of conducting an audit prior to supplying castings. All valve box parts shall be manufactured at the same producing foundry.

B MATERIALS

Gray iron castings shall be manufactured from iron conforming to AASHTO M105, Class 35B or ASTM A48, Class 35B, as noted in section 4.1 of AASHTO M306-10. The iron material used in products provided shall have a minimum recycled material content of 85%. The recycled material shall consist of post-consumer material.

C CONSTRUCTION

Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage, crack, and other surface defects. Castings shall be reasonably smooth and well cleaned by shot blasting. Surfaces of the castings shall be free from burned-on sand and shall be reasonably smooth. Runners, risers, fins, and other cast on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between covers and top sections shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. All cast dimensions may vary within accepted foundry tolerances as outlined in the Iron Castings Handbook published by the American Foundrymen's Society, Inc. Nominally, casting dimensional tolerances shall be +/- 1/16" per foot. All published casting weights are average and approximate values and shall vary +/- 5%. Casting dimensions and specific tolerances are identified on the associated casting drawings. Castings shall meet the weight and dimensional criteria as shown on the associated drawings. All castings shall fit properly and be fully interchangeable.

D TRAFFIC RATING

All gray iron valve box covers shall be rated for traffic service and meet the minimum proof load requirement for H2O as described in section 6 of AASHTO M306-10. Proof load test results shall be provided upon request.

E INSPECTION

Inspections shall be in accordance with section 8 of AASHTO M306. Results of these tests shall be furnished to the purchaser upon request. The heat or production date and product numbers, as cast on the casting, shall be the basis of traceability and recording of the tests.

F CERTIFICATION

A foundry certification shall be furnished to the purchaser stating that each lot meets the requirements of this specification. Applicable documentation shall be made available to the purchaser upon request.

G MARKING

Each casting shall be identifiable and show, at minimum, the following: name of the producing foundry, country of manufacture (such as "Made in USA"), ASTM A48, Class 35B, individual part number, and cast or heat date.

H COMPLIANCE

Gray iron valve boxes supplied to the City of Worcester shall comply with this specification and all other requirements of AASHTO M306-10, not specifically referenced herein.

I SPECIFICS OF VALVE BOX SIZES AND CONFIGURATIONS

Valve Boxes shall be domestically produced cast iron, two- (2) piece slip type having an extension range of 40 inches to 61 inches, with the flange located at the ***BOTTOM*** of the top section, either EJIW 8555 series or Tyler Union 6855 series. Valve Box extension sections shall have an extension range as listed below. When furnished separately, all valve box covers, valve box bottom sections, and valve box top sections shall be compatible with the above-mentioned castings.

Top Section: This section shall be 26 inches in length with a minimum internal diameter of 6-1/8 inches. A flange shall be located at the ***BOTTOM*** of the section and the flange shall have a minimum diameter of 9 inches.

Bottom Section: This section shall be 36 inches in length with a minimum internal diameter of 5-1/4 inches. The lower portion of this section shall be bell-shaped to accommodate the operating nut and packing assembly of the valve it will be set on. The minimum internal diameter of the bell-shaped portion shall be 8 inches and the minimum length of the bell-shaped portion shall be 6-1/2 inches.

Intermediate Extension Section: This section shall be 18 inches in length with an extension range up to 14 inches. The section shall have a minimum internal diameter of 5-1/4 inches.

Gate Box Cover: The cover shall be cast iron with the word "WATER" cast into the cover. The cover shall have a minimum overall depth of 3-1/2 inches.

Manufacturer's specifications, shop drawings, and descriptive literature shall be submitted with each bid. All required information shall be submitted with and attached to the bid. Failure to include the required certificates of compliance and manufacturer's information shall result in the rejection of the bid.

Roadway Boxes to accommodate 2-inch valves shall be cast iron, two- (2) piece slip type with an arched base having an extension range of 49 inches to 62 inches. Roadway Boxes shall be domestically produced EJIW or Tyler Union.

Top Section: This section shall be a minimum of 18 inches in length with a minimum internal diameter of 5-7/16 inches. A flange shall be located at the bottom of the section and the flange shall have a minimum diameter of 8 inches.

Bottom Section: This section shall be a minimum of 27 inches in length with a minimum internal diameter of 4-1/4 inches. The lower portion of this section shall be an arched bell-shape to accommodate the 2-inch valve and 2-inch pipe it will be set over. The minimum width and the minimum height of the arch shall be 3-5/8 inches and 3-1/4 inches respectively. The minimum internal diameter of the bell- shaped portion shall be 7 inches and the minimum height of the bell-shaped portion shall be 6 inches.

Extension Section: This section shall be a minimum of 22 inches in length with an extension range up to 18 inches. This section shall have a minimum internal diameter of 4-1/4 inches.

Cover: The cover shall be cast iron with the word "WATER" cast into the cover. The cover shall have a minimum width and length of 5-7/8 inches and 1-9/16 inches respectively.

All 2-inch corporation valves shall be ball-type equal to or exceeding the quality of series FB1000 or 74101BCAP-22 with tee head adapter (cc. thread x compression) as manufactured by Ford or A.Y. McDonald.

Bolts for all flexible couplings, flanged and mechanical joints shall be high strength, low alloy steel bolts only, conforming to AWWA C111 as latest revised. Bolt manufacturers certification of compliance shall accompany each shipment.

CUT-IN VALVES: Valves of a given size to be cut-in to an existing line shall have the same pay item number followed by the words "CUT-IN". A valve to cut-in shall meet the same specifications as valves of a similar size but shall include cutting of existing pipe, removing existing valve, stacking existing pipe and valve at the Millbury Street Yard, dewatering the trench, the required tie-ins, pipe, couplings, accessories, other fittings, labor, equipment, materials, excavation, and backfilling as specified herein. Under NO circumstances shall any of the work under this item be compensated by other pay items.

VALVES REMOVED & RESET: An existing valve to be removed and reset for the purpose of cleaning & cement lining shall have the same pay-item number as other similar valves followed by "R&R". A valve to be removed & reset shall utilize the existing valve but shall include cutting of existing pipe, removing existing valve, stacking

existing pipe and valve at the Millbury Street Yard, dewatering the trench, the required tie- ins, pipe, couplings, accessories, other fittings, labor, equipment, materials, excavation, and backfilling as specified herein. Under NO circumstances shall any of the work under this item be compensated by other pay items.

J DESIGN AND CONSTRUCTION

All valves shall be installed at a maximum of 500 feet, unless otherwise directed by the Contracting Officer. All valves shall be set level. Each gate shall be tightly closed before being placed in line, and shall remain so until the joint on each side is completely made.

All valves shall be carefully handled to avoid shock or damage.

Proper installation of valve boxes helps ensure against operating difficulties in the future. The soil shall be firmly compacted around the bonnet of the valve to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve. The valve box shall rest above the valve so the weight of traffic passing over the street will not be transferred to the pipe or valve.

Valve boxes shall be carefully fitted together and to each valve with a minimum overlap of six (6) inches between the box sections when in the most extended position. The valve box shall be securely held vertical and plumbed straight during backfilling. Covers shall be set to the finished grade as directed by the Contracting Officer. After the box is set, the contractor shall operate the valve or corporation stop to the satisfaction of the Contracting Officer.

During the course of water main construction and/or resurfacing of street, the contractor may have to adjust or remove and replace existing valve and service boxes. When adjusting a water box the contractor shall excavate the complete top section of the box, separate the top section from the lower or bottom section and raise or lower the top section to the specified line or grade. Some gate and service boxes that are called out to be adjusted may not be able to be adjusted as described above. There may be grade changes that exceed the range of adjustment within the existing box; the top and bottom sections of the existing box may be fused together due to age and corrosion and the sections cannot be separated or there may be damage to the box sections that is not visible from the surface. If one or more of these conditions exist, the Contracting Officer may deem it necessary to remove and stack the existing box and have a new valve or service box installed. The contractor shall make every effort to separate the sections of the existing box to be adjusted prior to the Contracting Officer allowing the removal and stocking of the existing box. The City shall supply new valve or service boxes to replace existing boxes that are not suitable for reuse only when the damaged box is on an existing public water main or service. **The City will not supply valve boxes for new construction or to replace damaged boxes that are on private water mains or services.**

Valve and service boxes that are removed and stacked shall remain the property of the City of Worcester

D.P.W. Water Operations. The contractor shall deliver, unload and store said valve and service boxes at the City's Milbury Street Yard at no additional cost to the City.

Valve and service boxes shall be trimmed and/or cut with an abrasive pipe saw only. The use of hammers and wrenches to hand trim the boxes shall not be allowed.

Valves that are furnished and installed in existing water mains will be known as Cut-In Valves. The work of cut-in valves shall include the cutting of the existing pipe and furnishing and installing all necessary items to successfully accomplish the work.

All tees shall be three (3) way gated and all crosses shall be four (4) way gated unless otherwise directed by the Contracting Officer.

Water Operations shall check and clean all main gates needed for a shutdown before the contractor starts the work.

K MEASUREMENT AND PAYMENT

Ball Valves, gate valves, butterfly valves, cut-in valves, valves removed & reset, tapping sleeves and valves, roadway boxes and valve boxes will be measured per Each as determined by actual count complete and in place.

Valves, cut-in valves, valves removed &reset

Tapping sleeves and valves, ball valves, and boxes will be paid for at the Contract Unit Price as set forth in the Proposal which price shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work specified herein.

Payment for a cut-in valve, valves removed & reset, butterfly or gate type, on an existing line, shall include cutting of existing pipe, removing existing valve, stacking existing pipe and valve at the Millbury Street Yard, dewatering the trench, the required tie-ins, pipe, couplings, accessories, other fittings, labor, equipment, materials, excavation, and backfilling shall be paid only under the item of cut-in valve. Under NO circumstances will any of the work under this item be compensated by other pay items.

Payment for Adjusting Gate Box or Service Box to Grade shall include all excavation, concrete or asphalt collars to anchor the top box, labor, equipment, materials, delivering and unloading of any boxes deemed unsuitable for reuse at 1065 Millbury Street and any incidentals necessary to complete the work. Please note: Adjusting the valve box includes lowering or adjusting to any grade other than finished grade. Gravel, temporary and permanent patch, gate boxes, service boxes, and any other items needed for this work shall be paid for at the respective Contract Unit Price for that item.

Valve boxes shall be product number 06800001C03 as manufactured by ej (East Jordan Iron Works) company. The valve boxes shall be cast iron two- (2) piece slip type having an extension range of 40 inches to 61 inches, with the flange located at the **bottom** of the top section. Gate box extension sections shall have an extension range as listed below.

Top Section: This section shall be ej product number 8555726. The valve box top shall be 26 inches in length with a minimum internal diameter of 6-5/8 inches. A flange shall be located at the bottom of the section and the flange shall have a minimum diameter of 9 inches.

Bottom Section: This section shall be ej product number 85556036. The valve box bottom shall be 36- inches in length with a minimum internal diameter of 5-1/4 inches. The lower portion of this section shall be bell-shaped to accommodate the operating nut and packing assembly of the valve it will be set on. The minimum internal diameter of the bell-shaped portion shall be 8-1/2 inches, and the minimum height of the bell-shaped portion shall be 6-1/2 inches.

Intermediate Extension Section: This section shall be 18 inches in length with an extension range up to 14 inches. The section shall have a minimum internal diameter of 5-1/4 inches.

Gate Box Cover: This cover shall be ej product number 06800001. The cover shall be cast iron with the word "WATER" cast into the cover. The cover shall have a minimum overall depth of 3-1/2 inches.

Fixed or adjustable cast iron riser sections that are less than 5-1/4 inches in diameter and can be placed on or inserted inside the existing top section shall not be allowed.

Roadway Boxes to accommodate 2-inch valves shall be cast iron, two- (2) piece slip type with an arched base having an extension range of 49 inches to 62 inches.

Top Section: This section shall be a minimum of 18 inches in length with a minimum internal diameter of 5-7/16 inches. A flange shall be located at the bottom of the section and the flange shall have a minimum diameter of 8 inches.

Bottom Section: This section shall be a minimum of 27 inches in length with a minimum internal diameter of 4-1/4 inches. The lower portion of this section shall be an arched bell-shape to accommodate the 2-inch valve and 2-inch pipe it will be set over. The minimum width and the minimum height of the arch shall be 3-5/8 inches and 3-1/4 inches respectively. The minimum internal diameter of the bell- shaped portion shall be 7 inches and the minimum height of the bell-shaped portion shall be 6 inches.

Extension Section: This section shall be a minimum of 22 inches in length with an extension range up to 18 inches. This section shall have a minimum internal diameter of 4-1/4 inches.

Cover: The cover shall be cast iron with the word "WATER" cast into the cover. The cover shall have a minimum width and length of 5-7/8 inches and 1-9/16 inches respectively.

All 2-inch corporation valves shall be ball-type equal to or exceeding the quality of series FB1000 or 74101BCAP-22 with tee head adapter (cc. thread x compression) as manufactured by Ford or A.Y. McDonald.

Bolts for all flexible couplings, flanged and mechanical joints shall be high strength, low alloy steel bolts only, conforming to AWWA C111 as latest revised. Bolt manufactures certification of compliance shall accompany each shipment.

CUT-IN VALVES: Valves of a given size to be cut-in to an existing line shall have the same pay item number followed by the words "CUT-IN". A valve to cut-in shall meet the same specifications as valves of a similar size

but shall include cutting of existing pipe, removing existing valve, stacking existing pipe and valve at the Ballard Street Yard, dewatering the trench, the required tie-ins, pipe, couplings, accessories, other

fittings, labor, equipment, materials, excavation, and backfilling as specified herein. Under NO circumstances shall any of the work under this item be compensated by other pay items.

VALVES REMOVED & RESET: An existing valve to be removed and reset for the purpose of cleaning & cement lining shall have the same pay-item number as other similar valves followed by "R&R". A valve to be removed & reset shall utilize the existing valve but shall include cutting of existing pipe, removing existing valve, stacking existing pipe and valve at the Ballard Street Yard, dewatering the trench, the required tie- ins, pipe, couplings, accessories, other fittings, labor, equipment, materials, excavation, and backfilling as specified herein. Under NO circumstances shall any of the work under this item be compensated by other pay items.

A DESIGN AND CONSTRUCTION

All valves shall be installed at a maximum of 500 feet, unless otherwise directed by the Contracting Officer. All valves shall be set level. Each gate shall be tightly closed before being placed in line, and shall remain so until the joint on each side is completely made.

All valves shall be carefully handled to avoid shock or damage.

Proper installation of valve boxes helps ensure against operating difficulties in the future. The soil shall be firmly compacted around the bonnet of the valve to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve. The valve box shall rest above the valve so the weight of traffic passing over the street will not be transferred to the pipe or valve.

Valve boxes shall be carefully fitted together and to each valve with a minimum overlap of six (6) inches between the box sections when in the most extended position. The valve box shall be securely held vertical and plumbed straight during backfilling. Covers shall be set to the finished grade as directed by the Contracting Officer. After the box is set, the contractor shall operate the valve or corporation stop to the satisfaction of the Contracting Officer.

During the course of water main construction and/or resurfacing of street, the contractor may have to adjust or remove and replace existing valve and service boxes. When adjusting a water box the contractor shall excavate the complete top section of the box, separate the top section from the lower or bottom section and raise or lower the top section to the specified line or grade. Some gate and service boxes that are called out to be adjusted may not be able to be adjusted as described above. There may be grade changes that exceed the range of adjustment within the existing box; the top and bottom sections of the existing box may be fused together due to age and corrosion and the sections cannot be separated or there may be damage to the box sections that is not visible from the surface. If one or more of these conditions exist, the Contracting Officer may deem it necessary to remove and stack the existing box and have a new valve or service box installed. The contractor shall make every effort to separate the sections of the existing box to be adjusted prior to the Contracting Officer allowing the removal and stocking of the existing box. The City shall supply new valve or service boxes to replace existing boxes that are not suitable for reuse only when the damaged box is on an existing public water main or service. **The City will not supply valve boxes for new construction or to replace damaged boxes that are on private water mains or services.**

Valve and service boxes that are removed and stacked shall remain the property of the City of Worcester

D.P.W. Water Operations. The contractor shall deliver, unload and store said valve and service boxes at the City's Ballard Street Pipe Yard at no additional cost to the City.

Valve and service boxes shall be trimmed and/or cut with an abrasive pipe saw only. The use of hammers and wrenches to hand trim the boxes shall not be allowed.

Valves that are furnished and installed in existing water mains will be known as Cut-In Valves. The work of cut-in valves shall include the cutting of the existing pipe and furnishing and installing all necessary items to successfully accomplish the work.

All tees shall be three (3) way gated and all crosses shall be four (4) way gated unless otherwise directed by the Contracting Officer.

Water Operations shall check and clean all main gates needed for a shutdown before the contractor starts the work.

B MEASUREMENT AND PAYMENT

Ball Valves, gate valves, butterfly valves, cut-in valves, valves removed & reset, tapping sleeves and valves,

roadway boxes and valve boxes will be measured per Each as determined by actual count complete and in place.

Valves, cut-in valves, valves removed &reset, tapping sleeves and valves, ball valves, and boxes will be paid for at the Contract Unit Price as set forth in the Proposal which price shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work specified herein.

Payment for a cut-in valve, valves removed & reset, butterfly or gate type, on an existing line, shall include cutting of existing pipe, removing existing valve, stacking existing pipe and valve at the Ballard Street Yard, dewatering the trench, the required tie-ins, pipe, couplings, accessories, other fittings, labor, equipment, materials, excavation, and backfilling shall be paid only under the item of cut-in valve. Under NO circumstances will any of the work under this item be compensated by other pay items.

Payment for Adjusting Gate Box or Service Box to Grade shall include all excavation, concrete or asphalt collars to anchor the top box, labor, equipment, materials, delivering and unloading of any boxes deemed unsuitable for reuse at 1065 Millbury Street and any incidentals necessary to complete the work. Please note: Adjusting the valve box includes lowering or adjusting to any grade other than finished grade. Gravel, temporary and permanent patch, gate boxes, service boxes, and any other items needed for this work shall be paid for at the respective Contract Unit Price for that item.

ITEM 309 SERVICES AND SERVICE CONNECTIONS

ITEM 309.1000 SERVICE CONNECTION

ITEM 309.2000 SERVICE BOX AND CURB STOP 1”

ITEM 309.3000 SERVICE BOX AND CUT-IN CURB STOP (3/4”- 1")

ITEM 309.4000 SERVICE BOX AND CUT-IN CURB STOP (1 ¼” - 2")

ITEM 309.5000 SERVICE BOX AND CURB STOP (1 ¼” - 2”)

A. *SCOPE OF WORK*

The work specified in this section includes the installation of new water service lines and the replacement of and the repair of existing water service lines as shown on the plans and specified herein.

B. *MATERIALS*

All brass valves, fittings and appurtenances used in underground service shall conform to ANSI/AWWA C800 (latest revision). ASTM B584 Brass components in contact with potable water, identified with “NL”, UNS C89833 (latest revision). Brass components not in contact with potable water, 85-5-5-5, UNS C83600 (latest revision). NSF/ANSI 61 and NSF/ANSI 372 and shall be manufactured by Ford Meter Box Company, A.Y. McDonald or equal unless otherwise approved by the Director. The design of all brass fittings shall be based on a minimum internal hydrostatic pressure (working water pressure) of 200 psi

1. Corporations:

For new taps one (1) inch FB1000 or 74701B-22 cc (AWWA) thread x pack joint (compression)

For new taps 1-1/4 inch to 2 inch FB1000 or 74101BCAP-22 with Tee Head Adapter cc (AWWA) thread x pack joint (compression)

For replacement of existing corporations one (1) inch or less FB1100 or 74704B-22 IP thread x pack joint (compression)

For replacement of existing corporations 1- 1/4 inch to 2 inch FB1100 or 74704B-22 with Tee Head Adapter IP thread x pack joint (compression)

2. Curb Stops:

B44 or 76100-22 Series full port pack joint x pack joint

3. Couplings:

C44 or 74758-22 Series - pack joint x pack joint

C22 or 74758 Series - flared joint x flared joint

All compression fittings shall be installed with solid tubular stainless steel internal insert stiffeners.

Service boxes shall be arch pattern rod type, with a one (1) inch diameter upper section, as manufactured by Quality Water Products, or approved equal. The service box shall adjust one (1) foot for proper height. The arch will accommodate up to one (1) inch ball curbs. The 36-inch rod shall be offset for centering in pipe and must be minimum 5/8" diameter. A brass cotter pin must be supplied with each rod. Rod shall be permanently attached to end yoke. The plug cover shall have a deep slot for the release of water and removal of debris. The brass pentagon plug shall have a coarse thread

Polyethylene tubing shall meet the latest revision of AWWA Standard C901, have a working pressure of 250 psi, and shall meet the nominal size as shown on the plan. All polyethylene tubing shall be copper tube size (CTS), meeting ASTM specifications D-1248, D-2239, and D-2737 and shall meet PE 4710 requirements.

Copper tubing shall conform to the requirements of ASTM-B88, Type K, “Annealed” (soft).

All materials and construction shall conform to figures W-8A, W-8B, W-8C and W-8D which are part of these specifications

C. *DESIGN AND CONSTRUCTION*

The minimum allowable size of any water service shall be one (1) inch.

All pipe and other appurtenance, on both fire and domestic service lines, from the public or private water main to the outlet side of the meter or to the main control valve immediately inside the foundation in case where meter pits are required shall conform to all City of Worcester DPW&P Standard Specifications and Details.

All service lines shall be tapped on or connected to a public water main on City property. No service line shall be connected to another service line without prior written approval from the Director of Water Operations. If one service line is allowed to be connected to another service line, the connection point and controlling valve shall be on City property.

All service lines, whether tapped on or connected to a public water main or another service line, shall be individually gated. This is to allow control of any one service line without affecting any other service line.

All individually owned units shall have separate water services installed a minimum of six (6) feet apart throughout their entire length.

Condominium and apartment-type developments shall be allowed one (1) adequately sized service. All service lines shall be sized by the owner's architect or engineer.

All water services shall have a five (5) foot minimum and an eight (8) foot maximum depth of cover as measured from the top of the pipe to finish grade.

Contemplated services shall be allowed in order to minimize trenching in base paved streets, particularly in developments. If a contemplated service is not used by the developers or owner, that service shall be properly plugged at the main and curb stop box removed by the developer or owner.

Water service lines shall be installed straight and perpendicular from the water main to the foundation unless otherwise directed by the Contracting Officer. This will facilitate the easy locating of the service pipe in the future. Service lines shall be installed a minimum of ten (10) feet away from any sewer service.

All service lines greater than two (2) inches in size shall be even sized pipe.

All service lines between 1-1/4 inches and 2 inches in size shall be copper tubing.

All service lines greater than two (2) inches in size shall be ductile iron pipe as specified in Item 301 of these specifications.

All service lines shall be pressure tested, disinfected and bacteria tested as specified in Item 301, Section C. of these specifications.

When any water service runs under a concrete floor the pipe shall be installed inside an approved conduit. The size of the conduit shall be at least twice the diameter of the service pipe being installed. See figure W-8D.

All taps shall be made on the horizontal and a minimum of three (3) feet away from any joint or bell in the water main unless otherwise directed by the Contracting Officer.

All one (1) inch taps on cast or ductile iron mains 8-inch or greater in size shall be made by direct means only using cc (AWWA) thread corporations. A minimum of three full threads shall be required for one (1) inch corporation stop taps. If the minimum number of threads cannot be achieved, a service saddle shall be used. All one (1) inch taps on cast or ductile iron mains between 2-inch to 6-inch in size shall be made with cc (AWWA) thread corporations using a service saddle.

All taps on PVC water mains shall be made using a service saddle.

All 1-1/2 inch and 2 inch taps made on mains less than 16 inches in diameter shall be made with cc (AWWA) thread corporations using a service saddle. All 1-1/2 inch and 2 inch taps made on mains 16 inches or larger shall be made by direct means using cc (AWWA) thread corporations.

All taps four (4) inches or greater in size shall be made as detailed in Item 311 of these specifications.

All lengths of polyethylene and copper tubing shall be joined by means of compression or flared fittings only. Joints below ground shall be kept to a minimum; ideally the service pipe shall be installed in one continuous length from the corporation stop to the curb stop and from the curb stop to the meter valve.

As a general rule, a curb stop and box shall be installed within the City right-of-way at or near the property line behind the sidewalk usually in the grass area. Curb stops and boxes shall not be located within the sidewalk unless directed by the Contracting Officer because of special or unique conditions. Curb stops boxes shall be supported by a flat brick or concrete block so that the weight of the traffic passing over the box will not be transferred to the valve or service pipe.

The Contractor shall be required to install new curb stops and service boxes on existing polyethylene and copper tube service lines with sufficient cover in sizes ranging from 3/4 inch through 2 inch. The pay items covering this operation shall be Item No. 308.3 “Service Box and Cut-In Curb Stop (3/4" - 1")” or Item No.

309.4 “Service Box and Cut-In Curb Stop (1-1/4" - 2").” Any 3/4" or 1" pipe used during the cutting in of any 3/4" or 1" curb stop shall be considered incidental to pay item 309.3 and shall be compensated for under pay item 309.3. Any 1-1/4", 1-1/2" or 2" pipe needed to cut-in any 1-1/4", 1-1/2" or 2" curb stop shall be supplied by the Contractor at no additional compensation to the Contractor. The Contractor is encouraged to reuse the existing service pipe whenever possible.

Polyethylene tubing shall be installed with enough slack to compensate for settlement and compaction.

When any service pipe is replaced, the contractor shall thoroughly rod out the existing corporation so that there are no obstructions and a full port of water is able to flow. The contractor shall then connect the changed service pipe to the existing corporation.

The changing of water service pipes 2-inch or less in size from an old water main to the new water main shall include the disconnecting of the service pipe from the old water main; the tapping of the new water main; the installation of the appropriate size corporation stop and the installation of a new copper or plastic gooseneck and fittings to reconnect the existing service pipe to the new water main. The minimum length of the service pipe or gooseneck used to connect the existing service pipe to the new corporation stop shall not be less than two (2) feet unless otherwise directed by the Contracting Officer. Payment for all service tubing installed during a service connection shall be made under pay items: 301.01, 1” Polyethylene Tubing; 301.015, 1” Copper Tubing or 301.02, 2” Copper Tubing, whichever is applicable.

The Contractor may be required to change, replace and/or lower existing water service pipes 2-inch or less in size on the City property only. All existing black iron or galvanized iron service pipes shall be replaced from the water main to the property line with the appropriate size polyethylene or copper water service tubing. If any existing water service is found to lack sufficient depth of cover the pipe shall be lowered to ensure a minimum of five (5) feet of cover. The existing service pipe shall be replaced with the appropriate size polyethylene or copper water service tubing and an appropriately sized curb stop and service box shall be set at the property line. The replacement and/or lowering of existing water service pipes shall be compensated for using pay items 301.01, 1” Polyethylene Tubing; 301.015, 1” Copper Tubing or 301.02, 2” Copper Tubing, whichever is applicable. Curb stops and service boxes installed as part of the replacing and/or lowering of water service pipes shall be compensated for using pay items pay item 309.2, Service Box and Curb Stop or pay item 309.5, Service Box and Curb Stop 2”, whichever is applicable.

All service pipes and water mains two (2) inch or less in size shall be installed on a bed of six (6) inches of moist

sand borrow and backfilled with such sand, well compacted, to a level of one (1) foot above the crown of the service pipe. The remaining backfill from a point one (1) foot above the crown of the pipe to a point one (1) foot below finished grade shall be select common fill or gravel borrow as directed by the Contracting Officer.

The Contractor shall be required to lower the existing street service boxes whether during the changing of the existing service pipe; on existing service lines that have receive a Service Box and Cut-In Curb Stop or already have a curb stop and box in place. The pay item covering this operation shall be Item no. 304.10 "Lowering Service Box." (see previous section for detailed description) This will be done by removing the existing top box and resetting it to the proper grade approximately 15" to 18" below finished grade unless a rigid road base exists in which case the box shall be set to finish grade of the rigid base. It shall be set in a plumb position over the corporation stop so that the corporation may be operated by a wrench. Gravel Borrow, where required, will be paid to the Contractor under its respective pay item. The Contractor shall be responsible for cleaning existing service boxes over corporation stops where needed. Compensation for this work shall be included as part of Item no. 304.10. When the Contracting Officer deems it necessary, the contractor shall pick up a new street service box for installation over an existing corporation to replace a broken box not suitable for reuse. The contractor shall pick up a street service box at 1065 Millbury Street using his copy of his water permit as a receipt to obtain the boxes. Street service boxes not suitable for reuse shall remain property of the City and shall be returned to the City's pipe yard.

The contractor shall operate the completely installed and backfilled curb stop in the presence of and to the satisfaction of the Contracting Officer. At this time the contractor shall flush the service to eliminate any foreign material that could clog the plumbing of the building being served. If the service line, meter or internal plumbing becomes plugged due to construction, the contractor under the supervision of the Contracting Officer shall remove the meter and flush the service line and the buildings internal plumbing.

D. *SPECIAL CONDITIONS*

New service connections made on existing two (2) inch copper or plastic mains shall consist of a 2 inch brass tee, with a one (1) inch cc threaded side outlet, cut in on the existing main unless otherwise directed by the Contracting Officer.

When a new main is installed and the existing service line consists of copper tubing; copper tubing shall be used to connect this existing service line to the new main. The minimum length of service pipe that shall be used to connect the existing service pipe to the new corporation stop is two (2) feet or unless otherwise directed by the Contracting Officer.

All service lines for gasoline service stations, gasoline and oil storage facilities, bulk chemical storage facilities or other high risk areas shall be copper tubing or ductile iron pipe in order to prevent the permeation of organic chemicals through the polyethylene tubing pipe wall and the subsequent contamination of the potable water.

PRIVATE STREET CONVERSION or **ROADWAY RECONSTRUCTION** may require lowering service lines that are deemed too shallow. Contractors shall be paid under the appropriate size in Item 301 at cost per foot for a given size service line.

When permanent repairs are made to any damaged or broken water service, all repairs shall be made as follows:

1. Plastic (PE) pipe up to one (1) inch in size shall be repaired with the same sized plastic (PE) pipe only.
2. Copper tubing up to two (2) inch in size shall be repaired with the same sized copper tubing only.
3. Iron or galvanized pipe up to one (1) inch in size shall be repaired with the same sized plastic (PE) pipe or copper tubing.
4. Iron or galvanized pipe between one (1) inch and two (2) inch in size shall be repaired with the same sized copper tubing only.
5. Cast iron or ductile iron pipe greater than two (2) inch in size shall be repaired with the same sized ductile iron pipe only.

E. *MEASUREMENT AND PAYMENT*

Service Connections, Service Box and Curb Stop, Service Box and Cut-in Curb Stop, Lower Street Service Box, and 2-Inch Taps will be measured per Each complete in place including excavation as specified herein.

All services 1" or less in size connected to the new main shall receive a service connection to be paid for at the Contract Unit Price. This price shall include all excavation less than 7 feet in depth, backfilling, compaction, the corporation stop, brass fittings, service saddle if required, tapping of the water main, tools, labor, and

equipment necessary to do the job.

Services that are to be relayed to the street line shall also include a service box and curb stop to be paid under the Contract Unit Price.

Cut-in Curb Stops shall be used where the existing service line is of acceptable material. This shall include all excavation less than 7 feet in depth, the curb stop, service box, service box extensions and base adapters, brass fittings, tools, labor, backfill, compaction, and equipment necessary to do the job.

Services to be abandoned, or boxes to be lowered at the main shall each be paid under the appropriate pay items. This shall include all excavation less than 7 feet in depth, brass fittings, a new service box if needed, tools, labor, backfill, compaction, and equipment necessary to do the job.

ITEM 310 HYDRANTS

ITEM 310.1000 NEW HYDRANT

ITEM 310.2000 HYDRANT EXTENSION

ITEM 310.3000 HYDRANT REMOVED AND STACKED

ITEM 310.4000 HYDRANT REMOVED AND RESET

ITEM 310.5000 INSTALL NEW CITY SUPPLIED HYDRANT

A. *SCOPE OF WORK*

The work under this section shall consist of furnishing and installing new hydrants and removing and resetting existing hydrants, as specified herein, as shown on the plans, or as directed by the Contracting Officer.

B. *MATERIALS*

Fire hydrants shall be manufactured to comply in all respects to the latest revision of AWWA Standard C-502 and shall comply with the specific requirements and design standards per the Kennedy Valve drawing no. 80783 which is attached and is part of these specifications.

The design of the fire hydrant described below shall be based on a minimum internal hydrostatic pressure (working water pressure) of 200 psi.

Hydrants shall be UL listed and FM approved.

Hydrants shall be a post type, dry top design with the main valve closing with the pressure of the normal water flow. The minimum main valve size shall be 5-1/4 inches.

Hydrants shall open right (clockwise).

The operating nut shall be one (1) piece bronze and it shall be pentagonal in shape measuring 1-5/8 inches from point to opposite flat. An alumite (grease) fitting shall be supplied threaded into the operating nut for periodic lubrication of the operating threads with grease.

The nozzle cap nuts shall be pentagonal in shape measuring 1-5/8 inches from point to opposite flat. Hydrants shall be designed for installation in a trench that will provide five (5) foot minimum depth of cover.

Hydrants shall be equipped with two (2) 2-1/2 inch hose nozzles and one (1) 4-1/2 inch pumper nozzle, national standard thread. Hose and pumper nozzles shall be the ¼ turn type, secured into the upper barrel of the hydrant by O-ring seals and stainless steel retaining screws. Each nozzle cap shall be provided with a Buna N rubber washer.

Hydrants shall be of the traffic model breakaway-type. The union between upper and lower stems shall be made by a breakable cast iron coupling retained into place by stainless steel pins. To insure proper repair, the breakable coupling shall have the word TOP cast on the appropriate half. The two (2) -piece traffic flanges shall be held in place by nuts and bolts. The upper barrel shall be able to be rotated 360 degrees without removing any bolts.

Lower barrel flanges shall be constructed of ductile iron and permanently screwed onto the ductile iron lower barrel. Flanges secured by snap rings are not acceptable. Lower barrel bolt holes mating with the break flange shall be notched to facilitate easy bolt replacement.

A dirt shield or weather cap shall be standard. This cap or shield shall be marked with an arrow and the word "open" to indicate the direction to turn the stem to open the hydrant.

The hydrant drain valve shall operate automatically, without the aid of springs, pin or toggles, each and every time the hydrant is used. The drain valve mechanism is to be an integrally cast part of the upper valve plate. The hydrant elbow shall have its interior and exterior coated with fusion bonded NSF approved epoxy. The hydrant elbow shall be equipped with at least two (2) copper or bronze lined drain ports. The seat ring shall thread into a bronze bushing or drain ring. Pressure seals shall be "O" ring.

Hydrants shall be factory tested at 400 psi with the main valve in both the open and closed positions.

Manufacturer shall provide independent verification of this test and of the hydrant flow characteristics.

Hydrant inlet connections shall be a 6-inch mechanical joint. Hydrant accessories kits shall be supplied with each hydrant and shall consist of one (1) M.J. gland, one (1) M.J. gasket, and six (6) 3-1/2 inch "T" head bolts and nuts.

Hydrants shall be painted high-visibility yellow above the break flange.

Bolts for all mechanical joints shall be high strength low alloy steel bolts only, conforming to ANSI/AWWA C111/A21.11-90. Bolt manufactures certification of compliance shall accompany each shipment.

To insure compliance with AWWA and other applicable standards, and access to manufacturing facilities for inspection purposes, and assure timely shipment and delivery, all Fire hydrants shall be manufactured, assembled, and tested in plants located with the continental United States.

As specified on figure W-9, part of these specifications.

C. *DESIGN AND CONSTRUCTION*

The contractor shall be responsible for obtaining properly sized hydrants. There shall be no additional compensation to the contractor if an extension is required to raise the hydrant up to obtain the proper exposed hydrant height.

Hydrant heights shall be obtained by measuring the distance from finish grade to the bottom or invert of the connection pipe.

The centerline of the lowest nozzle of the hydrant shall be eighteen (18) inches above finish grade.

The hydrant shall have a set back of twelve (12) inches from the curb line to the point of the hydrant nearest the curb or as the Contracting Officer directs.

All hydrants shall be installed in the grass plot between the curb and the sidewalk wherever possible. The pumper connection of the hydrant shall face the street.

In the event that a hydrant is borrowed from the Water Operations' yard, the contractor shall submit a Purchase Order for the exact hydrant height that was obtained.

Hydrants shall be properly supported and held plumb while the connections are being made, and during backfilling. One-half cubic yard of pea stone shall be placed as directed to drain each hydrant drip.

A layer of 8 mil. polyethylene shall cover the pea stone prior to backfilling to prevent clogging of the drainage area

Thrust blocks shall be placed in accordance with the details and as directed by the Contracting Officer.

Hydrants shall be located not more than 300 feet apart in high value areas, and shall not exceed 500 foot spacing in residential areas, and shall be located as directed by the Contracting Officer.

Abandoning any hydrant shall include the removing, transporting and unloading of the existing hydrant at 1065 Millbury Street. The cutting out of the hydrant tee and the installation of a section of appropriate sized CLDI pipe; the removal and stacking of the valve box; and the cutting and plugging of the old connecting pipe.

The contractor shall verify in the field that each hydrant drains in a reasonable amount of time and shall be approved by the Contracting Officer before acceptance.

The controlling valve for the hydrant shall be restrained to the water main by the use of an Anchor Tee. The fire hydrant barrel, from the surface to the valve, shall be polywrapped as specified herein.

D. *SPECIAL CONDITIONS*

Persons wishing to move, relocate or abandon any public hydrant shall petition the City Council for permission

to move or relocate that hydrant.

Private use of any public or private hydrant shall not be allowed without prior authorization. Persons wishing to use a hydrant shall apply for a permit at Water Operations Engineering for the use of that hydrant. No hydrant use shall be allowed during winter months.

Flow Tests shall be allowed with the persons requesting the test taking all readings and Water Operations' personnel operating all hydrants. No flow tests shall be allowed during winter months.

E. *MEASUREMENT AND PAYMENT*

Hydrants, Hydrants Removed and Reset, Hydrants Removed and Stacked, Install New City Supplied Hydrant will be measured per Each complete in place as specified herein.

Hydrants, Hydrants Removed and Reset, Hydrants Removed and Stacked, will be paid for at the Contract Unit Price, which price shall include all excavation, hydrants, hydrant extensions, and stone for drainage area, plastic to cover drainage area, backfill, materials, tools, labor, and equipment necessary to complete the work as specified herein.

Install New City Supplied Hydrant shall include all excavation, hydrant extensions, stone for drainage area, plastic to cover drainage area, backfill, materials, tools, labor, and equipment necessary to complete the work as specified herein.

Hydrant extensions shall be paid under the unit bid price per each. These shall only be allowed where road or sidewalk reconstruction has made a significand change in grade for an existing hydrant. The cost of any extensions used on a new hydrant installation shall be considered part of the hydrant and there will be no compensation for this extension.

ITEM 310.6000 HYDRANT PAINTING

A. *GENERAL*

Paint Specifications:

Specially formulated to protect metal surface from rust and corrosion. Resists chipping, peeling and impacts while retaining excellent color and gloss. Protects against mild chemical spills, fumes, oil, and grease while providing superior gloss, color retention, and hiding. Application Method: Brush, roller, or spray Surfaces: Metal, Steel Exposure Conditions: Mild and Moderate Color: OSHA Yellow Formulation: Metal Finish, Styrenated Alkyd base, Speedy Dry, Enamel, High Gloss Unit size: Gallon (U.S.) Weight: 10lbs/gal VOC: greater than 450g/l Tack free time: 5-15 min @ 75 Degrees Fahrenheit, 50% Relative Humidity Dry time: 1 to 2 hours @ 75 Degrees Fahrenheit, 50 % Relative Humidity Recoat: 2 to 4 hours @ 75 Degrees Fahrenheit Coverage: 200 to 400 sq.ft/gal Thinning/Cleaning: Tuluol, Xylol Acceptable Brands: Insil-X, Al Pro Wilbur Williams, Totrust Rust-O-Leum, High Performance Industrial

Acceptable Brands:

Insil-X, Al Pro; Wilbur Williams, Totrust; Rust-O-Leum, High Performance Industrial Known Supplier:

Economy Paint Supply Co., 140 Chandler Street, Worcester, MA 01609 Tel: (508) 754-0015; (508) 792-0883

B. *LABOR SPECIFICATIONS*

The contractor is to supply all labor and materials including paint, brushes, scrapers or other materials needed to adequately paint the City hydrant.

Inspection of the hydrants will consist of a visual inspection for damage. Any visual damage will be reported to Water Operations with the intention that the City will repair the hydrant prior to painting.

Brush and any other debris will be removed from around the hydrant to an approximate 3 foot radius around the hydrant if required. Any brush and debris to be disposed of will be placed in the back of the truck and disposed of by the Contractor at his expense in an approved manner.

A "skirt" or other type of covering shall be laid on the ground around the base of the hydrant to prevent paint from splattering on the ground or sidewalk.

Any loose paint will be scrapped from the hydrant using a wire brush. Paint chips will be cleaned or removed from around the hydrant.

Apply covering coat of paint to all areas of the hydrant. Hydrants will be painted in accordance with the Worcester Water Operation's color code system. Low Service hydrants shall be painted all yellow. High Service hydrants shall be yellow except for the bonnet, which shall be painted white. Super High Service hydrants shall be painted yellow except for the bonnet, which shall be painted red.

Painting will only be done under temperature and/or weather conditions as per the recommendations of the paint manufacturer.

All left over paint, paint cans or painting supplies such as brushes and rags shall be disposed of by the contractor at his expense in a pre- approved manner that complies with all regulations pertaining to hazardous materials.

The scope of work will be performed during the DPW's normal work hours, normally 7:30AM to 4:00PM Monday through Friday, unless otherwise noted.

Care shall be taken not to paint any anti-vandalism device that may be attached to a hydrant.

C. *MEASUREMENT AND PAYMENT*

The work under this item will include all materials and labor necessary to complete the work as specified herein.

The pay item will be paid per each.

ITEMS 311 and 312 TAPS AND TIE-INS

ITEM 311.0200 2" TAP

ITEM 311.0400 4" TAPPING SLEEVE & VALVE

ITEM 311.0600 6" TAPPING SLEEVE & VALVE

ITEM 311.0800 8" TAPPING SLEEVE & VALVE

ITEM 311.1200 12" TAPPING SLEEVE & VALVE

ITEM 312.0200 2" TIE-IN

ITEM 312.0300 3" TIE-IN

ITEM 312.0400 4" TIE-IN

ITEM 312.0600 6" TIE-IN

ITEM 312.0800 8" TIE-IN

ITEM 312.1000 10" TIE-IN

ITEM 312.1200 12" TIE-IN

ITEM 312.1400 14" TIE-IN

ITEM 312.1600 16" TIE-IN

ITEM 312.1600 18" TIE-IN

ITEM 312.2000 20" TIE-IN

ITEM 312.2400 24" TIE-IN

ITEM 312.3000 30" TIE-IN

ITEM 312.3600 36" TIE-IN

ITEM 312.4200 42" TIE-IN

ITEM 312.4800 48" TIE-IN

A. *SCOPE OF WORK*

Work under this section shall consist of making all connections (tie-ins) from the new main to existing mains, existing hydrant laterals and existing services 1-1/2" and greater in size and the making of any and all taps on new or existing mains 1-1/2" greater in size as shown on the plans and as directed by the Contracting Officer. (The tapping for and the tying-in of individual services 1" or less in size is not included in this item, see Item 309.)

B. *MATERIALS*

All bolted sleeve-type couplings, reducing couplings, transition couplings, and flanged coupling adapters used to join plain-end steel, cast iron and ductile iron pipe shall conform to the latest revision of AWWA C219 and shall in addition meet the specific requirements and exceptions which follow:

1. The design of bolted couplings shall be based on a rated working pressure of 200 psi, a transient or surge pressure allowance of 100 psi, and a hydrostatic test pressure of 300 psi.
2. Couplings shall be manufactured from carbon steel, stainless steel, ductile iron or malleable iron. All materials used shall conform to AWWA C219, section 4.2.
3. Bolts for all bolted, sleeve-type couplings shall be high strength, low alloy steel bolts only, conforming to AWWA C111 as latest revised. Bolt manufacturers certification shall accompany each shipment.
4. All couplings shall be clearly marked as specified in AWWA C219. These markings shall include the manufacturer's model number or type, pipe size (outside diameter of pipe), center sleeve section identification, or, for steel center sleeves, thickness and length, and the rated working water pressure

Tapping sleeves shall be cast or ductile iron full sleeve type capable of containing pressure within the full volume of the sleeve. Sleeves shall be mechanical joint type for use with Class AB or CD cast iron pipe or ductile iron pipe. All tapping sleeves shall conform to the provisions set forth in Items 302 and 303 of these specifications. All tapping sleeves shall have a threaded plug tapped into the body of the tapping sleeve for pressure testing purposes. **Wrap around stainless steel sleeves shall not be allowed. As an alternate to cast or ductile iron, rigid stainless steel tapping sleeves with removable bolts may be used. Sleeves shall be all stainless steel 304 (18-8) construction with a full gasket giving 360 degree pipe coverage. Sleeves may have stainless steel flange outlet to be used with standard tapping gate or mechanical joint (MJ) outlet suitable for use with standard (MJ) X (MJ) resilient wedge gate valves per AWWA C509.**

All service saddles shall conform to the following:

1. All service saddles shall have cc (AWWA) threaded outlet.
2. All service saddles for use on cast or ductile iron water mains shall be a double strap (bale) equal to or better than the PowerSeal 3413; Smith-Blaire 331; Ford F202, JCM402, Mueller DR2A.
3. All service saddles for PVC mains or cast or ductile iron mains in known or suspected corrosive soils shall be a stainless steel double strap (band) equal to or better than PowerSeal 3417; Smith-Blaire 317; Ford FSD202, JCM404, Mueller DR2S.

All 2 inch valves and tapping valves shall conform to all the provisions set forth in Items 303 through 309 of

these specifications.

Bolts for all Flexible Couplings, Flanged and Mechanical Joints shall be high-strength, low alloy steel bolts only, conforming to the latest revision of AWWA C111. Bolt manufacturers certification of compliance shall accompany each shipment.

C. *DESIGN AND CONSTRUCTION*

Where existing fittings are available, a tie-in shall be made to connect the existing main, hydrant lateral or service lateral to the new main.

Where the difference in O.D.'s between the two pipes being joined is greater than one-half (1/2) inch, a transition coupling shall be used. No couplings with transition style gaskets shall be used.

Where there are no existing fittings available in the existing main to which the new main is to be connected, a tap may be required.

When 1-1/2 inch and 2 inch taps are made on mains less than 16 inches in diameter, service saddles shall be used.

When 1-1/2 inch and 2 inch taps are made on mains 16 inches in diameter and larger, the tap shall be made by direct means only.

All tapping sleeves and tapping valve assemblies shall be hydrostatically pressure tested prior to tapping. The test shall be at 1-1/2 times the working pressure of the existing main or a minimum of 150 psi and shall be maintained for one (1) hour, or as directed by the Contracting Officer.

The water service shall be maintained as continuously as possible when taps and tie-ins are made. The contractor shall notify all persons affected by the disruption of water service a minimum of 24 hours prior to the shutdown.

Polyethylene wrap shall also be used for all couplings, including bolts used for this work.

The contractor shall install permanent blocking under the tapping valve to prevent any movement of the tapping sleeve and valve on the pipe.

The contractor shall construct a thrust block behind each tapping sleeve after the sleeve has been successfully pressure tested. All thrust blocks shall conform to all provisions in Item 313 of these specifications.

The contractor shall be responsible for the proper sizing of the tapping sleeve.

No full sized taps shall be allowed (example: 8" tap on an 8" main) without prior written approval from the Director of Water Operations.

All taps shall be made on the horizontal and a minimum of three (3) feet away from any joint or bell in the water main unless otherwise directed by the Contracting Officer.

D. *MEASUREMENT AND PAYMENT*

Taps and Tie-ins will be measured per Each complete in place as specified herein.

Taps and Tie-ins shall be paid for at the Contract Unit Price as set forth in the Proposal. Price shall include full compensation for furnishing all labor; materials, tools, equipment and incidentals for doing all the work as specified herein.

Included in the tap item shall be all necessary excavation, backfilling, compaction, dewatering, tapping sleeves, service saddles, tapping valves, 1-1/2 inch and 2 inch corporations.

Included in the tie-in item shall be the removal of any existing restraints, plugs, caps, reducers; the installation of all couplings, pipe nipples, rodding, pouring of lead joints if necessary; and all the necessary excavation, dewatering, cutting of pipe, backfilling and compaction.

ITEM 313 THRUST BLOCKS

ITEM 313.1000 THRUST BLOCK CY.

ITEM 313.2000 THRUST BLOCK EA.

A. *SCOPE OF WORK*

The work under this section shall consist of furnishing and placing thrust blocks, or other approved methods of thrust restraint wherever pipes change direction or size as directed by the Contracting Officer.

B. *MATERIALS*

Cement Concrete

All Cement Concrete shall conform to the requirements as set forth in the most recent edition and amendments thereto of the Standard Specifications for Highways and Bridges, Massachusetts Highway Department, Commonwealth of Massachusetts.

Cement Concrete for thrust blocks shall conform to Section 4.02 (3000 psi, 1-1/2", 470) of the above-mentioned specifications.

Mechanical Joint Thrust Restraining Fittings

Dimensions of glands used in mechanical joint restraining fittings shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of AWWA C110 (gray and ductile iron standard fittings) or AWWA C153 (ductile iron compact fittings) and AWWA C111.

C. *DESIGN AND CONSTRUCTION*

The balancing of thrust forces in buried pipelines is usually accomplished with the use of bearing or gravity thrust blocks, restrained joint pipe systems, or a combination of these two methods. The criteria and basis for the design of thrust restraint shall be as published by the Ductile Iron Pipe Research Association (DIPRA) entitled "Thrust Restraint for Ductile Iron Pipe", current edition.

All tees, bends, reducers, plugs, caps, offsets, hydrants and other fittings that either change the direction of flow or stop flow completely shall be restrained or blocked.

The following parameters shall be used for design purposes:

1. Soil Bearing Pressure shall be 3,000 LB. per SQ. FT. (psf).
2. Hydrostatic Test Pressure shall be 200 LB. per SQ. IN. (psi).
3. All cement concrete used for thrust blocks shall have a compressive strength of 3,000 LB. per SQ. IN. (psi) at 28 days as specified above.
4. Safety Factor (S_F) shall be 1.5. Thrust Blocks

The City of Worcester shall allow the use of thrust blocks on water mains and larger diameter water services as a means of restraining thrust.

Thrust blocks shall be constructed as directed by the Contracting Officer, and in full accordance with Typical Thrust Block Detail sheets which are a part of these specifications.

Thrust blocks shall be centered on the resultant thrust force to ensure an even transfer of forces from the pipe or fitting to the block. All thrust blocks shall cradle the pipe or fitting it is poured against.

Thrust Blocks shall be cement concrete poured against undisturbed original ground or approved compacted backfill to ensure an even transfer of forces to the surrounding ground.

All glands, joints, bolts and nuts shall be covered or wrapped with heavy duty polyethylene sheeting (8 mil or greater) to keep the concrete from bonding to the pipe and appurtenances. The plastic shall be placed so that pipe joints will be accessible for any future repairs. **NO** concrete shall directly cover pipe joints, fitting joints, nuts, bolts or hydrant drain holes.

Blocks shall be poured directly against forms.

Thrust anchors or a dead man may be used to restrain vertical bends. The weight or mass of the thrust anchor shall be the force balancing the vertical thrust component. Embedded steel rods anchor the fitting to the concrete block to resist the upward thrust. Anchoring rods spaced equally across the top of the bend shall be embedded in concrete. The number and size of the rods shall be as detailed in the Typical Thrust Block Detail sheets which are a part of these specifications.

Tie Rods

Yokes, friction clamps, pipe anchors and tie-rods can be installed to resist thrust forces either alone or as an addition to thrust blocks or restrained joint pipe when and as directed by the Contracting Officer. For mechanical joints, tie-rods may be threaded through the bolt holes in the flange and secured to the rod by using nuts and washers.

All steel, including rods, clamps, bolts and nuts shall be protected from galvanic action or corrosion by coating with an approved bitumastic coating or other corrosion retarding material before the pouring of concrete and/or backfilling.

Restrained Joint Pipe

Restrained push-on and mechanical joints can be used as an alternative to thrust blocking and/or tie- rods for resisting thrust forces. A restrained joint is a special push-on type or mechanical joint that is designed to provide longitudinal restraint where there is a shortage of space due to conflicts with other utilities and structures, and where there is the possibility that the soil behind the fitting has been or will be disturbed.

The criteria and basis of design for all restrained joint pipe shall be the Ductile Iron Pipe Research Association (DIPRA) publication entitled "Thrust Restraint Design for Ductile Iron Pipe," current edition. In addition to DIPRA a computer software program for pipe thrust restraint design has been developed by EBBA Iron Sales, Inc. entitled "Restrained Length calculator", current version. This program is based on the same engineering principles, criteria and analytical approach as the DIPRA design requirements. The use of the program by EBBA is approved. The parameters to be used shall be the same as those listed above.

D. *MEASUREMENT AND PAYMENT*

Thrust blocks will be measured per Cubic Yard completely in place as specified herein.

Or when specified

Thrust Blocks will be measured per Each completely in place as specified herein.

Thrust blocks will be paid for at the Contract Unit Price as set forth in the Proposal, which price shall include all materials, tools, labor, equipment, and incidentals necessary to complete the work as specified herein.

ITEM 314 BLOW-OFFS AND AIR RELEASE VALVES

ITEM 314.1000 1"- 2" AIR RELEASE VALVE

ITEM 314.2000 1" BLOW OFF

ITEM 314.3000 DIG AND PLUG EXISTING CONNECTION UP TO 2"

ITEM 314.4000 BLOW OFF MANHOLE

ITEM 314.5000 DIG AND PLUG EXISTING CONNECTION 3" AND LARGER

A. *SCOPE OF WORK*

The work under this section shall consist of furnishing and installing new air release valves and blow-offs of various sizes, including all necessary appurtenances, on new and existing water mains or digging and plugging an old service connection at the main as shown on the plans, or as directed by the Contracting Officer.

B. *MATERIALS*

All brass valves, fittings and appurtenances used in underground service shall conform to ANSI/AWWA C800 (latest revision). ASTM B584 Brass components in contact with potable water, identified with "NL", UNS C89833 (latest revision). Brass components not in contact with potable water, 85-5-5-5, UNS C83600 (latest revision). NSF/ANSI 61 and NSF/ANSI 372 and shall be manufactured by Ford Meter Box Company, A.Y. McDonald or equal unless otherwise approved by the Director. The design of all brass fittings shall be based on a minimum internal hydrostatic pressure (working water pressure) of 200 psi.

Corporations (for air release valves): F800 or 73121 cc thread x IP thread outlet.

Ball Valves (for air release valves): B11 or 76101 series (full port) F.I.P. x F.I.P.

Brass "Street" Elbow (for air release valves): F.I.P. x M.I.P.

All valves, pipe, fittings and other appurtenances other than these specified above shall conform to all applicable specifications set forth in the appropriate sections of these specifications and Detail Sheets 13, 13A and 13C which are part of these specifications.

C. *DESIGN AND CONSTRUCTION*

Air Release Valves shall be placed at all high points on any water main installation. Air Release Valves shall be used to expel air as the water main is filled with water and shall be shut after all air has been expelled. Air Release Valves shall also be used to allow air to enter the water main to aid in the draining of that main when it is shut down.

One (1) inch Blow-Offs shall be placed on any water main that is dead-ended and has no other means of flushing out that dead-end.

All one (1) inch Blow-Offs shall have a threaded connection on the top of the copper riser pipe to allow for a hose to be tied onto that Blow-Off to carry the water away to the drainage system.

All Blow-Offs greater than one (1) inch in size shall be installed with a blow-off manhole as shown in Detail Sheet 13C.

One-half cubic yard of pea stone shall be placed under and around the air release valve or one (1) inch blow-off prior to the setting of the valve box to drain the valve box. A layer of 8 mil polyethylene shall cover the pea stone prior to backfilling to prevent the clogging of the drainage area.

Taps for air release valves and one (1) inch blow-offs shall be made vertically plumb and shall remain that way during the setting of the valve box and backfilling.

Air release valves and one (1) inch blow-offs are not interchangeable. Each one has a specific purpose and shall be used for that purpose only.

Blow-Off manholes shall be pumped out when using that blow-off.

No blow-off shall be piped directly or indirectly into any sanitary or surface sewer.

The contractor may be required to plug and/or cap water service, blow-off, air cock or other pipe connections two (2) inch or less in size that are no longer in use and are called out on the plans to be abandoned. This plug or cap shall be made right into the water main whenever possible, with all old fittings or corporation stops removed, or as directed by Contracting Officer. This item shall apply to all pipes up to 2” or less in size and shall include all work, brass fittings and restraints as needed.

The contractor may be required to and/or cap water service, water main, blow-off, air cock and other pipe connections three(3) inch or greater in size that are no longer in use and are called out on the plans to be

abandoned. The plug or cap shall be installed as close to the valve, fitting and/or tee as possible or as directed by the Contracting Officer. This item may apply to the abandonment of old fire sprinkler services, old domestic water services, old water main connections, old blow-offs that are cross connected to sanitary sewers and any other connection found to be no longer in use or needed. This item shall apply to all pipes greater than 2” in size and shall include all work, restraints, rodding and incidentals as needed.

D. *MEASUREMENT AND PAYMENT*

Blow Off Manhole, 1-inch Blow-Offs and Air Release Valves and Dig and Plug Existing Connections shall be measured per Each, completely in place.

Blow Off Manhole, 1-inch Blow-Offs, Air Release Valves or Dig and Plugged Existing Connections shall be paid for at the Contract Unit Price as set forth in the Proposal, which price shall include excavation, dewatering, backfill, compaction, materials, tools, labor, equipment, and incidentals necessary to complete the work as specified herein. Payment for all thrust blocks and cast or ductile iron fittings used as part of Item 314.5, Dig and Plug Existing Connection 3” and Larger shall be made using the appropriate pay items for that item.

ITEM 315 INDICATOR POST

ITEM 315.1000 INDICATOR POST

A. *SCOPE OF WORK*

This work shall consist of furnishing and placing indicator posts at the direction of the Contracting Officer.

B. *MATERIALS*

All materials shall be in accordance with the Detail Sheet W-16 which is part of these specifications.

C. *DESIGN AND CONSTRUCTION*

Indicator post shall be a 6 inch iron pipe filled with stones and capped off with cement concrete. Exposed length shall not be less than 4 feet from final grade, and shall be buried for not less than 4 feet. The base around the indicator post will be secured with heavy rocks and poured concrete. The indicator post shall be painted according to the Contracting Officer's instructions, either silver, red or yellow.

Indicator posts shall be located at certain points to serve as a permanent marker for the purposes of locating valves, hydrants and other appurtenances.

Indicator posts shall be located within the City right-of-way but not in the traveled way.

D. *MEASUREMENT AND PAYMENT*

Indicator Post will be measured per Each completely in place as specified herein.

Indicator Posts will be paid for at the Contract Unit Price as set forth in the Proposal, which price shall include all materials, tools, labor, equipment, and incidentals necessary to complete the work as specified herein.

ITEMS 316 and 317 TEMPORARY BY-PASS-LINES WITH SERVICE HOSES AND TEMPORARY HYDRANTS

ITEM 316.0200 TEMPORARY 2" BY-PASS

ITEM 316.0400 TEMPORARY 4" BY-PASS

ITEM 316.0600 TEMPORARY 6" BY- PASS

ITEM 317.0000 TEMPORARY TAPS ON SERVICE LATERALS

A. *SCOPE OF WORK*

The work under this section shall include furnishing, installing, maintaining and removing temporary by-pass pipes with service hoses and temporary hydrants of the sizes directed to satisfactorily service all dwellings, shops and places of business served by the water mains to be taken out of service for construction. The location and extent of temporary by-pass pipes shall be as shown on the drawings or as directed by the Contracting Officer.

B. *MATERIALS*

All temporary by-pass pipe and other appurtenances shall be fusion welded high density polyethylene (H.D.P.E). Exceptions may be made at the discretion of the project engineer for mechanical fittings at hydrant feed connections or temporary hydrant connections. All non-HDPE materials must be approved in advance. All plastic pipe and hose for service connections shall bear the imprint of the National Sanitary Foundation (NSF) approval for potable water, NSF-PW or shall be capable of meeting the standards established by the NSF for its use.

The pipe materials selected shall be fully adequate to withstand the pressures to which they will be subject to and adequate to withstand whatever forces, such as traffic loading, they will encounter. All joints for all pipe and hoses shall be watertight.

Ramp material for driveway crossing or other crossings not set in a trench shall consist of rubber, plastic or other polymer material capable of holding the pipe in place and withstanding expected traffic flow. Cold patch, stone dust or other similar materials will not be allowed under normal conditions as determined by the Contracting Officer.

C. *DESIGN AND CONSTRUCTION*

The minimum allowable size of temporary by-pass pipe shall be two (2) inches.

When any public or private hydrant is taken out of service, the minimum allowable size of temporary by-pass pipe shall be four (4) inches.

The minimum allowable size of any temporary service hose shall be 3/4 inch.

All temporary by-pass pipes shall be laid within the City right-of-way in the traveled portion of the roadway, in the gutter, up against the curbing, unless otherwise directed by the Contracting Officer.

Temporary hydrants shall be installed along the pipe line wherever a public or private hydrant is taken out of

service or rendered inoperable due to by-pass connections. All temporary hydrants shall be individually gated; set approximately twenty (20) inches above the ground with the hose connection facing the street at a 90 degree angle to the hydrant riser pipe. The threads on all temporary hydrant hose connections shall be consistent with City of Worcester hydrant specifications.

The temporary by-pass pipes shall have a sufficient number of valves along its length to minimize the number of consumers affected by shutdowns of the temporary by-pass pipes during maintenance and repair. The number and locations of these valves shall be determined by the Contracting Officer.

The temporary by-pass pipes shall have multiple aboveground feed points to provide water at sufficient pressure and volume to supply the temporary by-pass system and to prevent the shutting-off of the entire by-pass piping during maintenance and repair. The Contractor shall be responsible for installing and maintaining any pressure reducing valves (PRV) used when connecting to one of the City's higher pressure zones for a feed to a lower pressure zone. Care shall be taken to assure pressure supplied to businesses or homes does not exceed that which is currently fed to those locations.

The pipe and other materials shall be watertight and care shall be exercised throughout the installation of the temporary pipe making up of all temporary connections to avoid any possible contamination of any City water main, house service or the temporary by-pass itself.

The Contractor shall disinfect and bacteria test all temporary by-pass pipes as outlined in Item 301 of these specifications. The temporary by-pass pipe shall be activated only after negative bacteriological results are obtained from the City.

The Contractor shall maintain unobstructed access to any and all handicapped and wheel chair ramps and curb cuts that are affected by the placement of temporary by-pass pipes by recessing the temporary by-pass pipes into the pavement.

No service hose of any size shall be laid across any street to supply a building that is on the opposite side of the road from the temporary by-pass pipe.

At driveways, provisions shall be made to permit property owners to drive over the temporary pipe by the use of ramps or other approved materials to form a ramp over each of the pipes.

At street crossings, the Contractor shall cut a narrow trench into pavement and the temporary pipe placed in the trench so the top of the pipe is below the surface. Cold patch shall then be placed in the trench and compacted to meet the existing grade of the existing pavement.

All temporary 6" and 8" by-pass lines shall be recessed into the pavement unless otherwise noted. Ramping of 6" and 8" by-pass will not be allowed. Hot patch shall be uses to cover this recessed temporary by-pass.

In certain situations, where the service hoses cannot be laid on the sidewalks due to heavy pedestrian traffic or when there is no access for the service hoses to be brought into the building to be supplied, the Contractor shall dig near the gutter, expose the service pipe, tap into or connect to that service pipe and properly secure the excavation for the duration of the construction. The method of connecting the service hose to the service pipe shall be approved of by the Contracting Officer.

Service hoses, fed from gated connections on the temporary by-pass pipes, shall be of approved size to adequately supply water at sufficient pressure and volume for the needs of building or dwelling affected by the construction.

At the conclusion of their use, the temporary by-pass pipes and service hoses shall be removed and hauled away by the Contractor and any connections, which had been previously interrupted, shall be completely restored by him.

The Contractor shall backfill all excavations and replace the surfacing in full conformity with the requirements previously specified herein. He shall restore the surface of any private property disturbed by him, shall remove all temporary filling adjacent to the temporary pipes and service pipes at driveway and other locations, and shall completely clean all areas which show evidence of his work by hauling away and removing all refuse and other materials which remain after the temporary by-pass pipes and service hoses have been removed. The Contractor must be prepared to supply a self-contained road sweeper to clean all road and driveway surfaces after either cutting temporary by-pass trenches or after final paving of such trenches.

The Contractor shall be responsible for all maintenance and repair of the temporary by-pass pipes and service hoses regardless of the time of day or the day of the week. A 24-hour telephone number shall be supplied to Water Operations by the Contractor along with the name of persons to be notified for repairs or emergencies.

Failure to respond shall necessitate the actuation of City crews at the Contractor's expense.

The Contractor shall be required to have his plan for the temporary by-pass pipe layout approved by Water Operations prior to it being installed in the field.

D. *SPECIAL CONDITIONS - FIRE CONNECTIONS*

The Contractor will be responsible for the adequate temporary feed of all fire service lines in accordance with the following:

Fire Systems with Fire Pump

The Contractor will not be allowed to connect to the Siamese connection except as noted in item 3 below.

The Contractor shall dig, tap and connect to the fire pipe below grade. The following minimum requirements shall apply depending upon the size of the existing connection.

8-inch fire pipe shall be fed at a minimum with 3 (three) 2-1/2-inch hoses or equivalent 6-inch fire pipe shall be fed at a minimum with 2 (two) 2-1/2-inch hoses or equivalent 4-inch fire pipe shall be fed at a minimum with 1 (one) 2-1/2-inch hose

The Contractor shall provide an additional temporary hydrant on the by-pass system at each building that has a Siamese connection. This temporary hydrant connection shall only be used as a feed to the Siamese connection as an interim fire protection when the contractor is installing new pipe work or valves that require the closure of the existing feed. NOTE: This hydrant is in addition to those required to replace existing hydrants.

The Contractor shall notify the District Chief and Fire Alarm in writing upon installation of the temporary by-pass and schedule a site visit with the District Chief. A copy of this notice shall be provided to the Water Operations' Project Engineer.

The Contractor shall notify the District Chief and Fire Alarm in writing of the date and item for any disconnection of a fire pipe as noted in Item 3 above.

The Contractor shall coordinate with each building owner and the building owner's sprinkler contractor for the connection of the fire service on a temporary basis as outlined in Item 3 above.

Fire Systems without Fire Pump

The Contractor shall install temporary by-pass to the Siamese connection. The following requirements shall apply depending upon the size of the existing connection:

8-inch fire pipe shall be fed at a minimum with 2 (two) 2-1/2-inch hoses or equivalent via a wye connection at one connection at the Siamese

6-inch fire pipe shall be fed at a minimum with 2 (two) 2-1/2-inch hoses or equivalent via a wye connection at one connection at the Siamese

4-inch fire pipe shall be fed at a minimum with 1 (one) 2-1/2-inch hose at the Siamese

One nozzle at the Siamese connection shall always be available for connection by the Worcester Fire Department.

The Contractor shall notify the District Chief and Fire Alarm in writing upon installation of the temporary by-pass and schedule a site visit with the District Chief. A copy of this notice shall be provided to the Water Operations' Project Engineer.

The Contractor shall coordinate with each building owner and the building owner's sprinkler contractor the disconnection of the fire service on a temporary basis as outlined in Item 3 above.

General Conditions

The contract drawings shall provide the size and location of each known fire pipe impacted by the construction, including side streets, which may require a one-day shut down. However, the Contractor will be required to locate all fire pipes affected by the work. There will be no additional compensation for by-pass of fire pipes not shown on the plans.

The Contractor shall provide temporary connection to fire pipes impacted by a one-day shut down except where buildings are substantially vacant at night or weekends. At these locations a representative of the building owner must be at the building during the shut down period. This may require the work to be performed during

off-peak hours.

The by-pass plan submitted shall demonstrate compliance with these provisions.

Buildings that have backup fire service for the entire building that will remain active do not need to be by-passed. The contractor shall coordinate this closure with the building owner.

E. *MEASUREMENT AND PAYMENT*

The length of 2-inch, 4-inch, 6-inch and 8-inch by-pass pipe shall be the number of linear feet, measured along the center line, actually furnished and installed in complete conformance with these Specifications. No payment will be made for any temporary service hoses or pipes which are smaller than 2-inches in size, as will be provided for connections to sill cocks or to house or other services, and no payment will be made for temporary by-pass pipes which are employed by the Contractor solely for his own convenience and use and not as directed and required by the Contracting Officer.

Temporary Taps on Service Laterals shall be measured per Each completely in place as specified herein. There will be no additional compensation made for multiple taps or connections made on a single service line.

Payment at the unit prices stipulated shall compensate the Contractor for all work required in conjunction with furnishing, installing, maintaining, and removing the temporary by-pass pipes and service hoses, together with all valves, fittings, and other facilities required in conjunction with the use of a temporary by-pass pipe to permit dewatering of the mains. Payment at the unit prices shall also compensate the Contractor for all mats or special provisions that may be required at driveways, street crossings, or otherwise for the protection of the temporary pipe, and to permit the normal flow of traffic and access to private property, and shall also compensate the Contractor for hauling away his material and any refuse of any kind which remains at the conclusion of his operations.

NO EXTRA COMPENSATION WILL BE GIVEN FOR EXCAVATION OR REPAIR OF PAVED SURFACES

WHEN EXCAVATED FOR RECESSED BY-PASS PIPING. Unit price per foot shall include all excavation of roadways or private paved surfaces for road crossings, driveway crossings or other recessed bypass. This unit price will include use of both temporary pavement repairs during the course of construction and permanent pavement repairs at the completion of work when used specifically for recessed by-pass trenches.

Temporary Taps on Service Laterals shall be paid for at the Contract Unit Price, which shall include all excavation, backfill, materials, service saddles, plugs, corporations, tools, labor, equipment, shoring and incidentals necessary to complete the work as specified herein. Pavement for temporary tap holes shall be compensated under the appropriate pavement item.

ITEMS 318 through 320 CLEANING AND CEMENT LINING CAST IRON PIPE

ITEM 318.0600 CLEAN AND LINE 6" MAIN

ITEM 318.0800 CLEAN AND LINE 8" MAIN

ITEM 318.1000 CLEAN AND LINE 10" MAIN

ITEM 318.1200 CLEAN AND LINE 12" MAIN

ITEM 318.1400 CLEAN AND LINE 14" MAIN

ITEM 318.1600 CLEAN AND LINE 16" MAIN

ITEM 318.1800 CLEAN AND LINE 18" MAIN

ITEM 318.2000 CLEAN AND LINE 20" MAIN

ITEM 318.2400 CLEAN AND LINE 24" MAIN

ITEM 318.3000 CLEAN AND LINE 30" MAIN

ITEM 318.3600 CLEAN AND LINE 36" MAIN

ITEM 318.4000 CLEAN AND LINE 40" MAIN

ITEM 318.4200 CLEAN AND LINE 42" MAIN

ITEM 318.4800 CLEAN AND LINE 48" MAIN

ITEM 319.0600 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 6" CLDI PIPE

ITEM 319.0800 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 8" CLDI PIPE

ITEM 319.1000 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 10" CLDI PIPE

ITEM 319.1200 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 12" CLDI PIPE

ITEM 319.1400 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 14" CLDI PIPE

ITEM 319.1600 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 16" CLDI PIPE

ITEM 319.1800 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 18" CLDI PIPE

ITEM 319.2000 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 20" CLDI PIPE

ITEM 319.2400 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 24" CLDI PIPE

ITEM 319.3000 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 30" CLDI PIPE

ITEM 319.3600 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 36" CLDI PIPE

ITEM 319.4000 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 40" CLDI PIPE

ITEM 319.4200 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 42" CLDI PIPE

ITEM 319.4800 REMOVE EXISTING VALVE AND/OR FITTING & INSTALL 48" CLDI PIPE

ITEM 320.0810 ADDITIONAL OPENINGS FOR 8" TO 10" MAINS

ITEM 320.1216 ADDITIONAL OPENINGS FOR 12" TO 16" MAINS

ITEM 320.1824 ADDITIONAL OPENINGS FOR 18" TO 24" MAINS

ITEM 320.3036 ADDITIONAL OPENINGS FOR 30" TO 36" MAINS

ITEM 320.4048 ADDITIONAL OPENINGS FOR 40" TO 48" MAINS

A. *SCOPE OF WORK*

The work under this section shall include the cleaning and application of a cement mortar lining to the inside surface of 6-inch and larger new and old steel, ductile iron, and cast-iron water pipelines that have been previously installed and all related work. All work completed under this section shall conform to latest revision of AWWA C602.

B. *MATERIALS*

All materials used in the cement mortar shall conform to requirements set forth in section 4.3, Materials for Construction, in the latest revision of AWWA C602.

C. *CONSTRUCTION*

DEWATERING PIPES

The Contractor shall dewater all pipe lines preparatory to the starting of work, drain all low spots, make all excavations at locations required to facilitate the work, and take special precautions to prevent the possibility of any water entering the sections in which men are working.

Water Operations personnel shall operate all valves in connection with work under this Contract unless specified or otherwise directed by the Director of Water/Sewer Operations. If permission is granted to the Contractor to operate valves, the valves must be operated in the presence of a representative of Water Operations. Under no circumstances shall the Contractor be paid any additional compensation for the operation of said valves. The Contractor will not be held responsible for any breakage or damage to said valves, unless in the opinion of the Contracting Officer, proper care was not executed in the operation of the said valve.

All valves that act in the capacity of sectioning or limiting valves for the work and are deemed inoperable and/or leaking by the City to the extent that cleaning and lining cannot be done as a result, shall be replaced by the Contractor with a new Worcester Standard Valve (open right), the necessary pipe and couplings supplied by the Contractor. The City shall make this decision within 24 hours of receiving the Contractor's request in writing through the Contracting Officer.

EMERGENCY SHUTDOWNS

In cases of emergencies, the City reserves the right to suspend the cleaning and/or lining operations at any time or times necessary and to require the Contractor promptly to restore the water main to service. The City will make every effort to avoid such suspension and, if such suspensions are unavoidable, will limit them to the shortest possible time. However, should any suspensions be effected for the above reason, the Contractor shall be allowed extensions of time equal to the delay caused thereby, but he will not be allowed any additional compensation for any losses or damages sustained or alleged to have sustained as a result of such suspensions, except for the actual extra expenses as approved by the Contracting Officer and allowed for in these specifications.

EXCAVATIONS

Pavement cuts shall be made with the edges reasonably smooth and without cracking or damage to the pavement outside the limits of the portion excavated. The excavations shall be as limited as possible, compatible with convenient and safe working conditions, so as to interfere with traffic as little as possible and limit the area to be resurfaced. All excavated materials must be removed and disposed of by the Contractor.

The Contractor shall, without extra compensation, furnish and put in place such sheeting and bracing as may be required, or ordered by the Contracting Officer, to support the sides of the excavation, to prevent undermining of the pavement or to protect from possible injury any pipes, sewers, ducts, poles, conduits, or other structures existing in the streets or highways, and shall remove such sheeting and bracing as the excavation is refilled, unless the Contracting Officer shall permit it to be left in place.

The Contractor shall, without extra compensation, maintain all excavations in proper condition for carrying on the work, and to this end shall do all bailing, draining, or pumping which may be necessary to keep the excavations free of water.

Steel plates used to cover trenches during non-working hours shall be secured to prevent movement, by either pins anchoring them to the roadway, or recessing them into the top grade of the roadway. These plates shall be properly maintained when in use and properly stored away from traveled ways when not in use, at no additional compensation to the Contractor.

PROTECTION OF PIPES AND DRAINS

All existing gas pipes, water pipes, sewers, drains, electrical conduits, telephone ducts, or other structures which are uncovered by the excavation, and which do not, in the opinion of the Contracting Officer require changes in location, shall be carefully supported and protected from injury by the Contractor, and in case of injury, they shall be restored by him without compensation therefore, to as good condition as that which they were found, and shall be kept in repair for the duration of the work.

BACKFILLING

Prompt backfilling and paving of excavations and maintenance thereof shall be considered a priority with the Contracting Officer reserving the right to suspend other work when deemed necessary to accomplish this objective.

All backfilling shall proceed as described earlier in section 300, of these specifications. TEMPORARY SURFACE REPAIR

All temporary surface repairs shall conform to all the provisions set forth in these specifications. PERMANENT SURFACE REPAIR

A permanent surface repair shall be made on all excavations or as the Contracting Officer directs upon completion of the major portion of work. The temporary surface repair shall be totally removed, edges cut square and smooth and additional gravel deposited and compacted as required. All permanent surface repairs shall conform to all provisions set forth in these specifications.

The Contractor will be required to make repairs to his trenches within 24 hours of being notified. To accomplish this, the Contractor may employ a local paving Contractor to maintain sunken trenches and additional required paving. The Contractor shall be responsible for trenches dug for a period of two (2) years after completion of work.

CUTTING OR OPENING PIPES

The Contractor shall open the pipe at each end of the section to be cleaned and lined, at intermediate gates, bends, fittings, and obstructions shown on the Contract Drawings and at other locations which may be necessary to permit satisfactory cleaning and lining. Every effort must be made to prevent foreign material or sludge from entering lines adjacent to the work. Open ends of pipe shall be temporarily sealed with mechanical caps or plugs at all times when not being worked on at **no extra compensation** to the Contractor. Openings in the pipes shall be made by burning out existing joints, removing existing couplings or cutting the pipe square and true by hand or machine. The Contractor may salvage and reuse any undamaged pipe, sleeves, or couplings, and any material not so used shall become the property of the Contractor, and shall be disposed of by him. All valves removed and not to be reused must be delivered to 1065 Millbury Street and shall remain the property of the City.

At openings adjacent to sections under pressure or in service, the Contractor shall install adequate blocking to prevent motion of the closed gate valves during the time the pipe is open.

REPAIRING PIPES

The Contractor shall furnish all materials and install same to satisfactorily close and make watertight all openings made in the pipelines under these items. Closures shall be made with cleaned and lined pipe salvaged from the existing line or with new ductile iron cement lined pipe, Class 52 minimum thickness, and with new couplings of approved design. The new couplings used shall be entirely encased in a polyethylene wrap after installation to resist corrosion.

MAIN LINE VALVES

The cleaner and/or lining machine shall not traverse through valves not scheduled for replacement. All valves specified shall be replaced with a new Butterfly Valve or Gate Valve (open right) in accordance with Items 305 through 308 of these specifications.

SERVICES, LATERALS, AND BRANCHES

The Contractor shall be responsible that cleaning debris or cement mortar does not interfere with the operations of air valves, services, laterals, blow-offs, etc. The Contractor shall enter these pipes to plug, and subsequently remove plugs, all mortar and debris from such services, laterals, branches, etc. All sidelines, services, hydrant connections, etc., shall be back flushed into the main immediately after cleaning and before cement lining is applied. After the mortar lining has been placed, but before it takes final set, laterals and services 2-inch and smaller in diameter shall be cleared by back flushing with air. The back flushing shall be performed in a manner that shall not damage the freshly applied cement lining. Service laterals larger than 2 inches or fire lines that do not have accessibility for backflushing immediately after the

cleaning/scrapping operations due to check valves or other appurtenances shall require a tap of 2 inch, or greater in size, at a location to be specified by the Contracting Officer outside of the building. Such taps shall conform to the provisions set forth in Item 311 of these specifications.

CLEANING PIPES

The interior surfaces of the pipe to be lined shall be cleaned to the satisfaction of the Contracting Officer by passing approved cleaning apparatus through the pipe in each direction as many times as required to satisfactorily remove all loose scale, rust, tuberculation, projecting jointing materials, loose deteriorated remains of old coating materials and all accumulations of dirt and debris. The cleaning tool may be dragged through the pipe by cables attached to both ends. No hydraulic flushing or cleaning of the debris from pipes will be allowed. The contractor shall dispose of the cleaning water and debris at a site and in a manner as approved by City and State agencies. **All residue shall become the property of the Contractor and lifted from the trench or access pit by a vacuum truck and removed from the site, not disposed of in the pit or trench nor**

reintroduced in any of the Cities other projects. The contractor shall take special care to avoid the staining of streets or private property with rust from pipe cleaning operations. No cleaning waste shall be allowed in City drains or sewer lines. Immediately following cleaning operations, streets and affected areas shall be hosed and swept clean of any residue.

CEMENT MORTAR LINING

As soon as possible after a section of pipeline has been cleaned to the satisfaction of the Contracting Officer, cement mortar lining shall be applied to the interior of the pipeline. The Contractor shall not install the lining in any section until approval of the interior surface has been obtained from the Contracting Officer. Immediately before the lining machine travels through a pipeline all foreign material shall be removed. The thickness of the lining shall, at no point, be less than 3/16 inch nor more than 5/16 inch with every effort being made to keep it uniformly between 3/16 inch and 1/4 inch. The lining shall consist of a one-course application of cement mortar and each section shall be placed in uninterrupted continuity by a centrifugal machine projecting the mortar against the wall of the pipe without rebound, and with sufficient velocity to cause the mortar to be densely packed and to adhere in place. Compressed air shall not be used, nor will air or sand pockets, or lack of homogeneity in the lining be permitted. All mortar lining shall be mechanically troweled to produce a lining of uniform thickness with a smooth, finished surface, free of spiral shoulders. The lining machine shall be designed and propelled in such a way that it will travel smoothly through the pipe without variation in speed or rate of application of the cement mortar. Hand placing of mortar shall not be permitted except adjacent to specials or at other points where machine placing is impossible or impractical.

CEMENT MORTAR FOR LINING

The composition of all cement mortar, and the materials from which it is made, shall conform to the latest revision of AWWA C602-00, “Cement Mortar Lining of Water Pipelines In Place – 4 inch and Larger”. The materials and mortar shall be subject to thorough inspection and testing, and any sample failing to meet the above-referenced requirements may be cause for rejection of the whole from which the sample was taken.

CURING OF LINING

Immediately upon the satisfactory completion of the lining of a section of pipeline, that section shall be closed at all openings to prevent the circulation of air. As soon as practicable after the placing of the lining, a sufficient amount of water shall be introduced into that section to keep the lining damp, and under no conditions shall the lining be permitted to dry out prior to returning the section to service.

PROTECTION OF LINING

Every precaution shall be taken to prevent injury to the lining. Should it be damaged or be found unsatisfactory at any time previous to the completion of the project, such damaged or unsatisfactory portions shall be removed to the extent directed, and replaced to the satisfaction of the Contracting Officer.

CLEANING UP

The Contractor shall exercise and shall cause each of his employees to exercise all responsible precautions to prevent contamination of the pipeline. At the conclusion of the work prior to filling and sterilization, the Contractor shall remove all fragments of mortar and all other debris from the pipeline, leaving it clean and ready for use to the satisfaction of the Contracting Officer.

During the course of the work, the Contractor shall keep the site of his operations in as clean and neat a condition as possible. He shall dispose of all residues resulting from the cleaning of the mains, and at the conclusion of the work, he shall remove and haul away any surplus material, broken pavement, lumber,

equipment, and any other refuse remaining from the reconditioning operations, and shall leave the entire site of the work in a neat and orderly condition. He shall satisfactorily repair or restore any driveways, walks, culverts, pipes, fences, walls, poles, posts, curbs, or other property damaged by him or by his employees, and shall leave them in condition to that which existed at the beginning of the work.

CHLORINATION OF WATER MAINS

Upon completion of all cleaning and lining operations in a section of pipe line and after the work has been approved by the Contracting Officer, the Contractor shall chlorinate the completed section in accordance with the AWWA Standard C651-99, “Disinfecting Water Mains.” The Contractor shall furnish all materials, equipment, labor, and chlorine. The entire procedure of chlorinating the pipes shall be discussed in advance of the time the work is to be done, and the methods employed shall be fully satisfactory to the Contracting Officer.

Disinfection shall proceed as specified in Item 301 of these specifications. GUARANTEE OF CEMENT-MORTAR LINING

The Contractor guarantees that the work to be done under this section shall be done in a good and workmanlike manner in complete conformance with these Specifications, and that the materials furnished by him and used in the construction of the same, shall be free from defects and flaws. This guarantee shall be for a period of one year after final completion and acceptance of the work. It is hereby, however, specifically agreed and understood that this guarantee shall not include any repairs made necessary by any cause or causes other than defective work or materials.

Performance Criterion – Surface Finish: The Contractor guarantees to restore all cleaned and cement- mortar lined water mains to the following coefficients "C" in Hazen-Williams formula, all based on nominal pipe diameters with proper allowance being made for bends and fittings in accordance with accepted practice:

Guaranteed Coefficient "C"	
Nominal Pipe Diameter	***Hazen-Williams Formula***
36 inch	***130***
30 inch	***130***
24 inch	***130***
20 inch	***125***
18 inch	***125***
16 inch	***125***
14 inch	***125***
12 inch	***120***
10 inch	***115***
8 inch	***110***
6 inch	***100***

After the mains under this Contract have been cleaned and cement lined, a reputable testing company, independent from the Contractor, shall be hired by the Contractor to perform loss-of-head tests to determine the Hazen-Williams coefficient of friction, called "C." The complete testing as described herein shall be performed at the Contractor's expense. The Testing Company shall be approved by the Contracting Officer prior to the commencement of testing work. The name, address, and a general qualification statement shall be submitted with the material submittals as required by the contract.

If, in any section of cleaned and lined water main, the coefficient "C" as determined by the loss-of-head test fails to meet the guaranteed figure, the Contract price for payment will be described as follows:

For a drop of five (5) points or fraction thereof below the guaranteed coefficient, there will be no reduction in price.

For the next ten (10) points drop in excess of five (5) points below the guaranteed coefficient, the appropriate Contract unit price shall be reduced one percent (1%) per point.

For a drop in excess of fifteen (15) points below the guaranteed coefficient, corrective measures shall take place in order to obtain the desired coefficients as specified herein. Whatever corrective measures are recommended by the Contractor, it shall have prior approval from the Contracting Officer.

For the purpose of establishing "C" coefficient on such mains where it is not practicable to carry the loss-of-head test through the full extent of the cleaned and cement-mortar lined main, the several sections thereof shall be tested and the weighted average coefficient "C" from tests of such portions shall be considered to be acceptable for the whole of the cleaned and cement-mortar lined main.

All tests for establishing the coefficient "C" for water mains cleaned and cement-mortar lined under this Contract will be completed prior to the final acceptance of this job.

In addition to the Hazen-Williams "C" factor tests, the Contracting Officer may deem it necessary to excavate and cut open at a designated location the cleaned and lined pipe for the purpose of a visual examination.

ADDITIONAL OPENINGS AT UNKNOWN BENDS OR FITTINGS

The Contractor shall make additional openings, as directed, in the pipe to be cleaned and lined, if necessary at bends or fittings not shown or noted on the drawings. The complete work of excavation and backfill and opening and repairing the pipe, etc., shall comply with the requirements of these specifications just as though said bend or fitting where shown or noted on the drawings.

VERIFICATION AND TESTING

All materials provided and work performed shall be subject to inspection and testing. The Contractor shall

provide, at no additional cost to the City, samples and reasonable assistance for the inspection and testing of materials and workmanship. The City, at its expense shall retain the services of a reputable testing firm to perform tests that include but are not limited to the following: cylinder compression tests on the cement mortar, slump tests on the freshly mixed cement mortar, gradation analysis of the sand use in the cement mortar.

D. *MEASUREMENT AND PAYMENT*

Cleaning and Cement Lining of Water Mains shall be measured as the number of linear feet, measured along the centerline, of pipe actually cleaned and lined with cement-mortar in complete conformance with these Specifications.

Payment for "Removing Existing Valve and/or Fitting and Installing Section of CLDI Pipe" under Pay Items

319.06 through 319.48 shall be measure per Each complete in place as specified herein.

Payment for the making of Additional Openings under Pay Items 320.0810 through 320.4048 shall be measured per Each complete in place as specified herein.

Cleaning and Cement Lining of Water Mains shall be paid for at the Contract Unit Price as set forth in the Proposal. The prices stipulated shall include the furnishing of all materials, equipment, and labor necessary to satisfactorily complete the cleaning and lining, dewatering the lines; making and backfilling all excavations; making and repairing all pipe openings, cleaning and lining the pipe; chlorination of pipe; cleaning all gates, services, laterals and branches, video inspection of the cement lined water main and cleaning up the site of work as specified herein.

The Contractor shall be paid the Contract unit prices for each additional opening according to the size of the main so ordered by the Contracting Officer as specified above. The Contract unit prices for the different sizes of mains shall include all excavation, gravel backfill, couplings, and the necessary length of pipe and repairing of the pipe associated with the opening of the pipe as specified above. The specific pay item used shall be determined by the size of pipe being opened.

ITEM 321 TELEVISION INSPECTION OF WATER PIPE

ITEM 321.1000 T.V. MAINS

A. *SCOPE OF WORK*

Under this item the Contractor shall television inspect cement-lined pipe in accordance with the provisions herein.

B. *MATERIALS*

Omitted, not applicable.

C. *CONSTRUCTION*

The Contractor shall television inspect all newly cleaned and cement lined pipe prior to activating the water main. Water Operations shall be allowed two (2) business days to review the tape and determine if the cleaned and cement lined pipe is acceptable prior to granting permission to activate the pipe. Where deemed necessary by unusual conditions, a recording of pipe condition may be requested after cleaning but prior to cement lining of the pipe.

The videotapes furnished to Water Operations shall be **DVD color format** and shall have a distance indicator present throughout the recording. The indicator distance on the recording shall be for general purposes only and NOT for measurement of the cleaned and cement lined pipe. The DVD tape shall also have audio capabilities for comments, as it may deem necessary.

All video recordings shall become the property of the City of Worcester DPW Water Operations.

D. *MEASUREMENT AND PAYMENT*

The video recording of the pipe condition shall be measured per linear foot as measured for the purpose of payment for cleaning and lining, and shall be recorded with the participation of the Contracting Officer.

The video recording of the water mains shall be included in the price per foot cost of Cleaning and Cement Lining of the pipe. This shall include all labor and equipment necessary to produce the tapes. There shall be no additional compensation for the re-recording of mains whereby the cleaning and/or cement lining was found to be not acceptable by the Contracting Officer.

ITEM 322 through 323 LINE STOPS & INSERTION VALVES

ITEM 322.0600 6" INSERTING VALVE

ITEM 322.0800 8" INSERTING VALVE

ITEM 322.1200 12" INSERTING VALVE

ITEM 323.0000 LINE STOP (VARIOUS SIZES)

A. *SCOPE OF WORK*

The work under this section shall include furnishing all materials, labor and equipment to properly install and set line stops into the existing water mains at the locations specified on the plans, as specified herein or as directed by the Contracting Officer.

B. *MATERIALS*

Line Stop Fitting (4" through 16")

The line stop fitting shall consist of a two-part, full encirclement stainless steel saddle with a stainless steel nozzle MIG welded to the upper half of the saddle. It shall include all fasteners and gaskets noted below.

The stainless steel used in the saddle shall be Type 304, with a minimum of 16 gauge (0.0598") thickness.

The line stop nozzle shall be machined from seamless pipe or tubing and shall have an external pipe thread to receive a screwed pipe cap at the end of the work. The interior of the nozzle shall be threaded to receive the completion plug.

The full encirclement saddle gasket shall be molded from an elastomer compound that will resist compression set and is compatible with drinking water in the temperature range of minus 40 degrees to 150 degrees F.

The gasket shall have a molded grid pattern on the surface that seals against the main. The longitudinal ends of the gasket shall be tapered to allow sealing at the lap joint.

Materials for bolts and nuts shall be Type 304 stainless steel.

Cement Concrete for thrust blocks shall conform to all provisions set forth in Item 313 of these specifications.

C. *DESIGN AND CONSTRUCTION*

The Contractor shall excavate, expose, and clean the exterior of the water main. The outside diameter (O.D.) of the pipe shall be taken to determine the class of the pipe and the corresponding size of the line stop fitting.

All line stop fittings and equipment shall be disinfected with a chlorine solution prior to their installation on and insertion into the water main.

The assembled line stop fitting and valve assembly shall be successfully pressure tested in accordance with the provisions set forth in Item 301 of these specifications prior to the cutting of the pipe.

The existing water mains, upstream of the line stop cannot be shut down or taken out of service. To ensure that the entire operation shall be accomplished without interruption of the upstream water flow, the installation of the line stop shall be accomplished by Contractor personnel skilled and experienced in the procedures specific to line stops of the size on cast iron or ductile iron water mains.

If the existing main is to be cut in the same excavation as the line stop, the Contractor shall be responsible for restraining the line stop fitting. Restraint of the line stop fitting may include yokes, friction clamps, rods, timbers and permanent cement concrete supports or blocking as deemed necessary by the Contracting Officer.

Heavy tuberculation shall be anticipated in the existing water mains. The line stop fitting shall be able to shut down heavily tuberculated water mains through expansion of the rubber stopper itself. Non-expandable stoppers needing a brushing technique are not acceptable.

All natural rubber shall be used in the sealing element allowing customized fit to the inside diameter of the water main to temporarily stop the flow of water in heavily tuberculated mains.

Because of the condition of the interior of the mains and the age of the valves, a "bottle-tight" shut down should not be anticipated. A satisfactory shut down is one that allows the required work to proceed using pumps to dewater the excavation.

In the event that a satisfactory initial shut down cannot be obtained by the line stop, the Contractor shall repeatedly insert and remove the line stop head in an effort to break up the tuberculation or other debris that interferes with a good shut down.

The appropriate water main shall be wet tapped with a shell cutter only after successful installation and pressure testing of the line stop fitting.

The plugging or sealing element shall be inserted into the main by self-contained hydraulic equipment.

After successfully completing the line stopping and required water main work the line stop equipment shall be removed, the completion plug installed and the pipe cap or blind flange installed.

D. MEASUREMENT AND PAYMENT

Line stops shall be measured per Each completely installed and in place.

Line stops shall be paid for at the contract unit price, which shall include all excavation, shoring, sheeting, restraint rods, yokes, friction clamps, timbers, dewatering, the installation, successful completion, and removal of the line stop, backfilling, labor, equipment, and other incidentals necessary to complete the work. Cement Concrete for thrust blocks, gravel, temporary and permanent bituminous patching shall be paid for at their respective contract unit prices.

ITEM 324.0000 WATER METERS

A. SCOPE OF WORK

The work under this section shall consist of furnishing and or maintaining new water meters pits and appurtenances and removing and replacing of existing water meters and appurtenances, as specified herein, as shown on the plans, or as directed by the Contracting Officer.

B. MATERIALS

All water meters shall be purchased through the City of Worcester Water Operations and shall be manufactured to comply in all respects to the latest revision of AWWA Standards C700, C701, C702, and C703 and shall comply with the specific requirements and design standards that follow:

Owners shall be responsible to submit to the City, documentation of expected demands within the structure to assist the City with determining proper meter sizing and typing.

C. DESIGN AND CONSTRUCTION OF METER PIT

See Sample Detail Sheets W-18A which is part of these specifications.

Owners shall be responsible to submit detailed plans to DPW&P Water Operations of all. meter pits of any size, or all meter installations larger than 2” in size in advance for approval by the City.

D. SPECIAL CONDITIONS

The property owner and/or his agent shall be responsible to comply with all Federal, State and City cross connection control regulations. The property owner and/or his plumbing contractor and sprinkler contractor shall be responsible to supply design data sheets for all proposed backflow device installations to the City for approval prior to permit approval.

SECTION 400 - PAVEMENT

ITEM 402.0000 FINE GRADING, ROLLING AND FINISHIN

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section 170, (MSSHB). See Detail for Item 116. Centerline and gutter-line grade stakes will be required every 25 feet when working under this item or as directed by the Contracting Officer.

B. MEASUREMENT AND PAYMENT

Payment for fine grading shall be at the bid price per square yard complete in place.

ITEM 403.0000 GRINDING AND MILLING 1-1/2 INCH

A. GENERAL

Description - This work shall consist of preparing a foundation for the placement of surfacing courses by the removal of excess bituminous material to a grade and cross section as directed by the Contracting Officer. The depth of bituminous material removed should average approximately 1-1/2".

Equipment - Equipment for removing the bituminous surface shall be a power operated planning machine or grinder capable of removing, in one pass, a layer of bituminous material 6 feet in width and 1-1/2 inches in depth. The equipment shall be capable of accurately establishing profile grades by referencing from either the existing pavement or from an independent grade control and shall have a positive means for controlling cross slope elevations. The equipment shall also have an effective means for removing excess material from the surface and for preventing any dust resulting from the operations from escaping into the air. The Contractor will be permitted to augment the large milling or grinding equipment with other more maneuverable machines for those areas inaccessible to the 6-foot grinder such as curb or casting cuts.

Construction Methods - The bituminous surface shall be removed to the depth, width, grade, and cross section as shown on the plans, or as directed by the Contracting Officer. Excess material resulting from the operation shall be removed and disposed of by the Contractor or as otherwise specified in the Contract.

B. *PROSECUTION OF WORK*

All milling or grinding shall be done during daylight hours unless otherwise specified in the Contract.

The Contractor shall exercise due care not to disturb or break existing manholes, valve boxes, catch basins, monument boxes, castings, etc. All castings broken shall be replaced or repaired at the Contractor's expense.

The cutting blade shall be such that the irregularities of the roadway pavement are removed without gouging and the blade can cut to the curb and around all castings when necessary.

C. *TESTING SURFACE*

The roadway surface shall be considered smooth when tested with a sixteen (16) foot straight edge placed parallel with the longitudinal centerline of the surface. There shall be no deviation from the true surface in excess of one-fourth (1/4") inch. A ten (10) foot straight edge may be used on a vertical curve.

D. *SWEEPING*

Sweeping shall be done prior to resurfacing where needed as designated by the Contracting Officer.

E. *RAMPING EDGES*

Immediately after sweeping ground edges at all transitions abutting streets shall be ramped with asphalt as per the discretion of the Engineer. Said asphalt shall be removed just prior to the application of the surface course.

F. *MEASUREMENT AND PAYMENT*

The method of payment for grinding and milling shall be at the bid price per square yard complete in place.

ITEM 403.1000 GRINDING (FULL DEPTH – 6” MAXIMUM)

ITEM 403.1100 GRINDING IN-EXCESS OF 6” MAXIMUM

A. *GENERAL*

Applicable provisions of Item 403 shall apply. The depth of bituminous materials shall be removed to the existing sub-base layer. It is the intent for this item to include the removal of all existing bituminous material including berm and berm mat. Removal of the existing asphalt berm and berm mat shall be done under this item as a subsidiary obligation of the Contractor.

B. *MEASUREMENT AND PAYMENT*

Payment for the grinding and milling shall be at the bid price per square yard complete in place. Item 403.11 shall be paid in addition to Item 403.1 in areas only where the asphalt depth is greater than 6”.

ITEM 403.2000 GRINDING AND MILLING 2 INCH

A. *GENERAL*

Applicable provisions of Item 403 shall apply. This work shall be specified by the Contracting Officer.

B. *MEASUREMENT AND PAYMENT*

Payment for this Item shall be at the bid price per square yard complete in place including removal of bituminous concrete pavement.

ITEM 403.3000 HOT-IN-PLACE ASPHALT RECYCLING

A. *GENERAL*

Item 403.3 The work to be done under this Item shall conform to all the relevant provisions of MassDOT Standard Specifications Section 400 and the following:

Hot-in-place recycling shall include all processes necessary to complete mutli-step rehabilitation of asphalt surfaces including softening the existing flexible pavement with heat, thoroughly stirring spinning or tumbling the mixture, applying an asphalt rejuvenator, milling, remixing, reshaping, and compacting the hot-in-place recycled surface. Installation of an asphalt overlay following this procedure is not included in this item and shall be paid for under a separate contract item.

Performance of hot-in-place recycling shall be performed when the road surface temperature is 45º F and rising. Hot-in-place recycling shall not be performed during precipitation events. Prior to the performance of hot-in-place recycling, the existing pavement to be recycled shall be cleared of all deleterious materials by mechanical sweeping. Pre-recycling performance of mechanical sweeping is the responsibility of the Contractor and shall be considered incidental to this item.

The installation of traffic control devices required for this work is the responsibility of the Contractor and shall be considered incidental to this item.

The contractor shall take care to avoid and prevent damage to existing tree and vegetation adjacent to the work area. Equipment to be used in the task is described below in Part B.

B. *EQUIPMENT*

Preheater

The preheating machine shall consist of one self-contained machine specifically designed to heat the upper layers of the existing asphaltic pavements. The preheating machine shall be a self-propelled and completely self- contained unit capable of operating at speeds from ten (10’) feet to twenty-five (25’) feet per minute while uniformly heating the existing surface of the asphalt. The heating unit shall consist of multi-rows of burners of a type specifically designed for and capable of producing 48 million BTUH; LPG will be used for the heating fuel in compliance with the standards of the Massachusetts’ Air Pollution Control Laws. The BTUH production rate shall be based upon heating twelve (12’) feet wide. Burners shall be located on the front of the heater boxes spaced no more than ten (10”) inches apart to achieve proper heat penetration at the required temperature while causing no injury due to overheating the asphaltic surface. The entire burner assembly shall be so designed so that it may be raised or lowered by a single control and capable of articulation. The burner assembly shall be adjustable in width from eight (8’) fee to fourteen (14’) feet. The entire heating unit shall be enclosed and vented to contain the heat and prevent damage to plant material or any structures along the roadway. Each unit shall be equipped with an on board 500-gallon water system to be used to adequately reduce the temperature of the exhaust in the venting system thereby preventing desiccation of trees and shrubs by evapotranspiration due to high heat. Hand hoses with adjustable nozzles will be placed on each unit to allow for prewetting of specific plants or objects.

Heater-Scarifier

The heater-scarifier machine shall consist of one self-contained machine specifically designed to reprocess upper layers of existing asphalt pavements. The heater-scarifier machine shall be a self-propelled and completely self- contained unit capable of operating at speeds of ten (10’) to twenty-five (25’) feet per minute while uniformly heating, scarifying, applying rejuvenator, mixing and screeding the existing pavement to a minimum depth of one (1”) to one and one-half (1-1/2”) inches at a minimum temperature of 250 degrees Fahrenheit. The wheelbase shall not be less than eighteen (18’) feet and the total weight shall not be less than 35,000 pounds. The heating unit shall consist of multi-rows of burners of a type specifically designed for and capable of producing 48 million BTUH; LPG will be used for the heating fuel in compliance with the standards the Massachusetts’ Air Pollution Control Laws. The BTUH production rate shall be based upon heating twelve (12’) feet wide. Burners shall be located on the front of the heater boxes spaced no more than ten (10”) inches apart to achieve proper heat penetration at the required temperature while causing no injury due to overheating the asphaltic surface. The entire burner assembly shall be designed so that it may be raised or lowered by a single control and capable of articulation. The burner assembly shall be adjustable in width from eight (8’) feet to fourteen (14’) feet. The entire heating unit shall be enclosed and vented to contain the heat

and prevent damage to plant material or any structures along the roadway. All equipment shall conform to Federal, State and local DOT and Fire Marshall regulations, and laws relative to the transportation of LPG.

Scarifying Unit

The scarifying unit shall consist of no less than two rows of spring loaded, carbide tip teeth adjustable in width from eight (8') to fourteen (14') feet in increments to one (1") inch and construction in one (1') foot sections to conform to the pavement contour to insure penetration of the teeth and prevent damage to utility structures.

Spraying Unit

Immediately behind the teeth of the scarifying unit, an application of polymer modified rejuvenator shall be applied to the newly remixed area. Nozzle size on the spray bar and pump shall be a combination that will deliver the approved rate of application according to the forward speed of the machine in conjunction with discretion of the Engineer. The tank on the machine shall be heated, and the heating unit on the storage tank for rejuvenator shall be thermostatically controlled to maintain an even specified temperature. In addition to the above, it will be required that the spraying unit on the machine be equipped with an electronic, digital measuring system (computer) to constantly monitor the quantity of rejuvenating agent being applied. This device will be calibrated to show gallons used to the nearest tenth.

Mill/Remixer Unit

Immediately following the application of the recycling agent, a dual-drum enclosed mill shall mill the heated asphalt to the depth of the heat thoroughly mixing the rejuvenating agent with the scarified and milled material. This mill/remixer system shall be an integral part of the scarifying machine and shall be located between the spraying system, which applied the rejuvenator, and the screed. This mill/remixer system shall be fully hydraulically operated and shall be retractable from 14.6 ft to 8.6 ft wide. This mill shall also be able to break in the center to allow for quarter point and crown control. No heater scarification can take place without this unit present and in operating condition.

Screed

The hot scarified material shall be uniformly distributed to the desired longitudinal and transverse section using a heated, augured vibratory screed. The screed must be equipped with an adjustable crown control, and each end of the screed must have handwheel adjusting screws for providing the desired longitudinal and transverse section.

Compaction Unit

Immediate compaction shall take place with rolling equipment of sufficient type and size to compact the recycled bituminous material to the required density. At a minimum, a 10-ton vibratory roller shall be used to perform this task. State specifications for bituminous concrete surfaces shall apply. Recycling operations shall cease immediately upon break-down or other impairment of the vibratory roller.

C. *MATERIALS*

Following scarification of the existing pavement, The Contractor shall apply a recycling agent as a rejuvenator. The purpose of the agent is to improve the penetration value of the recycled hot-mix asphalt, with the goal of extending the overall life of the existing pavement. The recycling agent shall meet the following requirements: Materials shall meet the requirements of ASTM D 4552, Standard Practice for Classifying Hot-Mix Recycling Agents, grades RA25 or ERA25 (Emulsified RA25) asphalt-based recycling agents. Only materials that are designed to perform as rejuvenating agents and meeting the requirements outlined in Table 1 – Recycling Agents

shall be permitted. At the start of production and during, certified test results and documented quantities shall be provided to the Engineer for each shipment of recycling agent. Acceptance of this material is based on a signed Manufacturer's Certification stating conformance to this specification. The use of any other grade of recycling agent shall require prior approval. Recycling Agent shall be heated in a thermostatically controlled tank on the recycling machine and maintained between 160° F and 170° F per product requirements. The bidder

shall include with bid a letter of supply of the recycling agent from an approved manufacturer and ability to meet the above specifications.

Table 1 – Recycling Agent

Test Requirements	*Test Method*	*Minimum*	*Maximum*
Tests on Residue from Distillation Viscosity,140 F cSt Flash Point, CSC, F	*T201 T48*	*901 215*	*4500*
Test on Residue from RTFO, 325 F Viscosity Ratio Weight Change, + , %	*T240*	*- -*	*3 4*
Specific Gravity	*T228*	*Report*	*Report*
Saybolt Furol Viscosity @77 F, s	*T59 *(1)*	*15*	*85*
Storage Stability, 24 hrs, %		*-*	*1.0*
Sieve, %		*-*	*0.1*
Cement Mixing, %		*-*	*2.0*
Asphalt Content by Evaporation, %		*65*	*-*

*

*This testing requirement is only for ERA25

D. *MEASUREMENT AND PAYMENT*

Measurement and payment for hot-in-place asphalt recycling shall be at the contract unit price per square yard, which price shall be full compensation for all necessary labor, materials, and equipment required to satisfactorily complete the work as described above.

ITEM 404.0000 RECLAMED PAVEMENT FOR BASE COURSE AND OR SUB BASE

A. *GENERAL*

The work to be done under work to be done under this Item shall conform to all applicable Worcester Department of Public Works specifications, the relevant provisions of MassDOT Standard Specifications Section 400 and the following:

The work shall include the pulverizing of the existing pavement, blending of the pulverized material with the existing underlying base material, spraying liquid calcium chloride on the pulverized mass, blending the material a second time, and grading and compacting the blended material to the finished grade required for installation of bituminous asphalt pavement.

The work shall also include screening or other approved methods to remove oversized stones and the addition and mixing of additional granular material into the blended material as necessary to bring the final reclaimed base course material into conformance with the specified gradation. The blended base course shall be thoroughly mixed to a uniform gradation. If the blended material does not conform to the specified gradation, the Contractor shall furnish and mix additional granular material into the blended material to bring it into conformance, as directed by the Engineer.

B. *PERFORMANCE OF WORK*

Pulverization Process

The existing road pavement shall be pulverized and mixed with the gravel base existing in the roadway foundation. The pulverization shall blend the asphalt and base material into a homogeneous mass. Pulverization shall occur to a minimum depth of 12" below the existing asphalt surface. Removal of any excess reclaimed material required to meet proposed grades is to be done by the Contractor before calcium chloride application. After the excess material is removed, 0.5 to 0.75 gallon of liquid calcium chloride shall be applied per square yard. The aggregate mass shall then be pulverized again to ensure proper asphalt, gravel, and calcium chloride blending to the desired depth. Following final fine grading and compaction, a final capping of 0.25 to 0.3 gallons of calcium chloride per square yard shall be applied.

Sampling and Testing

The Contractor shall be responsible for all sampling, testing, and analysis of materials associated with this item of work for the purposes of determining the material's existing and finished properties and characteristics as they may pertain to the specifications stated for this item of work. The Contractor shall employ a certified soils testing lab, subject to the approval of the Engineer, to perform the sampling, testing, and analysis. The Engineer shall specify the location of all test pits – at a minimum spacing of 300 feet. The results of the analysis shall be submitted to the Engineer for review and approval prior to the commencement of the dependent, respective activity of work. Any gradation deficiencies in the sampled materials, as indicated by the test results, shall be corrected by blending the appropriate aggregate size(s) into the mixture.

Coordination

Any proposed drainage and/or other subsurface utility improvements shall be constructed prior to the pavement reclamation work. The Contractor shall excavate and backfill all trenches in such a way as to provide sufficient granular materials at the top of the trench during backfilling operations in preparation for the reclamation process.

If the Engineer determines that unsuitable material has been placed in the upper portion of the trench within the proposed reclamation depth, the Contractor shall remove this material and replace it with gravel borrow at no additional compensation.

Compaction and Dust Control

The following supersedes the second paragraph of MassDOT Standard Specifications Section 403.64 :

The reclaimed base course shall be tested for compaction and smoothness and accuracy of grade by the Contractor in accordance with the applicable provisions of MassDOT Standard Specifications Subsection 401.60. The required density shall be measured by a Nuclear Density Gauge. If any portions are found to be unacceptable by the Engineer, such portions shall be reprocessed, re-graded, and re-compacted until the required smoothness and accuracy are obtained.

At the end of each day's progress, the Contractor shall apply Calcium Chloride in accordance with the applicable provisions of MassDOT Standard Specification Subsection 440: Roadway Dust Control. Water for roadway dust control shall be applied as directed by the Engineer. Dust control of areas at which pulverization has been performed shall be incidental to this item and no additional compensation shall be provided for this work.

Excess Material

Sufficient excess reclaimed material shall be stockpiled within the City limits to be used for subbase material in pavement and sidewalk areas, or other miscellaneous uses, as directed by the Engineer. The stockpiling, transporting within the City, placing, spreading, grading, and compacting of the excess reclaimed material shall be considered incidental and payment for this work is to be included in the unit bid price for Item 403.

Throughout the project, any excess reclaimed material that is not to be re-used on the project, or otherwise deemed of value to the Town, shall become the property of the Contractor and disposed of off the project site

by the Contractor in accordance with the requirements of “DISPOSAL OF SURPLUS EXCAVATED MATERIALS”, payment for which is to be included in the unit bid price for Item 403.

C. *MATERIALS*

Liquid Calcium Chloride

The calcium chloride solution shall meet the following material specifications (see ASTM Designation D98; AASHTO – M144, Type I or II):

Calcium Chloride	***35% ±***
Alkali Chloride as NaCl	***1%***
Magnesium as MgCl	***2% Max.***
	0.1%
Typical (in lbs. Per gallon): Calcium Chloride	***5.05***
Sodium Chloride	***0.2***
Magnesium Chloride	***0.004***
Calcium Sulfate	***0.004***
Water	***6.002***
Total (in lbs. Per gallon)	***11.26***

Reclaimed Pavement Borrow Material

Reclaimed Pavement Borrow material shall consist of crushed asphalt pavement and/or crushed cement concrete, and gravel borrow meeting M1.03.0: Gravel Borrow. The material shall be free of loam, clay, and deleterious materials such as brick, reinforcing steel, wood, paper, plaster, lathing, and building rubble, etc. The coarse aggregate shall have a percentage of wear not greater than 50 as measured by the Los Angeles Abrasion Test. Gradation requirements shall be determined by AASHTO T 311 except the material shall not be oven dried. It shall be air dried, fan dried at low speed, or other low temperature heat so as not to liquefy the asphalt or cause the asphalt to adhere to the sieves. Water used for the No. 200 sieve analysis shall be cold tap water.

The portion of materials passing the No. 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6. The reclaimed pavement borrow shall be compacted to a minimum of 95% of AASHTO T 180 proctor density. Liquid limits shall be determined by AASHTO T 90. If a location fails to meet the above compaction standards, this requirement may be waived at the discretion of the Engineer. Waiver of this requirement shall only be applicable for locations at which, in the opinion of the Engineer, the composition, nature, and/or physical characteristics of the existing underlying material are such that achieving 95% compaction would have a negative impact on the stability and/or structural integrity of the roadway. Waivers of the compaction requirement shall be issued on a location specific basis. Issuance of a waiver for one testing location does not extend the waiver of testing requirements to other locations along the same roadway. If a location is granted, Contractor shall compact sub-base to the satisfaction of Engineer.

Reclaimed pavement borrow material shall be processed by mechanical means and blended to form a homogeneous material. The equipment for producing crushed material shall be of adequate size and have sufficient adjustments to produce the desired materials. Blended materials that are stockpiled for more than 3 months shall be reworked to a uniform material and retested prior to use however, the Engineer may require additional testing any time the materials appear excessively hard, wet and/or segregated. The processed materials shall be stockpiled in such a manner as to minimize segregation of particle sizes. All reclaimed pavement borrow material shall come from approved sources and stockpiles. The amount of combined crushed asphalt pavement and crushed cement concrete shall not exceed 50% by volume as determined by visual inspection, and/or by laboratory tests required by the Engineer

The gradation shall meet the following requirements:

Sieve Designation	Percent Passing
3 in	100%
1 1/2 in	70%-100%
3/4 in	50%-80%
No. 4	30%-60%
No. 50	8%-24%
No. 200	0%-10%

D. MEASUREMENTAND PAYMENT

Payment for work under this item shall be made at the unit contract price per square yard and shall full compensation for all necessary labor, equipment, and materials required to satisfactorily complete the work including the pulverizing of the existing pavement, blending of the pulverized material with the existing underlying base material, spraying liquid calcium chloride on the pulverized mass, blending the material a second time, and grading and compacting the blended material to the finished grade required for installation of bituminous asphalt pavement

Aggregate to correct gradation deficiencies shall be paid for at the contract unit price per ton for Item 130 Crushed Stone ¾ Inch and/or Item 132 Crushed Stone 1-1/2 Inch, whichever is required to meet the gradation standards set forth above for Reclaimed Pavement Borrow Material.

Fine grading and compacting of the reclaimed material is considered incidental to this item and shall be included in the unit bid price per square yard for Item 404.

Application and blending of the liquid calcium chloride shall be included in the unit bid price per square yard for Item 404.

The costs of all sampling and testing shall be included in the unit bid price per square yard for Item 404.

The raising of all lowered drainage, utility, and municipality structures and gate boxes shall be done at the direction of the engineer, and to a grade as determined by the engineer. Structures may be raised to an intermediate grade prior to being adjusted to final grade at the direction of the engineer. The remodeling and adjusting of all drainage, utility, and municipal structures and gate boxes, including frames and grates or covers, will be paid for at the unit bid price for the respective Item only once, regardless of the number of times adjustments are made.

Items 405 through 414 shall be City of Worcester standard curb or edging constructed in conformance with the applicable provisions of Section 501, (MSSHB).

ITEM 405.0000 STRAIGHT CURB (VA-4)

ITEM 408.0000 CIRCULAR CURB (10' RADIUS & OVER) (VA-4)

ITEM 409.0000 CIRCULAR CURB (10" RADIUS & UNDER) (VA-4)

ITEM 410.0000 CIRCULAR CORNER (WORCESTER STANDARD)

ITEM 412.0000 GRANITE EDGE (10' AND OVER) TYPE SB

ITEM 414.0000 GRANITE EDGE (10' AND UNDER) TYPE SB

A. MEASUREMENTAND PAYMENT

Items 405, 408, 409, 412, and 414 shall be measured and installed at the price per linear foot bid therefore in the proposal. Removal and re-setting curb corners will be paid for at the contract unit price per linear foot for curb removed and reset. Item 410 shall be paid for per each, complete in place. Where the street is to be pulverized or ground full depth, the curb shall be set prior to placement of the binder course. Should the contractor wish to place the binder prior to the resetting of the curb, no payments shall be made for saw cutting, any leveler course(s) required to bring the crown to grade, or replacement of the binder course at the curb.

Payment for concrete used around curb will be paid for under Item 446.1 Class B Concrete (CY). It will be used at the front, back, and under the joint area to support the curb.

ITEM 416.0000 CURB REMOVE & RESET

ITEM 417.0000 COBBLESTONE CURB REMOVE & RESET

A. GENERAL

The work to be done under these items shall conform to the applicable provisions of Section 580, (MSSHB). Any disruption of the roadway caused by the Contractor shall be repaired by the Contractor without extra cost to the City. Driveway curb corners that are reset shall be paid for under this item. Where the street is to be pulverized or ground full depth, the curb shall be reset prior to placement of the binder course. Should the contractor wish to place the binder prior to the resetting of the curb, no payments shall be made for saw cutting, any leveler course(s) required to bring the crown to grade, or replacement of the binder course at the curb.

B. MEASUREMENTAND PAYMENT

Payment for Items 416 and 417 shall be measured and installed at the price per linear foot bid therefore in the proposal. Removal and re-setting curb corners will be paid for at the contract unit price per linear foot for curb removed and reset.

ITEM 418.0000 CURB REMOVAL & STACK

A. GENERAL

The work to be done under this item shall conform to the applicable provisions of Section 580, (MSSHB) and will be transported to the Department of Public Works and Parks, 1065 Millbury Street or as directed by the Contracting Officer.

B. MEASUREMENTAND PAYMENT

Payment for Item 418 shall be measured at the price per linear foot bid therefore in the proposal.

ITEM 419.0000 SAW CUTTING OF GRANITE CURB

A. GENERAL

The contractor shall saw cut the granite curb for the installation of sidewalk ramps as specified by the City of Worcester. The saw cut shall be a smooth and continuous cut. The distance between the bottom of the gutter pan and the saw cut section of the granite curb shall be one quarter inch (1/4 in) or less. The slope of the saw cut shall match the slope of the ramp. The point at the top of the curb where it intersects the saw cut shall be ground off, making it a rounder surface. If the granite curb is saw cut, and the previously noted dimensional requirement is not met as determined by the Engineer, the complete curb and gutter shall be removed and replaced at no additional cost to the City of Worcester.

B. MEASUREMENTAND PAYMENT

Payment for this item shall be complete in place, including any necessary regrading, cleanup, and disposal of debris. This item will not relieve the contractor of his responsibility to reset or saw cut the granite curb as required under item 452 or 454. Payment for replacement of the wheel chair ramp surface will be under item 430 Existing Bituminous Concrete Driveway Repair or item 446 Concrete Driveway Repair, when this item is utilized. Payment will be per linear foot, under the item “Saw Cutting of Granite Curb”.

ITEM 420.0000 CURB RESET FROM DPW YARD

A. *GENERAL*

Work under this item shall consist of the Contractor receiving curbing stored at the Department of Public Works and Parks, 1065 Millbury Street and transporting it to the work site as directed by the Contracting Officer. This curbing will then be reset so as to conform to the applicable provisions of Section 580, (MSSHB) at the desired locations as directed by the Contracting Officer within the work site.

B. *MEASUREMENTAND PAYMENT*

Payment for this item shall be paid for by Item 416 curb R&R price.

ITEMS 422 - 432 BITUMINOUS CONCRETE

ITEM 422.1000 SUPERPAVE 9.5 MM LEVEL 2

ITEM 422.2000 SUPERPAVE 12.5 MM LEVEL 2

ITEM 422.3000 SUPERPAVE 12.5 MM LEVEL 3

ITEM 422.4000 SUPERPAVE 19 MM LEVEL 2

ITEM 424.0000 BITUMINOUS CONCRETE DRIVEWAY & VARIOUS AREA

ITEM 426.0000 NEW BITUMINOUS CONCRETE SIDEWALKS

ITEM 427.0000 BITUMINOUS CONCRETE WINTER CONDITIONS (HOT BOX)

ITEM 428.0000 BITUMINOUS CONCRETE ROADWAY REPAIR

ITEM 430.0000 EXISTING BITUMINOUS CONCRETE DRIVEWAY REPAIR

ITEM 432.0000 EXISTING BITUMINOUS CONCRETE SIDEWALKS REPAIR

ITEM 432.1000 EXISTING BITUMINOUS CONCRETE SIDEWALKS REPAIR < 25 L.F.

The bituminous concrete shall be laid and thoroughly rolled in two courses consisting of a bituminous concrete binder course mix and a top course mix or dense mix to the thickness as indicated below:

	Binder Course	*Top Course*
Roadway up to 12% grade	*2" or As Directed*	*1.5" or As Directed*
Roadway from 12% to 16% grade	*2.5"*	*2" or As Directed*
Roadway 16% and over	*2.75"*	*2" or As Directed*
Driveway	*1.5"*	*1"*
Sidewalk	*1"*	*1"*

Under Items 424 through 432 the mix design for sidewalks shall be SUPERPAVE 9.5mm Level 2 for top course and SUPERPAVE 12.5mm Level 2 for binder course. Item 427 will allow for the substitution of non- SUPERPAVE hot mix bituminous concrete if a SUPERPAVE mix is unavailable during winter conditions.

Payment for Items 424 & 426 shall constitute full payment for all labor and materials required to construct bituminous concrete sidewalks or driveways, including all gravel, excavation, fine grading and compacting to the grade specified by the Contracting Officer. No additional payments for these items will be made under their individual bid item prices.

When a substantial grade change is encountered by the Contracting Officer, he will direct the Contractor to establish new grades and pay for additional gravel and fine grading as needed.

Item 428 will be applied to those roadway repairs with a length up to 35 feet, measured parallel to the roadway. This item will be payable by the square yard and will encompass all construction activities involved with the repair of the roadway (Excavation, milling, gravel, berm, etc.). Those repairs with a length greater than 35 feet will be payable under the bid contract unit prices.

When the contractor encounters bituminous asphalt sidewalks and driveways that exceed the City of Worcester

standards, gravel may be used in lieu of asphalt. There will be no additional payment for excavating, gravel and fine grading. This applies to Items 430, 432, 432.1.

Any sub-base disturbed by the Contractor without the Contracting Officer's approval shall become the Contractor's responsibility to replace with approved gravel (graded and compacted).

All abutting surfaces of bituminous pavements shall be trimmed to a neat straight line and painted with an asphaltic cement, cutback with naphtha or approved emulsion. This work of treating the pavement edges shall be the responsibility of the Contractor and payment for the work shall be covered under the contract price for Items 422 thru 436.

Under Items 430 - 432 any unsatisfactory sub-base, such as red bricks or unsuitable material is encountered in the sidewalk areas, as directed by the Contracting Officer, shall be removed and re-graded and paid for under the Item 116 Excavation, Item 126 Gravel Borrow, and Item 402 Fine Grading, Rolling, and Finishing.

The contractor will be responsible for installing tree pits, where sidewalk width allows. All tree pits are to have the following minimum dimensions; 6 feet in length by 3 feet in width. All tree pit dimensions shall be approved by the contracting officer. The tree pit shall be back filled with loam borrow, complying with ITEM 128 CREENED LOAM BORROW, to a minimum depth of 30" for the entire area of the tree pit, Tree pits shall be free of and construction debris or litter throughout their depth.

HOT MIX ASPHALT ROADWAY PAVEMENT TON

A. DESCRIPTION

SCOPE

Work under this item shall consist of furnishing hot mix asphalt composed of mineral aggregate and asphalt binder, mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and conformance to the lines, grades, thickness and typical cross sections shown on the plans or as directed by the Engineer. Where reference is made to MHD Standard Specifications, Form 1995 shall apply for section references; latest edition shall apply for specifications.

Each course shall be constructed to the depth, typical section, or elevation required by the contract and/or plans and shall be rolled, finished, and approved before the placement of the next course. Each course shall be placed to a smooth, dense and uniform appearance.

Many state agencies are implementing Quality Assurance specifications. It is the intent of these municipal quality-based HMA specifications to move toward the goal of quality assurance implementation but tailored toward the real world of municipal construction. To that end, the Contractor is required to establish, provide, and maintain a Quality Control System (QCS) that will detail the methods and procedures that will be taken to assure that all materials and completed construction conform to project specifications, plans, technical specifications and other requirements, whether manufactured or processed by the Contractor or procured from subcontractors or vendors.

B. QUALITY ASSURANCE

The Contractor assumes the responsibility of the quality for all materials and construction incorporated into the work and will control all the processes leading to the final result through this function. Quality Control activities should include:

1. Maintain a Contractor Quality Control System
2. Proficiency testing prior to/during production with Engineer
3. Inspection and Testing of Hot Mix Asphalt Production
4. Inspection and Testing of Hot Mix Asphalt Placement

See Section G "Contractor Quality Control of HMA Pavement" of these specifications for additional information.

The City of Worcester or their authorized agent will perform the Quality Acceptance function for this work. All material will be considered for acceptance through a sampling, testing and inspection program performed by the Engineer or their agent. Quality Acceptance activities include:

1. Proficiency testing prior to/during production with Contractor,
2. Inspection of HMA Production Plant and Testing Laboratory.
3. Production Trials of HMA Products Intended for Use in the City of Worcester.
4. Inspection/Testing for Acceptance of Hot Mix Asphalt Production
5. Inspection/Testing for Acceptance of Hot Mix Asphalt Placement
6. HMA Quality Acceptance Report of Activities

C. *MATERIALS*

Aggregate – Aggregate shall meet the requirements of MHD M3.11.04 latest edition of the Standard Specifications and as further stipulated herein.

1. Coarse Aggregate

The sodium sulfate soundness loss shall not exceed nine (9) percent, nor the magnesium soundness loss exceed twelve (12) percent, after five cycles, when tested in accordance with AASHTO T104.

The coarse aggregate shall not contain more than one (1) percent of material such as crusher dust, sand or soft, disintegrated pieces. The coarse aggregate shall not contain more than ten (10) percent, by weight, of flat or elongated pieces, when tested in accordance with ASTM D4791 at a ratio of 5:1.

For the Marshall mixes contained in Table 6, the coarse aggregate shall contain a minimum of 75% by weight having at least two or more fractured faces and 85% by weight having at least one fractured face for the base and intermediate courses, when tested in accordance with ASTM D5821. The surface courses in Table 6 shall contain a minimum of 85% by weight having at least two or more fractured faces

and 95% by weight having at least on fractured face, when tested in accordance with ASTM D5821. When two fractured faces are continuous, the angle between the planes of fracture shall be as least 30 degrees to count as two fractured faces. For the Superpave mixes contained in Table 5, the coarse aggregate shall conform to the coarse aggregate angularity requirements listed in Table 3 for the traffic level and depth within the pavement structure.

The use of steel slag or blast furnace slag shall not be permitted as a coarse aggregate.

2. Fine Aggregate

Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing natural stone, or gravel that meets the requirements for wear and soundness specified for the coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The combined materials that passed the No. 100 mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO T90.

Fine aggregates shall have sand equivalent values of 40 or greater when tested in accordance with AASHTO T176. The sand equivalent value shall be determined for the combined mix aggregates, including coarse and fine aggregates and mineral filler portions.

Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification. The aggregate shall have a fine aggregate angularity value of 40% or greater when tested in accordance with AASHTO T304, Method A. The uncompacted void content shall be evaluated for the combined mix aggregates including both coarse and fine aggregate portions.

3. Mineral Filler

If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of AASHTO M17.

HMA mixtures shall contain a dust to effective asphalt ratio by mass between 0.6 and 1.2. For Superpave designed mixtures, mixtures that pass beneath the Primary Control Sieve (PCS) control point established by AASHTO M323 may contain a dust to effective asphalt ratio by mass between 0.8 and 1.6.

4. Reclaimed Asphalt Pavement (RAP)

The use of a maximum of 15% recycled asphalt pavement (RAP) will be allowed in the HMA courses.

The RAP, incorporated into the HMA mixtures, shall be maintained as a separate captive stockpile and shall not be added to without prior approval. RAP shall consist of asphalt pavement recovered by cold milling or other removal techniques. The RAP shall be crushed so that 100 percent passes the maximum aggregate size of the HMA mix in which it will be used. The Contractor's Quality Control system shall assure that the RAP is free from detrimental amounts of contaminating substances such as joint seal compound and, is reasonably uniformly graded from fine to coarse.

The coarse aggregate in the RAP shall be crushed stone and the top-size shall not exceed the maximum aggregate size established by the JMF. The final HMA mixture containing RAP shall conform to all the specification requirements contained herein.

For mixtures containing 15% or less RAP, the asphalt binder shall be a PG 64-28 or PG 64-22. RAP content shall

not exceed 15%.

The laboratory RAP-virgin binder blend viscosity value established from the RTFO residue at 140°F (60°C) shall establish the maximum viscosity allowed for the binder after discharge from the HMA plant and/or silo storage, if applicable, when recovered by AASHTO T170 and tested in accordance with AASHTO T202 and AASHTO T316.

For design purposes, the specific gravity of the combined aggregate blend with RAP used in a HMA mixture shall be determined in accordance with the attached test method for BULK SPECIFIC GRAVITY OF AGGREGATE BLENDS WITH RAP.

Sampling and Testing

All aggregate samples required for testing shall be furnished by the Contractor when requested. AASHTO-T2 shall be used in sampling coarse aggregate and fine aggregate, and AASHTO T127 shall be used in sampling mineral filler. All tests for initial aggregate submittals necessary to determine compliance with requirements specified herein will be conducted by the Contractor under their Quality Control System. No aggregate shall be used in the production of mixtures without prior approval.

Sources of Supply

Sources of aggregate shall be selected well in advance of the time the materials are required in the work. Preliminary approval may be given when the materials are obtained from a previously approved source or an existing quarry source producing aggregates that has a satisfactory service record in hot mix asphalt construction for at least five years. Samples shall be submitted upon contract award. When time permits, samples shall be submitted fourteen days prior to the start of production. An inspection of the producers operation will be made by the Engineer. When new sources are to be developed, the Contractor shall indicate the sources and submit a plan of operation thirty days in advance of starting production. Samples from test pits, borings and other excavations shall be submitted at the same time. Approval of the source of aggregate does not relieve the Contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

Samples

Samples of aggregates shall be furnished by the Contractor at the start of production and at intervals during production of HMA mixtures. The intervals and points of sampling will be designated by the Engineer.

ASPHALT BINDER MATERIAL - The types, grades, and controlling specifications, the maximum mixing temperatures and compaction temperatures for the asphalt binder materials shall conform to the following:

Performance Graded Asphalt Binder: The Asphalt Binder shall be a Performance Graded Asphalt Binder (PGAB) which meets the specification requirements of AASHTO M320 and AASHTO R29. Acceptance of the PGAB will be in accordance with AASHTO R26 “Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders”. PGAB shall be provided by an Approved Supplier (AS) under the Approved Supplier Certification (ASC) system.

THE PGAB GRADE SELECTED FOR THIS WORK IS PG 64-28 or 64 -22 - If traffic speed and/or level warrant, the PGAB may be adjusted by the Engineer for the design traffic conditions in accordance with the table below. **No chemically modified PGAB shall be used on this project.**

Table 1. SUPERPAVE PGAB Adjustment for Design Traffic Conditions

Traffic Loading	***Adjustment to PGAB Grade***
Standing <12mph(<20 km/h)	***Increase high temperature grade by 2 grades (12°C), or 76-XX. Use low temperature grade as determined by LTTP BIND software.***
Slow Transient 12 to 44mph(20 to 70 km/h)	***Increase high temperature grade by 1 grade (6°C), or 70-XX. Use low temperature grade as determined by LTTP BIND software.***

Traffic Level (ESALs)	*Adjustment to PGAB Grade*
1 x 10^7 to 3 x 10^7	***Consideration should be given to increasing high temperature grade by 1 grade (6° C), or 70-XX. Use low temperature grade as determined by LTPP BIND software***
>3 x 10^7	***Increase high temperature grade by 1 grade (6° C), or 70- XX. Use low temperature grade as determined by LTTP BIND software.***

1. A separate JMF with TSR results shall be submitted for each PGAB grade proposed for use on this project.
2. Limit one binder grade per production day unless otherwise adjusted by the Engineer for the City of Worcester traffic conditions.
3. Documentation of the type of binder used per production day is to be stated on the weigh slips.

The Contractor shall furnish manufacturers' certified test reports for each carload or equivalent of binder shipped to the project as well as applicable Materials Certificates for the shipment of each carload or equivalent to the production plant. The reports shall be delivered to the Engineer before production of the HMA. The furnishing of the vendor's certified test reports and material certificates for the PGAB material can be used as the basis for final acceptance of the bituminous material, or, tested by the Engineer. If the Engineer

elects to test the binder material at their costs, then the Contractor shall set aside one (1) 1-qt samples of the asphalt binder material obtained from each truckload, shipment, or equivalent of asphalt binder material shipped to the production facility. Each sample shall be labeled with the PG grade, source and batch number, quantity, project name, plant, date, and the sampling inspector. The Contractor shall maintain documentation in the form of a Materials Certificate of each shipment, with a copy attached to each quart sample.

After receiving the quart samples, obtained by the Contractor, the Engineer may test the samples for verification of the performance grade. Material shall conform to the specification requirements for the applicable performance grade as specified herein. Material not conforming to specification requirements shall be subject to corrective action, production suspension, rejection, removal, or reduced payment as determined by the Engineer.

The blending at the HMA plants of PG binder from different suppliers is strictly prohibited. Contractors may switch to another approved source of PG binder, upon written notification to the Engineer, and by certifying that the tank to be utilized has been drained to an un-pumpable condition. The tank shall not retain more than 0.5% in volume capacity of previous residue source. Contractors who blend PG binders will be reclassified as a supplier and required to certify the binder in accordance with AASHTO M320 and AASHTO R26. Also if any modifications, blending, or addition of additives occurs, the Contractor shall re-certify the material in accordance with AASHTO M320 and AASHTO R26.

A copy of the Certified Test Reports shall be provided in accordance with the frequency requirements established in the latest version of AASHTO M320, and shall include the following:

1. Flash point
2. Rotational viscosity at 275°F and 329°F
3. Specific gravity at 77°F
4. Original G*/sinδ and phase angle at test temperature
5. RTFO percent mass loss
6. RTFO - G*/sinδ and phase angle at test temperature
7. PAV Residue - G*(sinδ) and phase angle at test temperature
8. Creep stiffness and m-value at test temperature
9. Direct tension results (when equipment available)
10. Strain sweep in accordance with AASHTO T315 (optional)
11. Physical hardening after 24 hours in accordance with AASHTO T313 (optional)

Asphalt Binder Anti-Stripping Additive - This specification provides for an additive to asphalt to assist in the coating of wet aggregate and to increase the resistance of the binder coating to stripping in the presence of

water. The additive shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 400°F (204°C) for extended periods without loss-of effectiveness.

Composition: Anti-stripping compound shall be an organic chemical compound, free from inorganic mineral salts or inorganic mineral soaps. It shall contain no ingredient harmful to the binder material or to the operator, and shall not appreciably alter the specified characteristics of the binder material.

Anti-stripping additive shall be incorporated and thoroughly dispersed in the asphalt binder material in an amount equal to the percent by weight established by the job mix formula. This percent is based on the efficiency of the additive as determined by laboratory tests. The treated composite mixture shall have a minimum tensile strength ratio (TSR) of not less than 80, when tested in accordance with AASHTO T283 with the freeze/thaw cycle. The specimens for the AASHTO procedure shall be 4" (100mm) in diameter, compacted with the Marshall hammer or the Superpave gyratory compactor to the desired air void level of

7.0 ± 1.0%. If the TSR ratio is less than 80, the aggregates shall be treated with an approved antistrip in sufficient quantity to produce acceptable results. The hot mix asphalt materials and asphalt binder material that require antistrip additives (either liquid or mineral) shall continue to meet all requirements specified herein for binder and HMA. The anti-strip agent shall be included in the bid price.

Tack Coat: Emulsified asphalt; AASHTO M140/ASTM D 997 or AASHTO M 208/ASTM D 2397, RS-1 or CRS- 1

PRELIMINARY MATERIAL ACCEPTANCE - Prior to delivery of HMA materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials certified under the Contractor's quality control system:

Coarse Aggregate

1. Percent of wear
2. Soundness
3. Flat and Elongated
4. Coarse aggregate angularity Fine Aggregate
1. Liquid limit
2. Plastic index
3. Sand equivalent
4. Fine aggregate angularity Mineral Filler

Performance Graded Asphalt Binder: The certification(s) shall show the appropriate AASHTO and/or ASTM test(s) for each material, the test results, and a signed statement that the material meets the specification requirement.

The Engineer may request samples for testing, including but not limited to, modifiers, truck coatings, and emulsion, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

D. *COMPOSITION OF HMA MIXTURES*

Hot Mix Asphalt - HMA plant mix may be composed of a homogeneous mixture of aggregate, filler if required, bitumen, and/or additives, combined to meet the composition limits by weight and other characteristics as specified. The several aggregate fractions shall be sized, uniformly graded and combined in such proportions that the resulting mixture meets the grading requirements of these specifications.

Hot Mix Asphalt Mix Design - The Contractor shall be responsible for the development of all job mix formulas. All job mix formulas other than for Surface Treatment and Base mix shall be based on and supported by volumetric mix designs, either Marshall Method or Superpave method. Marshall Mix design method, procedures and criteria shall be based on Asphalt Institute MS-2 and AASHTO T245 and the requirements contained herein. At the option of the Contractor, or as specified by the Engineer, Superpave mix designs may be utilized. Superpave mix designs shall be based on Asphalt Institute SP-2 and AASHTO M323, R35, R30, T312, and the requirements contained herein. For the Superpave volumetric mix design, the mixture of asphalt and aggregate shall be oven aged at the mixture's specified compaction temperature in accordance with AASHTO R30.

JOB MIX FORMULA (JMF) - Work shall not begin nor shall any mixture be accepted until the Contractor has submitted a job mix formula, samples of the existing and new materials intended for use, and has established a separate, job mix formula (JMF) for each mixture. A separate job mix formula shall be submitted for each mixture and each approved RAP stockpile (the stockpile shall be of a uniform quality throughout).

JMF Submittal - The job mix formula shall establish the percentage of each additional aggregate required, a single percentage of aggregate passing each required sieve size, a single percentage and the grade of asphalt binder to be added, the percentage of recycling additive, and a single temperature at which the mixture is to be discharged from the plant, and the number of seconds for dry mixing time and the number of seconds for wet mixing time. AASHO-T195 (Ross Count) with a coating factor of ninety-eight

(98) percent will be used when necessary to evaluate proper mixing time. The moisture content of all hot mix asphalt upon discharge from the mixer shall not exceed 0.5 percent when tested in accordance with AASHTO T110. The job mix formula shall also specify a single source or uniform blend of particular sources for fine aggregate, a single source for each nominal size of coarse aggregate, and a single source of supply for mineral filler and for asphalt. The JMF shall be submitted in writing by the Contractor to the Engineer at least 30 days prior to the start of paving operations and shall include as a minimum:

a. Percentage of each individual aggregate and percent passing each sieve. Combined percent passing each sieve size and target gradation desired.
b. Percent of asphalt binder.
c. Performance grading test results and Material Certificate certifying the PG grade.
d. Number of gyrations for the estimated design ESAL loading.
e. Mixing temperature.
f. Compaction temperature.
g. Temperature of mix when discharged from the mixer.
h. Plot of the combined gradation on the Federal Highway Administration (FHWA) 0.45 power gradation curve.
i. Percent natural sand.
j. Percent fractured faces.
k. Percent flat or elongated particles.
l. Tensile Strength Ratio (TSR).
m. Antistrip agent – type and quantity.
n. Sand equivalent value.
o. Fine aggregate angularity value.
p. Percentage of wear.
q. Sulfate soundness loss.
r. Individual and combined aggregate specific gravity.
s. Dust to effective asphalt ratio.
t. Graphical plot of air voids, voids in mineral aggregate (VMA), and voids filled with asphalt (VFA) versus asphalt content. The Superpave mixes shall also show density at $N_{initial}$, density at N_{design}, and density at $N_{maximum}$ versus asphalt content.

The Contractor shall submit samples to the Engineer, upon request, for JMF verification testing.

The JMF for each mixture shall be in effect until modified in writing by the Engineer. Should a change in sources of materials be made, a new JMF must be approved by the Engineer before the new material is used.

JMF Tolerances - The job mix formula, operating within the allowable action limits for individual measurements as specified in Table 7 herein, shall be set within the design master limits specified for each mixture class, either Table 5 for Superpave design or Table 6 for Marshall design except that the Engineer may modify the design limits if they determine this to be necessary and in the best interest of the City of Worcester.

Plant Trial Mixtures - After receiving the job mix formula prepared by the Contractor, the Engineer will notify the Contractor regarding a verification of the optimum asphalt content and/or pre-production trials and Control Section for those mixtures so designated by the Engineer. A minimum of one trial mix shall be produced at the Contractor's proposed asphalt binder content and aggregate gradation.

JMF Approval - The Contractor will be notified by the Engineer if the JMF submittals are approved for production. The approved job mix formula for the mixture shall be in effect until modified in writing. As indicated in Section D, Plant Trial Mixtures, of this specification, the Engineer will notify the Contractor regarding the placement of a Control Section (See Section E). Following placement and testing of the Control Section, the JMF may have to be modified to meet both production and placement requirements of this specification. If warranted, the JMF resubmittal shall follow the applicable requirements of Section D of this specification. A JMF, once approved, will not be required for further mix approval for the construction season

unless a change has occurred that warrants a new JMF approval or as directed by the Engineer. The approval of all JMFs will terminate on December 31st each year, regardless of if the work is carried over to the following year. Control sections are required by the contractor for in-place mat thickness, uniformity, longitudinal joint characteristics, and density requirements before approval Table 6 Notes:

Dense mix including approved anti-stripping compound shall be furnished and used for protective (bottom) courses of pavement on bridges, and elsewhere shown on the plans.

The asphalt content of all mixtures shall be calculated on the percentage basis by weight of the total mix.

HMA MIXTURE DESIGN CRITERIA

TABLE 2. PERCENT VOIDS IN MINERAL AGGREGATE (VMA)	
Nominal Maximum Aggregate Size	***Percent Minimum***
#4 (4.75mm)	***16.0***
3/8" (9.5 mm)	***15.0***
1/2" (12.5 mm)	***14.0***
3/4" (19.0 mm)	***13.0***
1.0" (25.0 mm)	***12.0***
1.5" (37.5 mm)	***11.0***

Traffic Levels	Design ESALs (80 kN)	Coarse Aggregate Angularity (5) ASTM D5821		Fine Aggregate Angularity (5) AASHTO T-304		Flat or Elongated Particles ASTM D-4791	Sand Equivalent AASHTO T-176
	(million)	(Depth from final surface) ≤ 100 mm	(Depth from final surface) > 100 mm	(Depth from final surface) ≤ 100 mm	(Depth from final surface) > 100 mm	> 9.5 mm	- - - - -
1	< 0.3	55/- -	- -/- -	- -	40	- - -	40
2	0.3 to < 3.0	75/- -	50/- -	40	40	10	40
3	3.0 to < 30.0	95/90 (6)	80/75 (6)	45	40	10	45
4	≥ 30.0	100/100	100/100	45	45	10	50
	Design EASAL s are the anticipated project traffic level expected on the design lane projected over a 20 year period regardless of the actual expected design life of the roadway	Criteria presented minimum values 95 / 90 denotes that a minimum of 95% of the coarse aggregate by mass shall have one fractured face and that a minimum of 90% should have two fractured faces.		Criteria presented minimum present air voids and loosely compacted fine aggregate passing the 2.36mm sieve		Criteria presented as maximum percent by mass of flat or elongated particles of materials retained on the 4.75mm sieve determined at 5:1 ratio. Not applicable for the 4.75mm nominal Max aggregate size mix	Criteria presented as minimum values for fine aggregate passing the 4.75mm sieve

TABLE 3: Consensus Properties of Combined Aggregate Structure for Superpave Mixtures.
***Note 5:** If less than 25 % of a given layer is within 100 mm of the anticipated top surface, the layer may be below 100 mm for mixture design purposes.*

***Note 6:** For Superpave mixtures with design ESALs between 3.0 and 10.0 million, the coarse aggregate angularity criteria shall be 85/80 for layers < 100 mm depth*

from final surface and a criteria of 60/- - for layers >100 mm from final surface.

TABLE 4: Hot Mix Asphalt and Volumetric Properties for Superpave Mixtures.

Traffic Levels	Design ESALs (million)	Number of Gyrations by Superpave Gyratory Compactor			Percent Density of Gmm from HMA specimen			Voids Filled with Asphalt (VFA) Based on Nominal mix size					
		Nini	Ndes	Nmax	Nini	Ndes	Nmax	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm
1	< 0.3	6	50	75	≤ 91.5	95 - 97	≤ 98.0	70 – 80	70 - 80	70 - 80	70 - 80	67 – 80	64 – 80
2	0.3 to < 3.0	7	75	115	≤ 90.5	95 - 97	≤ 98.0	65 – 78	65 - 78	65 - 78	65 - 78	65 - 78	64 - 78
3	3.0 to < 30	8	100	160	≤ 89.0	95 - 97	≤ 98.0	75 – 78	73 - 76	65 - 75	65 - 75	65 - 75	64 - 75
4	≥ 30.0	9	125	205	≤ 89.0	95 - 97	≤ 98.0	75 - 78	73 - 76	65 - 75	65 - 75	65 - 75	64 - 75

TABLE 5. SUPERPAVE HOT MIX ASPHALT MIXTURES

	Percent by Weight Passing Sieves											
Sieve Size in. (mm)	4.75mm Control Points		9.5mm Control Points		12.5mm Control Points		19.0mm Control Points		25.0mm Control Points		37.5mm Control Points	
	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %
2" (50.0)									-	-	100.0	
1-1/2" (37.5)	-	-	-	-	-	-	-	-	100	-	90.0	100.0
1" (25.4)	-	-	-	-	-	-	100.0	-	90.0	100.0	-	90.0
3/4" (19.0)	-	-	-	-	100.0	-	90.0	100.0	-	90.0	-	-
1/2" (12.5)	100.0	-	100.0	-	90.0	100.0	-	90.0	-	-	-	-
3/8" (9.5)	95.0	100.0	90.0	100.0	-	90.0	-	-	-	-	-	-
#4 (4.75)	90.0	100.0	-	90.0	-	-	-	-	-	-	-	-
#8 (2.36)	-	-	32.0	67.0	28.0	58.0	23.0	49.0	19.0	45.0	15.0	41.0
#16 (1.18)	30.0	60.0	-	-	-	-	-	-	-	-	-	-
#30 (0.600)	-	-	-	-	-	-	-	-	-	-	-	-
#50 (0.300)	-	-	-	-	-	-	-	-	-	-	-	-
#100 (0.150)	-	-	-	-	-	-	-	-	-	-	-	-
#200 (0.075)	6.0	12.0	2.0	10.0	2.0	10.0	2.0	8.0	1.0	7.0	0	6.0
Dust to Binder Ratio(Note):	0.9	2.0	0.6	1.2	0.6	1.2	0.6	1.2	0.6	1.2	0.6	1.2

TABLE 2. PERCENT VOIDS IN MINERAL AGGREGATE (VMA)	
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#4 (4.75mm)	***16.0***
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3/4" (19.0 mm)	***13.0***
1.0" (25.0 mm)	***12.0***
1.5" (37.5 mm)	***11.0***

Traffic Levels	*Design ESALs (80 kN)*	*Coarse Aggregate Angularity (5) ASTM D5821*		*Fine Aggregate Angularity (5) AASHTO T-304*		*Flat or Elongated Particles ASTM D-4791*	*Sand Equivalent AASHTO T-176*
	(million)	*(Depth from final surface) ≤ 100 mm*	*(Depth from final surface) > 100 mm*	*(Depth from final surface) ≤ 100 mm*	*(Depth from final surface) > 100 mm*	*> 9.5 mm*	*- - - - -*
1	*< 0.3*	*55/- -*	*- -/- -*	*- -*	*40*	*- - -*	*40*
2	*0.3 to < 3.0*	*75/- -*	*50/- -*	*40*	*40*	*10*	*40*
3	*3.0 to < 30.0*	*95/90 (6)*	*80/75 (6)*	*45*	*40*	*10*	*45*
4	*≥ 30.0*	*100/100*	*100/100*	*45*	*45*	*10*	*50*
	Design EASAL s are the anticipated project traffic level expected on the design lane projected over a 20 year period regardless of the actual expected design life of the roadway	*Criteria presented minimum values 95 / 90 denotes that a minimum of 95% of the coarse aggregate by mass shall have one fractured face and that a minimum of 90% should have two fractured faces.*		*Criteria presented minimum present air voids and loosely compacted fine aggregate passing the 2.36mm sieve*		*Criteria presented as maximum percent by mass of flat or elongated particles of materials retained on the 4.75mm sieve determined at 5:1 ratio. Not applicable for the 4.75mm nominal Max aggregate size mix*	*Criteria presented as minimum values for fine aggregate passing the 4.75mm sieve*

TABLE 3: Consensus Properties of Combined Aggregate Structure for Superpave Mixtures.
***Note 5:** If less than 25 % of a given layer is within 100 mm of the anticipated top surface, the layer may be considered to be below 100 mm for mixture design purposes. **Note 6:** For Superpave mixtures with design ESALs between 3.0 and 10.0 million, the coarse aggregate angularity criteria shall be **85/80** for layers < 100 mm depth from final surface and a criteria of **60/- -** for layers >100 mm from final surface.*

TABLE 4: Hot Mix Asphalt and Volumetric Properties for Superpave Mixtures.

Traffic Levels	Design ESALs (million)	Number of Gyrations by Superpave Gyratory Compactor			Percent Density of Gmm from HMA specimen			Voids Filled with Asphalt (VFA) Based on Nominal mix size					
		Nini	Ndes	Nmax	Nini	Ndes	Nmax	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm
1	< 0.3	6	50	75	≤ 91.5	95 - 97	≤ 98.0	70 – 80	70 - 80	70 - 80	70 - 80	67 – 80	64 – 80
2	0.3 to < 3.0	7	75	115	≤ 90.5	95 - 97	≤ 98.0	65 – 78	65 - 78	65 - 78	65 - 78	65 - 78	64 - 78
3	3.0 to < 30	8	100	160	≤ 89.0	95 - 97	≤ 98.0	75 – 78	73 - 76	65 - 75	65 - 75	65 - 75	64 - 75
4	≥ 30.0	9	125	205	≤ 89.0	95 - 97	≤ 98.0	75 - 78	73 - 76	65 - 75	65 - 75	65 - 75	64 - 75

TABLE 5. SUPERPAVE HOT MIX ASPHALT MIXTURES

	Percent by Weight Passing Sieves											
Sieve Size in. (mm)	4.75mm Control Points		9.5mm Control Points		12.5mm Control Points		19.0mm Control Points		25.0mm Control Points		37.5mm Control Points	
	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %
2" (50.0)									-	-	100.0	
1-1/2" (37.5)	-	-	-	-	-	-	-	-	100	-	90.0	100.0
1" (25.4)	-	-	-	-	-	-	100.0	-	90.0	100.0	-	90.0
3/4" (19.0)	-	-	-	-	100.0	-	90.0	100.0	-	90.0	-	-
1/2" (12.5)	100.0	-	100.0	-	90.0	100.0	-	90.0	-	-	-	-
3/8" (9.5)	95.0	100.0	90.0	100.0	-	90.0	-	-	-	-	-	-
#4 (4.75)	90.0	100.0	-	90.0	-	-	-	-	-	-	-	-
#8 (2.36)	-	-	32.0	67.0	28.0	58.0	23.0	49.0	19.0	45.0	15.0	41.0
#16 (1.18)	30.0	60.0	-	-	-	-	-	-	-	-	-	-
#30 (0.600)	-	-	-	-	-	-	-	-	-	-	-	-
#50 (0.300)	-	-	-	-	-	-	-	-	-	-	-	-
#100 (0.150)	-	-	-	-	-	-	-	-	-	-	-	-
#200 (0.075)	6.0	12.0	2.0	10.0	2.0	10.0	2.0	8.0	1.0	7.0	0	6.0
Dust to Binder Ratio(Note):	0.9	2.0	0.6	1.2	0.6	1.2	0.6	1.2	0.6	1.2	0.6	1.2

Note: The Engineer may increase the Dust to binder ratio from 0.6-1.2 to 0.8-1.6 if the proposed aggregate gradation

passes beneath the Primary Control Sieve (PCS) control point established in AASHTO M323.

Table 6. MARSHALL DESIGN MASTER RANGE TOLERANCES

Sieve Designation and % Binder Content	HMA Base Course	HMA Base/ Intermed. Course - Binder	HMA Intermed. Course Dense Binder	HMA Surface Course Dense Binder	HMA Surface Course Standard Top	HMA Surface Course Modified Top	HMA Dense Mix	HMA Surface Treatment	HMA OGFC
2 inches	100								
1 inch	57 – 87	100	100	100		100			
¾ inch		80 - 100	80 – 100	80 –100		95 - 100			
5/8 inch					100				
½ inch	40 - 65	55 - 75	65 – 80	65 – 80	95 - 100	79 – 100	100		100
3/8 inch					80 - 100	68 – 88	80 - 100	100	90 – 100
No. 4	20 - 45	8 - 50	48 – 65	48 – 65	50 - 76	48 – 68	55 - 80	80 - 100	30 – 50
No. 8	15 - 33	20 - 38	37 – 49	37 – 49	37 - 49	33 – 46	48 - 59	64 - 85	5 – 15
No. 16					26 - 40	20 – 40	36 - 49	46 - 68	
No. 30	8 - 17	8 - 22	17 – 30	17 – 30	17 - 29	14 – 30	24 - 38	26 - 50	
No. 50	4 - 12	5 - 15	10 – 22	10 – 22	10 - 21	9 – 21	14 - 27	13 - 31	
No. 100					5 - 16	6 – 16	6 - 18	7 - 17	
No. 200	0 - 4	0 - 5	0 – 6	0 – 6	2 - 7	2 – 6	4 - 8	3 - 8	1 – 3
Binder	4 - 5	4.5 - 5.5	5 – 6	5.1 – 6	5.6 - 7.0	5.1 – 6	7 - 8	7 - 8	6 – 7
HMA Temp (F)	255-295	265-325	265-325	265-325	265-325	265-325	265-325	275-325	Per Design
HMA Temp (C)	124-146	129-163	129-163	129-163	129-163	129-163	129-163	135-163	Per Design
Marshall Blows	N/A	50	50	50	50	75	50	N/A	Per Design
Stability, lbs. Min		1000	1000	1000	1000	1500	1000		
Stability, Newtons		4500	4500	4500	4500	6750	6750		
Flow, 0.01" (.25mm)		8-16	8-16	8-16	8-16	8-16	8-16		
Air Voids, %		3.0-6.0	3.0-6.0	3.0-6.0	3.0-6.0	3.0-5.0	3.0-6.0		

Additional HMA Criteria - In addition to the above HMA design requirements, the HMA mixtures shall also conform to the following:

1. Stripping

   Each mixture shall be evaluated for stripping by performing indirect tensile tests on compacted mixtures. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by AASHTO T283 with freeze/thaw, is less than 80, the aggregates shall be rejected or the asphalt treated with an approved anti-stripping agent. The amount of anti-stripping agent added to the asphalt shall be sufficient to produce a TSR of not less than 80. If an antistrip agent is required, it will be provided by the Contractor at no additional cost.

2. Aggregate Composition:

   The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in either Table 5 or Table 6, whichever is applicable, when tested in accordance with AASHTO Standards T27 and T11. The gradations in either Table 5 or 6, whichever is applicable, represent the limits which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as selected (and used in the JMF) and blended, shall have a gradation within the limits designated in either Table 5 or 6, whichever is applicable, and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine.

3. JMF Deviations:

   Deviations from the final approved mix design for asphalt binder content and gradation of aggregates shall be within the action limits for individual measurements as specified in Table 7. The limits still will apply if they fall outside the master grading band in Table 5 or 6, whichever is applicable.

4. Minimum Lift Thickness Consideration:

   The maximum size aggregate used shall not be more than one-half of the compacted thickness of the course being constructed on a prepared surface or that which can be placed to achieve specification requirements. The maximum size is defined as one sieve size larger than the nominal maximum size. The nominal maximum size is defined as one sieve size larger than the first sieve to cumulatively retain more than 10 percent

5. HMA

   May be stored in surge or storage bins provided that the mixture used from the bins is of a uniform quality and meets the following requirements:

   Temporary Storage of Bituminous Mixture - Use of surge bins or storage bias for temporary storage of hot mix asphalt will be permitted as follows:

   a. The hot mix asphalt mixture may be stored in surge bins for a period of time not to exceed three hours.

   b. The hot mix asphalt mixture may be stored in insulated and heated storage bins for a period of time not to exceed twelve hours, provided an inert gas atmosphere is maintained in the bin during the storage period.

   c. If the Engineer determines that there is an excessive amount of heat loss, segregation and/or oxidation of the mixture due to temporary storage, use of surge bins or storage bins will be discontinued.

   In addition, the recovered asphalt from the mix samples obtained 30 days after production shall meet the following requirements:

RECOVERED ASPHALT ASTM D1856
ABSON METHOD

Test Property	***Min.***	***Max.***
Viscosity, poises @ 140F.	***-***	***6000***
Penetration, dmm @ 77F.	***45***	***100***
Ductility, cm @ 77F	***75***	***-***
T_{max} for G*/Sin (d) DSR (RTFO Aged)	***-***	***One Grade Higher***

Warm Mix Asphalt (WMA) - All SUPERPAVE Hot Mix Asphalt Mixtures may be modified using a WMA additive capable of lowering plant production temperatures to below 260° F. Warm Mix Asphalt additives reduce compaction effort and permit lower production temperatures than conventional hot mix asphalt. The WMA additive shall be a product listed on the Northeast Asphalt User Producer Group (NEAUPG) website - http://www.superpave.psu.edu/NEAUPG.html , except that no WMA foaming technology will be permitted which requires the mechanical injection of steam or water into the liquid asphalt.

The WMA additive must be compatible with polyphosphoric acid modified binders, polymer modified binders, and the HMA producer's HMA anti-stripping agents. The WMA additive shall be introduced in accordance with the Manufacturer's dosing rates and approved blending methods. The WMA additive Manufacturer shall have an on-site representative at the beginning of paving operations as directed by the engineer. The Manufacturer's representative shall be available for consultation during Warm Mix production.

All work done under this Item shall conform to the provisions of City of Worcester - Hot Mix Asphalt Roadway Pavement Specification. The WMA mixture design shall incorporate the requirements of AASHTO R35. All WMA additive equipment shall be fully automated and integrated into the plant controls.

When the asphalt binder is modified with the WMA additive at the HMA plant, all WMA additive equipment shall be fully automated and integrated into the plant controls and shall record actual dosage rates on the plant printouts.

The HMA QC Plan shall incorporate the modification of asphalt binders when the WMA additive is blended with the asphalt binder at the plant. This plan shall conform to the most current Northeast Asphalt User Producer Group (NEAUPG) binder testing requirements and specifically address WMA metering requirements, tolerances and other QC measures.

All costs associated with these provisions will be considered incidental. No additional compensation will be provided for the Manufacturer's representative, production of samples, the Warm Mix additive or other incidental costs.

E. *HMA CONTROL SECTION*

If required by the Engineer and prior to full production for the City, the Contractor shall place a quantity of hot mix asphalt according to the JMF and the project specifications. The amount of mixture should be sufficient, at a minimum, to construct a test section 300 feet long and 20 to 30 feet wide placed in two lanes, with a longitudinal joint, and shall be of the same depth specified for the construction of the course which it represents. The underlying grade or pavement structure upon which the Control Section is to be constructed shall be the same as the remainder of that project course represented by the Control Section. The equipment used in construction of the Control section shall be the same type and weight to be used on the remainder of the course represented by the Control Section. The control section may be as large as one production day on a City street as long as a longitudinal joint has been constructed.

Two Random sample(s) shall be taken at the plant by the Engineer and tested for air voids, aggregate gradation, and asphalt binder content in accordance with the Section H, "Plant-Produced Material".

Three randomly selected cores shall be taken from the finished pavement mat in the Control Section, and three from the longitudinal joint, and tested in accordance with Section H, "Field Placed HMA Material". Random sampling shall be in accordance with procedures contained in ASTM D3665.

Mat density and air voids shall be evaluated in accordance with Section H, “Field Placed HMA Material”. Joint density will be evaluated in accordance with Section H, “Field Placed HMA Material”.

The Control Section shall be considered acceptable if the uniformity, thickness, and 1) mat density, plant air voids, VMA, and VFA are within the requirements of this specification, and 2) gradation and asphalt binder content are within the action limits specified herein for individual Measurements and 3) , and 3) meet the minimum 100% payment criteria set forth in tables 9 and 10,meet the minimum 100% payment criteria.

If the initial Control section should prove to be unacceptable, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second Control section shall then be placed. Payment for the initial control section will not be rendered until an acceptable second control section is completed. Upon completion of an acceptable second control section, both it and the initial control section shall be paid for in accordance with Section J, “PAYMENT”. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional Control sections, as required, shall be constructed and evaluated for conformance to the specifications. The Contractor will be responsible for all testing and oversight costs associated with all required control sections beyond the first and second. Any additional sections that are not acceptable shall be removed at the Contractor's expense. Full production shall not begin until an acceptable section has been constructed and accepted by the Engineer. Any control section that meets specification requirements shall be paid for in accordance with the Section J, “PAYMENT”.

Job mix formula quality control testing is to be performed by the Contractor at the start of plant production and in conjunction with the calibration of the plant for the JMF. It should be recognized that the aggregates produced by the plant might not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to re-evaluate and re-design the mix using plant-produced aggregates. Specimens should be prepared and the optimum asphalt binder content determined in the same manner as for the original design tests. A revised JMF will need to be submitted and a test section constructed prior to approval and full production. The test section and JMF submittal shall conform to all the specification requirements contained herein.

F. *EQUIPMENT*

Hot Mix Asphalt Mixing Plant - Shall meet MHD M3.11.07. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold elevator feeding the drier. The storage yard shall be neat and orderly, and separated stockpiles shall be readily accessible for sampling.

1. Sampling Platform: A safe and adequate platform or catwalk with stairway and railing shall be provided to accommodate the inspector while checking temperatures and obtaining samples of the mixture from haul vehicles. The height of the platforms and raised platforms shall be adequate to accommodate safe acquisition of mix samples from the type of hauling unit(s) being utilized on the project.
2. Testing Laboratory - The Contractor or producer shall provide a testing laboratory at the production plant for quality control and quality acceptance functions during periods of mix production, sampling, and testing, and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory shall contain adequate equipment, space, and utilities as required for the performance of the specified tests.

It shall be available for joint use by the Contractor for quality control testing, if applicable, and by the Engineer for acceptance testing. The testing laboratory must have adequate equipment for the performance of the tests required by these specifications and the requirements of NETTCP. The Engineer shall have priority in use of the equipment necessary for acceptance testing. All the necessary testing equipment shall be located at the HMA plant supplying material to the project. In addition, all ancillary and miscellaneous equipment needed to perform the testing in accordance with these specifications shall be provided by the Contractor at no additional cost.

The effective working area of the laboratory shall be a minimum of 150 square feet with a ceiling height of not less than 7.5 feet. Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70°F ± 5°F.

The plant laboratory shall further contain and be kept supplied with the following laboratory equipment: Scale (digital): 20,000gm capacity minimum, sensitivity 0.1gm.

Marshall Equipment: Automatic hot mix asphalt compactor mounted in accordance with ASTM D1559 and conforming to specifications for AASHTO T-245 which consists of totally enclosed, rigidly mounted

operated frame, a standard circular-foot compaction hammer assembly designed to ensure an eighteen

(18) inch drop regardless of specimen height, a one third (1/3) horsepower motor with belt guard and controls, an automatic counter that shuts off the power after the set number of hammer drops, and a standard compaction pedestal with guide pins for centering one standard (4 inch diameter) bituminous mold at a time. The Contractor shall also provide two (2) stability compaction molds conforming to ASTM D1559 and suitable for use with the automatic bituminous compactor.

NOTE: The Soil test Model AP-800 automatic bituminous compactor and AP-166 stability compaction molds have been found suitable.

Superpave Gyratory Compactor (For plants supplying materials contained in Table 5) conforming to the requirements of AASHTO R30, R35, M323, T312 and the Asphalt Institute Manual SP-2.

Bulk specific gravity determination equipment (AASHTO T166), and theoretical maximum specific gravity equipment (AASHTO T209).

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities, if applicable. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

Hauling Equipment - Trucks used for hauling hot mix asphalt mixtures shall have tight, clean smooth metal beds which have previously been cleaned of all foreign material. To prevent the mixture from adhering to them, the beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, soluble oils or other approved material. When coating is applied, truck bodies shall be raised immediately prior to loading to remove any excess coating material in the truck bed. Containment of the excess anti-adhesive material may be required for environmental concerns depending on the type of anti-adhesive agent used. Each truck shall have a securely fastened, both front and rear, waterproof cover to protect the mixture at all times. The use of mesh type tarps will **not** be permitted. When necessary, so that the mixture will be delivered to the site at the specified temperature within 25^{o}F of the approved JMF, truck beds shall be insulated.

Pavers - Pavers shall be self-contained, heated, power-propelled units with an automated controlled screed, and shall be capable of spreading and finishing courses of hot mix asphalt material which will meet the specified thickness, smoothness, and grade. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of hot mix asphalt material in widths shown on the plans.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The hopper shall be maintained in excess of 25% volume of hot mix during normal paving operations thereby eliminating exposure of the drag slat conveyor. The screed assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, segregating or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture. The paver shall be maintained with non-worn reverse augers or kickback paddles at the center of the screed at the auger bearing box.

The paver 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.

The paver 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. To construct tight longitudinal paving joints, the end gate, or an edge plate, and the notched wedge joint maker, must be down just off the surface to ensure a light compaction and setup of the material on the joint. The paver shall be capable of spreading the mixture without segregation in layers to the depths and widths required. They shall be equipped with a single joint automated tracker device for proper matching of the elevation of longitudinal joints between adjacent strips or courses of the same thickness. Extensions shall contain auger and tunnel extensions if the end gate exceeds 18" from the end of the auger shaft.

An approved device will be required for heating the screed to the temperature required for the laying of the

mixtures without pulling or marring.

The term "screed" includes any 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.

The pavers employed on Worcester projects shall operate by the use of a sensing grid for operation to a stringline and an automated joint matcher for joints, and an automatic grade control device for profile. The paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.

The controls shall be capable of working in conjunction with any of the following attachments:

1. Ski-type device of not less than 30 feet (9.14 m) in length.
2. Taut stringline (wire) set to grade.
3. Short ski or shoe.
4. Laser control.
5. Sonic control.

The paver screed may be equipped with a Longitudinal Notched - Wedge Joint paver attachment or Straight Wedge Joint paver attachment and screed mounted roller attachment. When placing HMA pavement courses at a thickness of 1.5" or greater, the notched wedge is recommended; when placing HMA pavement courses less than 1.5", the straight wedge is recommended. The notched wedge joint includes a variable notched vertical edge (the notch vertical height to be equal to the mixture's maximum aggregate size). The sloped surface of the diagonal wedge joint shall not exceed a 6:1 slope.

Rollers - Rollers of the vibratory, steel wheel, oscillatory, and pneumatic-tired type may be used. They shall be in good condition, capable of reversing direction without backlash, and operating at slow speeds to avoid displacement of the hot mix asphalt. Static rollers shall be operated at speeds not to exceed 3 mph and vibratory rollers shall be operated at a minimum of 10 to 12 impacts/ft. in vibratory mode. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition.

The use of equipment which causes excessive crushing of the aggregate or that which does not produce a smooth, dense and uniform HMA mat will not be permitted.

The Contractor shall exercise great caution when using vibratory rollers so as not to cause damage to buried infrastructure or adjacent infrastructure. Damage to buried or adjacent infrastructure will be the responsibility of the Contractor. The new Oscillation type rollers are acceptable for use for intermediate compaction and back rolling of HMA in the City of Worcester.

The Contractor is encouraged, when applicable, to use a pneumatic square edge-tired compaction roller (either one or both axles) as another acceptable alternate for the Intermediate and Final rolling of hot mix in the City of Worcester.

G. *HMA CONSTRUCTION*

Weather Limitations - The HMA/WMA shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture (film of water). When the surface temperature of the underlying course is less than 50°F but above 40°F, the Contractor shall determine the time available for compaction. No material will be placed by the Contractor when the surface temperature is below 40°F, unless approved by the Engineer. The time available for compaction shall be calculated based on the time, date, air temperature, average wind speed, sky conditions, latitude, mix type, PG grade, lift thickness, mix delivery temperature, existing surface type, existing moisture content of surface, existing state of moisture in surface, and surface temperature. The estimated time available for compaction can be calculated with computer programs, e.g., Pave Cool Tool 2.4.

This program is available at the following web location: http://mnroad.dot.state.mn.us/research/mnroad_project/restools/cool tool.asp

The information regarding the air temperature, average wind speed, sky conditions, mix delivery temperature, and existing moisture conditions shall be evaluated by the Engineer and a Contractor's representative

located at the paving operation. The estimated time available for compaction shall be provided by the Contractor to the Engineer. The Engineer and the Contractor shall determine if there is an adequate amount of time available to

compact the mixture. Options can be explored to extend the time available for compaction. If there is an adequate amount of time available to compact the mixture, the temperature requirements may be waived by the Engineer; however all other requirements including compaction shall be met. The Contractor assumes responsibility for constructing the pavement to meet compaction, bonding to the underlying surface and specification requirements.

The Engineer will not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown will not be placed until the pavement surface shows no signs of free moisture, provided the mixture is within temperature limits as specified.

The construction of HMA/WMA concrete pavements shall terminate on November 15 and shall not be resumed prior to April 1 except as determined and directed in writing by the Engineer.

Thermometer - The Contractor will supply an approved dial type thermometer with a temperature range of 50°F to 500°F and an infrared pistol thermometer for use during HMA placement. The infrared pistol thermometer shall be Fahrenheit or Celsius selectable and conform to the following requirements:

Portable and battery operated Accuracy of +/- 2% Repeatability of +/- 3°C Emissivity preset at 0.95

LCD Display to nearest 1° Temp. Operating range of

-4°F to 752°F

The thermometers will remain the property of the Contractor upon completion of the project.

Pre-Paving Conference - Prior to the placing of any HMA, a pre-paving conference (approximately 5 hours in length) shall be held to discuss and approve the paving schedule, source of HMA, job mix formula approvals, type and amount of equipment to be used, sequence of paving pattern, rate of HMA supply, all sampling, testing and reporting procedures to be used, traffic control, safety, and general continuity of the operation. Engineer's representatives, Contractor's plant, quality control and field representatives and Engineer's testing and inspection agents (any and ALL personnel anticipated to be on job site) shall attend this meeting. All equipment used shall be approved on the project site prior to starting up each day. **It will be mandatory for the Contractor and the paving subcontractor, if utilized, to attend this conference.** The Contractor will be responsible for all costs associated with additional training.

The Engineer, upon 48 hours' notice, may be able to hold this conference preferably on the forecast of an inclement day.

Preparation of the Underlying Surface - Immediately before placing the hot mix asphalt, the underlying course shall be thoroughly cleaned of all dust and debris by a self-propelled sweeper. Areas inaccessible by power sweepers shall be broom swept until the pavement surface is clean. Extra care shall be required during fall leaf fall.

Proof roll prepared base material surface, if applicable, to identify areas requiring removal and re-compaction, and to provide a uniform degree of compaction over the entire pavement area.

Do not begin paving work until deficient base material areas and utility trenches have been corrected and are ready to receive paving. Paving shall not be applied until the Engineer inspects and approves the finished base.

When an existing surface or new base upon which the lower course is to be placed contains unsatisfactory irregularities, in the Engineer's judgment, such irregularities may be eliminated by an adequate placing and compaction of HMA mixture so as to furnish a surface with true contour and grade before placing any specified course of mixture.

Check all frames, covers, grates, water valve boxes and other miscellaneous castings that are located in the proposed pavement areas to ensure that all have been correctly positioned and set to the proper slope and elevation. All covers and grates shall be set flush with the required finished surface. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of castings.

For Reclaimed base, reconstruction or where new base is graded, the Contractor shall furnish, set, and maintain all line and grade stakes necessary to guide the automated grade control equipment. Where required these

control stakes shall be maintained by the Contractor and used throughout the operations, from the grading of the subbase material up to and including the final layers of the pavement.

Adequate artificial lighting shall be provided during night placements. Hauling over freshly placed material shall not

be permitted until the material has been compacted, as specified, and allowed to cool to an internal temperature of 140°F minimum.

Proper precautions shall be taken to prevent damage by construction operations to edges adjacent to the hot mix asphalt. These edges may be, but are not limited to, gutters, catch basins, curbs, concrete structures, and hot mix asphalt concrete. If damage occurs, repairs shall be made to the satisfaction of the Engineer with no additional payment.

Tack Coat - Contact surfaces of manholes, structures, vertical pavement edges, etc. shall be painted with a thin, uniform tack coat just before the material is placed against them.

Tack coat is required on all surfaces to be paved; this includes leveling, base or intermediate layers of HMA, unless the underlying HMA layer was placed during the same day. Particular attention should be made during the application that the longitudinal joint areas be treated with no bare spots. Missing areas adjacent to the longitudinal joint area will require either re-application or localized hand work application as directed by the Engineer.

Tack coat shall be applied at a residual binder amount on the pavement between 0.03 to 0.05 gallons per square yard. Use the lower application amount between new lifts and the higher application rate on milled or Portland cement surfaces. This amounts to a very thin application that needs to be carefully applied. Massachusetts uses RS-1 and CRS-1 type asphalt emulsions for tack coating. These can be applied, as an emulsion, between 0.05 to 0.08 gallons per square yard. Tack coat shall be supplied as part of the HMA operation.

Allow tack coat to dry from a brown color to a black color prior to paving.

HMA Production - The aggregates and the asphalt binder material shall be weighed or metered and introduced into the mixer in the amount specified by the JMF and within the allowable action limits as stated in Table 7 HMA PRODUCTION LIMITS. These limits shall be applied to the target values established in the JMF. Corrective action shall be taken by the Contractor when the calculated individual result for gradation or asphalt content falls outside the target JMF value beyond the action limit listed in Table 7. The Contractor shall take the appropriate action when results indicate the material is out of tolerance. The Contractor shall be required to suspend production when the calculated individual result for gradation or asphalt content falls outside the target JMF value beyond the suspension limit listed in Table 7, or when the asphalt binder content is below the minimum values stated in Table 6 for Marshall Mixes. The Contractor shall be required to suspend production if two points in a row fall outside the Action Limits for individual measurements or if three nonconsecutive samples fall outside the Action limits. The Contractor shall be required to suspend production if one point falls outside the Suspension Limits for individual measurements. The Contractor shall also be required to suspend production if one point falls outside the Suspension Limits for range, Table 8.

1. Plant Trials – If production is suspended, the production facility shall be required to produce material on a trial basis for testing purposes without shipment to the project. No payment will be made for material and labor employed for nonconforming plant trials. The Engineer or his representative shall pay for acceptance sampling and testing for the first set of trials necessary to determine conformance with the specification requirements. If the first set of trials does not conform to specification requirements, the Contractor shall pay for any additional trial sampling and testing for acceptance. When trials have been approved, the plant will return to its normal operation.

Failure to stop production and make adjustments when required due to an individual test(s) not meeting the specified requirements may subject all of the mix from the stop point to be considered unacceptable.

The temperature of the mixture shall be in accordance with the Performance Graded Asphalt Binder (PGAB) allowable mixing and compaction temperature range. The temperature of the mixture when discharged from the mixer or silo shall be $\pm$ 20°F (-6°C) from the value stated in the job mix formula. Mixtures exceeding these limits shall be subject to rejection.

RAP VERIFICATION - The City will randomly test HMA mixtures from the production plant or storage silos to determine the quality of the PG binder. For non-modified binder mixtures, the absolute viscosity of the recovered asphalt shall be no greater than 6,000 poises at 140°F. If the absolute viscosity is greater than 6,000 poises, then a full PG binder test verification will be run for conformance to the PG grade specified. For modified asphalt binder mixtures, a full PG binder test verification will be run for conformance to the PG

grade specified. Failure of the PGAB to conform to specification requirements may be cause for rejection of the Lot. Further PGAB tests may be conducted on previous Lots; all costs for the PGAB tests will be the responsibility of the Producer if the results do not meet specifications [T_{MAX} for G*/Sin (d) DSR (RTFO Aged)] for PG 64-28 or 64-22 (whichever is applicable) recently placed.

Transporting, Placing and Finishing - HMA deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver.

Upon arrival, the mixture shall be placed to the full width by a hot mix asphalt paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the hot mix asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet except where edge lanes require less width to complete the area. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least one (1) foot, however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least two feet from transverse joints in the previous layer. The placement of the material along the longitudinal joint may be performed by setting the screed to overlap the first mat. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. The overlapped material shall be bumped by the lutes, if necessary, to optimize the density along the longitudinal joint. Under no circumstances should the overlapped material be broadcast across the mat. Excess material should be removed by hand. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools. When hand spreading is permitted, the mixture shall be distributed into place by means of hot shovels and spread with lutes in a loose layer of uniform density and correct depth. The use of rakes to spread the hot mix asphalt shall not be permitted. Loads shall not be dumped any faster than they can be properly handled by the shovelers and the shovelers shall not distribute the dumped load any faster than it can properly be handled by the lutes. The luting shall be carefully and skillfully done to avoid segregation and so that, after the first passage of the roller over the luted mixture, no back patching will be necessary. Compaction must immediately follow hand spreading such that specification density is achieved while the mixture temperature is above the manufacturers recommended compaction temperature for the performance graded binder.

The mixtures shall be placed and compacted only at such times as to permit the proper inspection and checking by the Engineer.

The mixtures shall only be placed in the work when they can be efficiently and satisfactorily placed, compacted, smoothed, and made uniform in accordance with these specifications. Unless otherwise permitted by the Engineer for special particular conditions, only machine methods of placing shall be used.

No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled to 150^{o}F, or that minimum compaction temperature specified by the binder manufacturer and provided that the density and uniformity of the completed pavement attains specification compliance.

No traffic of any kind shall be permitted on the HMA intermediate or HMA base when dirt or any other foreign substance may be tracked thereon.

Immediately after any course is screeded and before roller compaction is started, the surface shall be checked, any irregularities adjusted, any accumulation from the screed removed by rake or lute, and all fat spots in any course removed and replaced with satisfactory materials. Irregularities in alignment and grade along outside edges shall be corrected by the addition or removal of mixture before the edges are rolled. Indiscriminate casting of mix on the new screeded surface, where irregularities are not evident, shall not be permitted.

All hot mix shall be placed and compacted in such a manner as to ensure a continuous bond between the tacked hot mix pavement surfaces and obtain the required density.

1. Production Trial – If it is determined, during the performance of the contract, that the pavement does not conform to the surface tolerance, density and uniformity requirements, the Engineer may order the Contractor to cease all operations and construct an additional HMA CONTROL SECTION consisting of a sufficient quantity of surface course mixture. The Contractor shall construct a control section as directed by the Engineer either: a minimum of 100 feet long by 12 feet wide, or a minimum

of 50 feet long by a minimum of 24 feet wide depending upon the problem. A control section may be required each time a change is made in the Job Mix Formula, sources of supply or paving and rolling equipment.

The mixture shall be prepared, placed, and compacted in accordance with this specification. When the control section pavement has cooled sufficiently, a total of six (6) core samples of the finished pavement shall be taken and tested in accordance with the requirements of Section E.

If the tests by the Engineer indicate that pavement does not conform to specification requirements, necessary adjustment to plant operation and placement/rolling procedures shall be made.

Where the average density of the core samples does not conform to specification requirements, the pavement shall be removed at no cost to the Engineer. No payment will be made for material and labor employed, either in placement or removal of the nonconforming control section.

The control section may be removed at the direction and at no cost to the Engineer if the test result of any one mat core density falls below 90% of theoretical maximum laboratory density and/or any one longitudinal joint density falls below 88% of theoretical maximum laboratory density.

The Contractor shall not be permitted to place surface course pavement until a control section is approved by the Engineer.

Joints - The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade. When abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure.

Transverse Joints - The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by temporarily tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. In both methods, all contact surfaces shall be given a coat of hot-pour rubberized asphalt sealer before placing any fresh mixture against the joint.

Longitudinal Joints - All longitudinal joints shall be constructed with the first paver pass in a neat straight line. Deviation from trueness will negate the ability to form a properly compacted longitudinal joint.

The paver screed may be equipped with a Longitudinal Notched - Wedge Joint or Straight Wedge Joint paver attachment and screed mounted roller attachment when placing HMA pavement courses. Use the Notched Wedge Joint for thicknesses of 1.5" or greater and use the Straight Wedge Joint for thicknesses less than 1.5". The notched wedge joint shall include a variable notched vertical edge (the notch vertical height to be equal to the mixture's maximum aggregate size). The sloped surface of the diagonal wedge joint shall not exceed a 6:1 slope. Prior to placing the adjacent paver pass for sloped joints, all joint contact surfaces shall be given a tack coat prior to placing any fresh mixture against the joint.

Vertical butt joints which are not constructed straight, or are not constructed with an edge restraining device (either a commercial paver screed attachment or by dropping the end gate down to the surface), or are damaged or otherwise defective shall be cut back 3 inches to expose a clean, sound surface for the full depth of the course. All contact surfaces shall be given a coat of hot-pour rubberized asphalt sealer prior to placing any fresh mixture against the joint. The Vertical butt Joint will be the preferred method joint to construct when paving

Longitudinal and transverse joints shall have an in-place density when measured by the average of three, six (6") inch cores between 91.0% to 98.0% of maximum theoretical.

Compaction of HMA Mixture After Placing - The mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. Rolling shall be initiated with the drive roll or wheel towards the paving machine. When rolling on steep grades, the previous procedure may need to be altered.

The speed of the roller shall, at all times, be sufficiently slow and of uniform speed to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. The number of rollers and passes required shall be governed by the compaction results; however, at least two rollers shall be provided for each paver employed on the paving operation. The City of Worcester is encouraging the use of pneumatic or oscillation rollers. If one of the selected rollers is pneumatic, it shall be equipped with the European square edge tires. This will allow the pneumatic roller to handle both the intermediate compaction as well as the back rolling responsibilities on two-roller trains. An alternate to a full pneumatic European tired roller would be a combination 10-ton steel vibratory with large pneumatic square edge rear wheels. An acceptable alternative to the vibratory or pneumatic tired rollers would be the "Hamm" Oscillatory roller. Each roller shall be operated by a competent,

experienced roller operator and shall be kept in as nearly continuous operation as practicable while work is underway. A plate shall be attached to each roller showing the ballasted and un-ballasted weight per length-width of tread.

To prevent adhesion of the mixture to the steel roller, the drums or shall be kept properly moistened, cocoa mats kept clean and scrapers used, but excessive water will not be permitted. Pneumatic rollers shall be operated on adjacent pavement surfaces to get the tires warm to hot from friction, then moved to the fresh mat.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers and vibratory plate compactors.

Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

Along any adjoining edge such as curb, gutter or an adjoining pavement, and after the HMA is placed by the paver, just enough of the hot HMA shall be placed by hand method to fill any space left open. These joints shall be properly 'set up' with the back of a lute at the proper height and level to receive the maximum compaction. Any areas where the rollers cannot access shall be hand tamped or plate compacted.

Shaping Edges - While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back of a lute or smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.

Surface Smoothness - The finished surfaces of the pavement shall be uniform in appearance, free from irregularities in contour and texture and shall present a smooth-riding surface. Smoothness evaluation applies to all hot mix asphalt concrete roadways receiving 1.5" or more in plan (compacted) thickness of HMA pavement.

Tests for conformity with the specified crown and grade shall be made by the Contractor immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.

The finished surface of the pavement, when measured with a 10-foot straightedge, shall not vary more than 1/4 inch for the surface course and 3/8 inch for the intermediate course measured perpendicular and parallel to the centerline. If, in the opinion of the Engineer, the surface visually appears wavy, but meets the surface tolerance test with the 10-foot straightedge, the Engineer reserves the right to additionally test with the use of Inertial Profile Equipment which records cumulative vertical deviations per unit length using a statistic called International Roughness Index (IRI). City of Worcester street upset limit for IRI is set at 135 in/mile using similar equipment that MHD specifies in their Quality Assurance HMA projects.

After the completion of final rolling, the smoothness of the course shall again be tested; humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective work and replacing with new material, as directed by the Engineer. This shall be done at the Contractor's expense.

Skin patching will not be permitted.

When profile corrections are required, the Contractor shall use one or more of the following corrective methods: Removing and replacing the entire pavement thickness;

Diamond grinding or micro milling;

Overlaying (not patching) with the specified surface course;

Removing the surface by milling and applying a lift(s) of the specified course(s); Use of other methods that will provide the desired results;

The corrective method(s) chosen by the Contractor shall be performed at the Contractor's expense, including all necessary equipment and traffic control. Areas of removal and replacement shall be removed the full width of the lane. The removal areas shall begin and end with a transverse butt joint which shall be constructed with a transverse saw cut perpendicular to the centerline. Replacement materials shall be placed in sufficient quantity so the finished surface will conform to grade and smoothness requirements. The corrective area shall conform to all material and density specification requirements. When the corrective work consists of an overlay, the overlay shall cover the full width of the pavement including shoulders. The area overlaid shall begin and end with a transverse butt joint which shall be constructed with a transverse saw cut and asphalt removal. All materials shall meet contract requirements. The overlay shall be placed so the finished surface will conform to grade and smoothness requirements. The overlayed area shall be compacted to the specified density.

The Engineer shall retest any sections where corrections were made to verify that the corrections produced a surface that conforms to the grade and smoothness requirements.

Uniformity - The HMA mat shall be smooth, dense, and uniform. Uniformity is generally affected by Thermal and/or Aggregate segregation.

If segregation is evident and discernable by either the Contractor or the Engineer, the Contractor shall immediately cease production and take steps to correct and eliminate the cause(s) of the segregation to the satisfaction of the Engineer.

The Contractor shall review all potential causes of segregation as it relates to its operation, including but not limited to HMA Plant issues, loading and transportation issues, placement issues, thermal segregation, and hand work. The Contractor shall employ additional investigation methods and make the necessary changes in their operation such that segregation is eliminated and mat uniformity is acceptable.

The Engineer shall obtain two (2) six inch diameter cores from the identified (segregated) area and two (2) six inch diameter cores from the non-segregated area. The cores may be evaluated for resilient modulus, dry tensile strength, change in air voids, maximum in place air voids, aggregate gradation and binder content. The results of the data obtained on the cores from the segregated area will be compared to the results of tests performed on the cores from the non-segregated area.

If any mix property is beyond the tolerance limits stated in the table below, that area shall be considered segregated and shall be repaired by the contractor.

SEGREGATION LIMITS

Change in Mix Properties Expressed as a Percentage of the Properties in the Non-Segregated Areas	
Property	***Limits***
Resilient Modulus, psi @ 77ºF	***<80%***
Dry Tensile Strength, psi @ 77ºF	***<90%***
Aggregate Gradation and Binder Content	***Refer to Table 7 (Action Limits)***
Change in Air Voids	***>2.5%***

The samples for the segregation analysis will be considered separately from the mat and joint cores tested for acceptance.

Segregated areas not meeting the requirements stated above or areas having more than 13% air voids shall be removed and replaced for the entire pavement thickness and lane width, or as directed by the Engineer. All corrective methods shall be performed at the Contractor's expense. The removal areas shall begin and end with a transverse butt joint which shall be constructed with a transverse saw cut perpendicular to the centerline. The corrective area shall conform to all grades, smoothness, material, and density specification requirements. The Engineer may retest any areas where corrections were made to verify that the material meets specification requirements.

Thickness - The thickness requirements contained herein shall apply only when each pavement layer is specified to be a uniform compacted thickness of 1 inch or greater. Thickness shall be evaluated for acceptance by the Engineer to the requirements shown on the plans. Measurements of thickness may be checked periodically by the Contractor in following their QC system for field operations. Measurements of

thickness for acceptance shall be made by the Engineer using four-inch minimum diameter pavement cores removed also for subsequent density measurement.

The finished surfaces of each HMA pavement course shall not vary from that specified or cross sections shown on the contract drawings by more than one-quarter (1/4) of an inch. The Contractor shall correct pavement areas varying in excess of this amount by removing and replacing the defective work or as ordered by the Engineer. Skin patching will not be permitted.

Grade - The finished surface of the pavement shall not vary from the grade line elevations as shown on the plans by more than 1/2 inch. The Contractor shall remove deficient areas and replace with new material. Sufficient material shall be removed to allow at least 1.5 inches of hot mix asphalt to be placed. Skin patching for correcting low areas shall not be permitted. High points may be ground off.

Leveling Course - Any HMA used for truing and leveling shall meet the requirements of the mix design methods and the requirements of the TABLE 6 or TABLE 3, 4, and 5 specifications for the applicable mixtures. Leveling courses shall not be subject to density requirements. The thickness of the Leveling Course shall be measured off the interface with the existing milled or un-milled pavement surface. The leveling course shall be compacted with the same effort used to achieve placement and density of the test section. The truing and leveling course shall not exceed a nominal thickness of 1.5 inches.

Opening to Traffic - 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 an internal temperature of 140°F or less. If the climatic or other conditions warrant, or if the PGAB manufacturer recommends, the period of time before opening to traffic may be extended at the discretion of the Engineer.

Contractor Quality Control of HMA Pavement

1. General - Although guidelines are established and certain requirements are shown, they are suggested at this time. The QC system addresses all elements which effect the quality of the pavement including, but not limited to:

a. Mix Design
b. Aggregate Grading
c. Quality of Materials
d. Stockpile Management
e. Proportioning
f. Mixing and Transportation
g. Placing and Finishing
h. Joints
i. Compaction
j. Surface smoothness and uniformity
k. Thickness and grade

The Contractor shall be prepared to discuss and present, at the pre-paving conference, their understanding of quality control for this contract.

2. Control Charts

Contractor shall develop production control charts and post for visual reference in the testing laboratory. The control charts should identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the production test results. If the project data during production indicates a problem and the Contractor is not taking satisfactory corrective action, then the Engineer may suspend production or acceptance of the material, in accordance with these specifications.

Individual Measurements: Control charts for individual measurements may be established to indicate production quality control within given tolerances for aggregate gradation and asphalt binder content. The control charts will use the JMF target values as the indicator of central tendency for the following test parameters with associated Action and Suspension Limits:

TABLE 7 HMA PRODUCTION LIMITS FOR INDIVIDUAL MEASUREMENTS

Sieve Size	*Action*	*Suspension*
1-1/2" (37.5mm)	*0%*	*0%*
1" (25.0 mm)	*±6%*	*±9%*
3/4" (19.0 mm)	*±6%*	*±9%*
1/2" (12.5 mm)	*±6%*	*±9%*
3/8" (9.5 mm)	*±6%*	*±9%*
#4 (4.75 mm)	*±6%*	*±9%*
#8 (2.36 mm)	*±5%*	*±7.5%*
#16 (1.18 mm)	*±5%*	*±7.5%*
#30 (0.600 mm)	*±4%*	*±5.5%*
#50 (0.300 mm)	*±3%*	*±4.5%*
#100 (0.150 mm)	*±3%*	*±4.5%*
#200 (0.075 mm)	*±2%*	*±3%*
Asphalt Binder Content	*±0.4%*	*±0.70%*
Design Air Voids (4.0%)	*±1%*	*±1.7%*
Voids in Mineral Aggregate	*0.4% below mix specified min.*	*0.7% below mix specified min.*
Voids Filled with Asphalt	*±1% below or above mix specified range*	*±2% below or above mix specified range*

When evaluating the production limits, the sieve sizes above the maximum size aggregate should be deleted from the Individual Measurements Chart and the maximum aggregate sieve size Action and Suspension Limits should be changed to 0%.

Range. Control charts for range may be established to indicate production variability for the test parameters and Suspension Limits listed below. The range may be computed as the difference between the high and low test results per lot for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. If more than two tests per lot were used, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

Table 8 CONTROL CHART LIMITS BASED ON RANGE	
(Based on n = 2)	
Sieve	*Suspension Limit*
1-1/2" (37.5 mm)	*11 percent*
1" (25.0 mm)	*11 percent*
3/4" (19.0 mm)	*11 percent*
1/2" (12.5 mm)	*11 percent*
3/8" (9.5 mm)	*11 percent*
#4 (4.75 mm)	*11 percent*
#8 (2.36 mm)	*10 percent*
#16 (1.18 mm)	*9 percent*
#50 (0.30 mm)	*6 percent*
#200 (0.075 mm)	*3.5 percent*
Asphalt Binder Content	*0.8 percent*
Design Air Void Content	*2.0 percent*

Corrective Action. The Contractor should review the control charts on a continuous basis making adjustments to the process when necessary to keep the product consistent. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

Design Air Void Content or Asphalt Binder Content falls outside the Suspension Limit line for individual measurements or range; or

Design Air Voids and two or more points fall outside the Action Limit line for individual measurements as indicated in Table 7; or

Design Air Voids fall outside the Action Limit and one point falls outside the Suspension Limit for individual measurements as indicated in Table 7; or

Three points in a row fall outside the Action Limit line for individual measurements as indicated in Table 7.

Three nonconsecutive samples out of 5 samples fall outside the Action Limit line for individual measurements as indicated in Table 7.

Two consecutive streets or two consecutive 1,000 ton lots of material tested for mat density or longitudinal joint density falls below the threshold density for 100% adjustment, as noted in Table 9 and Table 10.

The Contractor's Quality Control system shall include an appropriate action to be taken when the process is believed to be out of tolerance. The Contractor should review the control charts on a continuous basis making adjustments to the process when necessary to keep the product consistent.

Acceptance testing requirements are the responsibility of the Engineer.

H. *QUALITY ACCEPTANCE OF HMA*

All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the contractor, unless otherwise stated herein. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be calibrated and verified by a testing organization prior to the start of operations. Such verification/certification shall be furnished to the Engineer prior to production. Engineer's testing personnel shall be certified by the New England Transportation Technician Certification Program (NETTCP). This function does not relieve the Contractor from performing their daily quality control tasks as part of their normal operating business.

The Engineer or their agent shall have access at any time to all parts of the producing plant for:

a. Inspection of the condition and operations of the yard, plant and laboratory.
b. Confirmation of the adequacy of equipment in use.
c. Verification of the character and proportions of the mixture.
d. Determination of temperatures being maintained in the preparation of the mixtures.
e. Inspection of incidental related procedures.

Samples of all material including compacted specimens and certified copies of all reports and printouts shall be made available to the Engineer or its agent as often as requested including: asphalt binder; virgin aggregates; modifiers, loose and compacted mixture specimens; and combined aggregate samples.

1. PLANT-PRODUCED MATERIAL

Plant-produced material shall be sampled and tested for VMA, VFA, gradation, asphalt binder content, and air voids (Marshall or Superpave at N_{design}), on a lot basis. The Engineer's testing personnel shall be certified by the New England Transportation Technician Certification Program (NETTCP), as HMA Plant Technicians. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. A lot will consist of:

- one day's production and shall be divided into 300 ton sublots. A minimum of one sample shall be obtained for each lot.

Where more than one plant is simultaneously producing material for, the job, the lot sizes shall apply separately for each plant.

Sampling - Sufficient material for analysis and preparation of test specimens will be sampled by the Engineer on a random basis, in accordance with the procedures contained in ASTM D 3665. A minimum of one set of laboratory compacted specimens will be prepared for each lot in accordance with AASHTO T312, at the number of gyrations required by Table 4 herein (for Superpave only), or in accordance with Marshall design criteria, Table 6. Each set of laboratory compacted specimens will consist of two test portions prepared from the same field sample.

The sample of hot mix asphalt may be put in a covered metal tin and placed in an oven for not more than 30 minutes to maintain the heat. The compaction temperature of the specimens should be as specified in the JMF.

In addition to the hot mix asphalt samples, the Contractor shall take one, one-quart sample of the PG binder used to produce the hot mix asphalt at the start of the work. The PG sample shall be turned over to the Engineer on the first day of project production.

Testing

Bulk Specific Gravity - Two (2) laboratory fabricated sample specimens shall be tested for bulk specific gravity per sublot in accordance with AASHTO T166 or T331, whichever is applicable, for use in computing air voids and density. Air voids shall be computed in accordance with AASHTO T269.

Gradation and Asphalt Binder Content - The gradation and asphalt binder content of the mixture shall be measured for each sublot in accordance with the following:

Asphalt Binder Content – An extraction test be performed in accordance with AASHTO T164 or AASHTO T308 for determination of asphalt content. The weight of ash portion of the extraction test, as described in AASHTO T164, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture. If utilizing AASHTO T308 for asphalt content determination, the calibration process and calibration factor, as described in AASHTO T308, shall be determined as stated, prior to acceptance testing. A verification shall be performed as part of every twentieth test performed thereafter or when changes in the mix are apparent.

Gradation - Aggregate gradations shall be determined from mechanical analysis of extracted aggregate in accordance with AASHTO T 30 and AASHTO T27 (Dry Sieve).

The Dust-to-Effective Asphalt ratio shall be determined once for each sublot from the mechanical analysis of extracted aggregate and the asphalt binder content. The Dust-to-Effective Asphalt ratio shall be determined by the Engineer in accordance with AASHTO R35.

The Theoretical Maximum Specific Gravity of the mixture shall be measured for each sublot in accordance with AASHTO T209, Type C, D, or E container. Samples shall be taken on a random basis in accordance with ASTM D 3665. The value used in the field placed void computations shall be the average of the maximum specific gravity measurements for the lot.

Temperatures: Temperatures of the HMA shall be checked in the first three (3) haul units departing the production facility for each production day, and additionally once for each sublot. Additionally, temperatures may be checked to determine the temperatures of the dryer, the asphalt binder in the storage tank, the mixture at the plant, and the mixture at the job site for specification conformance.

VMA, VFA, and air voids, for each plant sample, will be determined by the Engineer in accordance with the applicable AASHTO test method. The VMA, VFA, and air voids for each sublot shall be computed by averaging the results of the two test specimens representing that sublot.

Acceptance of Plant Produced HMA - Acceptance of plant produced HMA material will be based upon plant air voids, Marshall stability and flow (if applicable), VMA, VFA, gradation, asphalt binder content, and temperature, and shall be determined by the Engineer in accordance with these specifications.

Field Placed HMA Material - HMA material placed in the field shall be tested for mat and longitudinal joint density on a completed street or public facility basis. The Engineer's testing personnel shall be certified by the New England Transportation Technician Certification Program (NETTCP), as HMA Paving Technicians or HMA Plant Technicians. The Engineer may conduct any necessary testing to monitor the specified density, uniformity and smoothness. A properly correlated density gauge may be used to monitor the pavement density in accordance with ASTM D2950 or ASTM 7113. Monitoring density with density gauges by the Engineer does not imply acceptance or rejection; the Contractor is ultimately responsible to meet the requirements of the specification.

Sampling - Density gauges may be used by the Engineer to determine density of the paving course mat and/or longitudinal joints. Cores of the material shall be minimized and only taken at the direction of the Engineer and approval of the City. Mat and longitudinal joint density tests will be located by the Engineer or their representative on a stratified random sampling basis for each street or facility paved. The length of the longitudinal paving joint will be divided into sub-lots for sampling and testing purposes. If more than one longitudinal joint is formed on a street, then the random sample length will be the total lineal feet of longitudinal joint placed. A mat and longitudinal joint test will be taken by the Engineer randomly from each of these sub-lot intervals. Sub-lots will be determined on the basis of five (5) sub-lots per one thousand (1,000) tons of material placed or a minimum of five (5) sub-lots from each street or facility paved. Sampling and testing for density will be conducted in the following manner:

Paving courses will be tested with the density gauge (for correlation), then sampled by coring the mat and the centerline of the longitudinal joint for confined edge joint construction, or on the hot side of the longitudinal joint when using notched wedge joint construction. A 6 inch diameter wet-core bit specifically designed for cutting pavement shall be used. The cores will be tested for density and thickness.

When sampling of the longitudinal joint for density determinations by coring, the core will be taken directly over the joint for confined edge construction, on the hot side of the longitudinal paving joint, or adjacent to the vertical edge of an existing longitudinal joint, or as directed by the Engineer.

A density sample will be tested from each sub-lot segment. The total width of the paved surface (curb to curb) will be determined at the longitudinal sub-lot location to sample and test for mat density. A transverse off-set distance from the centerline of the roadway will be established for mat density sampling and testing. The location, either right or left of centerline, will be based on whether a random number is "odd or even" (odd=left; even=right). When the offset location is within 2 foot of the pavement edge, curb, catch basin or structure, or 1 foot off a longitudinal joint, or 10 foot off a transverse joint, the sample shall be relocated.

For nuclear gauge test locations, four 60 second readings will be taken with the gauge turned 90 degrees for each increment. The average of the four readings will be reported as the density value for each location. For non-nuclear density tests, five readings will be taken, after the first reading is taken the gauge will be moved up and to the right approximately 2" (the 2 o'clock position), three more readings will then be taken at the 4 o'clock, 8 o'clock, and 10 o'clock positions using the manufacturers operating procedures. The average of the five density values will be reported for each location.

If the results of the average density gauge readings for a street or pavement facility are below the threshold for 100% adjustment as indicated in Table 9 or Table 10, pavement cores may be removed as per this specification, and used for determining the actual pavement density. Pavement cores will only be removed if a written request is received from the Contractor within 14 calendar days of the City's

receipt of the density report. If a written request is not received, the average density gauge readings will be utilized for payment adjustment.

In the event that a new density gauge needs be correlated for this project, cores should be taken from the mat and longitudinal joint representing the test locations. If previous core locations are available, the new density gauge

should be correlated in accordance with the "re-correlation" procedure. If "re- correlation" is necessary, take four tests at quarter points around each of five previously cored and tested locations; making sure that the side of the nuclear or non-nuclear gauge is at the edge of the patched core location and firmly seated. Each test must be the average of four test increments turning the gauge 90 degrees.

All core samples shall be neatly cut with a core drill and water cooled bit where the cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be 6 inches. Samples that are clearly defective, as a result of sampling, shall be documented and retained, then another sample taken for testing. The Contractor, Engineer or the Owner's agent shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes shall be filled in a manner acceptable to the Engineer and within one day after sampling.

The average density will be used to determine the percent payment.

Resampling of the pavement shall be in accordance with applicable provisions of the NETTCP Quality Assurance Technologist Manual, latest edition and these specifications.

With the exception of any Control Sections, if the Contractor is concerned about the test results obtained by the Engineer, the Contractor may request up to one time per street, that an equal number of random core samples be obtained and tested to supplement (not replace) the original core samples (or density gauge samples when bonus applies). The coring, patching and testing of the additional samples will be the responsibility of the Contractor. Cores for the mat and/or longitudinal joint density tests will be located by the Engineer and witnessed by the Contractor. Cores locations will be based on a new stratified random sampling plan for each street or facility paved in accordance with the procedures stated above. Upon approval of the coring operation, the Contractor will notify the Engineer 48 hours in advance of the cores being taken such that the Engineer can witness the sampling. The additional cores must be tested by a NETTCP certified HMA plant technician in the presence of the Engineer or his designated representative.

Only one (1) set of additional mat and/or longitudinal joint cores will be allowed on a street or lot.

Testing - The bulk specific gravity of each cored sample will be measured by the Engineer's NETTCP certified technician in accordance with AASHTO T166 or T331, whichever is applicable. The theoretical maximum specific gravity shall be the average maximum specific gravity for the lot in accordance with the plant-produced material section. The percent density of each sample will be determined in accordance with AASHTO T269, using the bulk specific gravity of each sample and the average theoretical maximum specific gravity. Retesting of pavement shall be in accordance with applicable provisions of the NETTCP Quality Assurance Technologist Manual, latest edition.

Adjustment Pay Schedule for Mat Density - The pay factor based on the density adjustment schedule will be applied to the bid price per ton for compacted mixtures greater than or equal to 1-1/2 inches thickness as shown in the contract award.

Table 9.
HOT MIX ASPHALT MAT DENSITY
Adjustment Schedule

Average Percent of Maximum Density (minimum 5 samples)	***Percent Payment***
100.0 - 98.1	***98***
98.0 - 95.0	***102***
94.9 - 92.0	***100***
91.9 – 89.0	***90***
88.9 – 87.0	***75***
86.9 or less	***rejection***

Adjustment Pay Schedule for Longitudinal Joint Density - The pay factor based on the joint density adjustment schedule will be applied to the bid price per ton for compacted mixtures greater than or equal to 1 1/2 inches thickness as shown in the contract award.

Table 10.
HOT MIX ASPHALT LONGITUDINAL-JOINT DENSITY
Adjustment Schedule

Average Percent of Maximum Density (minimum 5 samples)	*Percent Payment*
100.0 - 98.1	*98*
98.0 - 95.0	*102*
94.9 - 91.0	*100*
90.9 - 89.0	*90*
88.9 - 88.0	*80*
87.9 - 87.0	*70*
86.9 or less	*50% or rejection*

The total hot mix asphalt adjustment will be based on the weighted sum as follows:

.60 Mat Adjustment + .40 LJ Adjustment = Total HMA Adjustment

When the construction of the pavement does not include the construction of a longitudinal joint, the payment adjustment will be based on Table 9 only, no weighted sum will be calculated. Any bonus will be credited against any payment adjustment in the contract for HMA, but in no case will the payment for HMA exceed 100%.

Rejection of Inferior HMA The Engineer may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of hot mix asphalt which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. Similarly, the Engineer may at any time, notwithstanding field acceptance for mat density, reject and require the Contractor to correct any HMA pavement that was placed with unacceptable mat uniformity or paving joints due to low density, segregation, improper elevation, or tearing. In the event of such rejection, the Contractor and Engineer may take random split samples of the area(s) in question in the presence of the Engineer, and if it can demonstrate in the laboratory, in the presence of the Engineer, that such material/pavement was erroneously rejected, payment will be made for the material at the contract unit price.

2. Rounding - Numbers used in all calculations shall be carried to the correct significant figures and rounded as follows:

When the first digit after those you want to drop is 4 or less, that digit and all others to the right are dropped. Ex. 62.9437 to 3 significant digits = 62.9

When the first digit after those you want to retain is 5 or greater, that and all others to the right are dropped and the last digit retained is increased by one. Ex. 1.955234 to 3 significant digits = 1.96.

All Intermediate calculations should not be rounded and shall be reported to two more significant figures than the least number of significant figures in the data values.

Test Standards and technical look-up tables serve as first priority over these rounding rules.

3. Outliers - Due to the extremely low probability of an outlier occurring in a small number of samples representing the Lot, no outliers will be considered. If a result is suspect, it would be prudent to take the time to investigate the sampling, testing, equipment calibration, production, and construction operation to identify the cause of the suspect reading.

I. *MEASUREMENT*

Method of Measurement - The quantity of hot mix asphalt to be paid for shall be the measured by the ton complete in place. The quantity of each truck load shall be obtained from printed tickets indicating the recorded batch weights or certified truck scale weights that have been properly countersigned by an authorized representative of the Engineer at the time of delivery. HMA quantities shall be verified by the Engineer using HMA yield calculations which will include the in-place bulk specific gravity and actual area and nominal depth for the mixture placed.

J. *PAYMENT*

Basis of Payment

Payment shall be made at the contract unit prices per ton complete in place with any applicable adjustments. This payment shall be full compensation for furnishing and placing all quality hot mix asphalt materials, including tack coat where specified, hot-pour rubberized asphalt sealer, cutting of keyways or milling/stripping of pavement to produce neat joints, mechanical sweeping of streets and for all labor, tools, equipment, materials, and all incidentals necessary to complete the work. No consideration will be given for additional payment for small areas of sidewalk

left incomplete during construction.

Adjustment for Density

Adjustment for mat and joint density shall be made when the HMA material varies from the specification target limits but is within the tolerances stated in Sections H "Adjustment Pay Schedule for Density"; the material will be allowed to remain in place with the specified adjustment in payment with the exception of mixtures placed with mat density below 86.9 percent of maximum. Any bonus (102% payment for 95.0% to 98.0% density) will be credited against any payment adjustments in the contract for HMA, but in no case will the Payment for HMA exceed 100%.

PAY ITEM	***DESCRIPTION***	***PAY UNIT***
Bid Item 422.1	***Superpave 9.5mm, Level 2 Top Course***	***TON***
Bid Item 422.2	***Superpave 12.5mm, Level 2 Binder Course***	***TON***
Bid Item 422.3	***Superpave 12.5mm, Level 3 Modified Top Course***	***TON***

K. *TESTING REQUIREMENTS*

AASHTO T104 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate AASHTO T11 Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing

AASHTO T96 Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

AASHTO T27 Sieve Analysis of Fine and Coarse Aggregates

AASHTO T255 Total Evaporable Moisture Content of Aggregate by Drying AASHTO T2 Sampling of Aggregates

AASHTO M17 Mineral Filler for Bituminous Paving Mixtures AASHTO T170 Recovery of Asphalt from Solution by Abson Method

AASHTO T331 Bulk Specific Gravity and density of Compacted Hot Mix Asphalt (HMA) using automatic vacuum sealing

AASHTO T110 Moisture or Volatile Distillates in Bituminous Paving Mixtures

AASHTO T245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus AASHTO T209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures AASHTO T164 Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)

AASHTO T176 Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test AASHTO T195 Determining Degree of Particle Coating of Bituminous-Aggregate Mixtures

AASHTO T166 Bulk Specific Gravity (Gmb) of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens

AASHTO T269 Percent Air Voids in Compacted Dense and Open Asphalt Mixtures ASTM D 2950 Density of Bituminous Concrete in Place by Nuclear Method ASTM D 3665 Random Sampling of Paving Materials

ASTM D 3666 Inspection and Testing Agencies for Bituminous Paving Materials AASHTO T287 Asphalt Binder Content of Asphalt Mixtures by the Nuclear Method AASHTO T89 Determining the Liquid Limit of Soils

AASHTO T90 Determining the Plastic Limit and Plasticity Index of Soils ASTM D 4791 Flat or Elongated Particles in Coarse Aggregate

ASTM E 178 Practice for Dealing with Outlying Observations

ASTM D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate AASTHO T304 Uncompacted Void Content of Fine Aggregate

AASHTO T30 Mechanical Analysis of Extracted Aggregate AASHTO T202 Viscosity of Asphalts by Vacuum Capillary Viscometer

AASHTO T240 Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin Film Oven Test) AASHTO T283 Resistance of Compacted Asphalt Mixtures to Moisture Induced Damage

AASHTO T308 Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method The Asphalt Institute's Mix Design Methods for Asphalt Concrete Manual No. 2 (MS-2).

ADDITIONAL REQUIREMENTS

AASHTO M320 Standard Specification for Performance Graded Asphalt Binder AASHTO M323 Standard Specification for Superpave Volumetric Mix Design AASHTO R30 Standard Practice for Mixture Conditioning of Hot Mix Asphalt (HMA) AASHTO R29 Grading or Verifying the Performance Grade of an Asphalt Binder

AASHTO R26 Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders AASHTO R35 Standard Practice for Superpave Volumetric Design of Hot Mix Asphalt (HMA)

AASHTO T312 Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

AASTHO T315 Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)

AASHTO T316 Viscosity Determinations of Asphalt Binder Using the Rotational Viscometer

1. METHOD OF TEST FOR BULK SPECIFIC GRAVITY OF AGGREGATE BLENDS WITH RAP

Scope

This test method covers the procedure to determine the bulk specific gravity (Gsb) of a combined aggregate blend with RAP used in a HMA mixture.

This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with the test method’s use. The test method user's responsibility is to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Referenced Documents AASHTO Standards

T-2 Sampling Aggregates

T-84 Specific Gravity and Absorption of Fine Aggregates

T-85 Specific Gravity and Absorption of Coarse Aggregate T-100 Specific Gravity of Soils

T-164 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures T170 Recovery of Asphalt from Solution by Abson Method

T-209 Maximum Specific Gravity of Bituminous Paving Mixtures

T-228 Specific Gravity of Semi-Solid Bituminous Materials (Pycnometer Method)

Other References

MS-2 Mix Design Methods for Asphalt Concrete by the Asphalt Institute Terminology

Terms and Abbreviations. Definitions for terms and abbreviations shall be in accordance with the Standard Specifications.

Significance and Use

This test method is used to determine the bulk specific gravity of a combined aggregate blend with RAP used in HMA mixture.

The bulk specific gravity (Gsb) of a combined aggregate blend is calculated using an estimate of the bulk specific gravity of the aggregate in the RAP and the actual bulk specific gravity of the other aggregates.

The bulk specific gravity of an aggregate blend is used to perform a volumetric analysis on compacted HMA in accordance with the Mix Design Methods for Asphalt Concrete by the Asphalt Institute.

Apparatus

Apparatus shall be as stated in the referenced test methods. Sampling

Sampling shall be as stated in the referenced test methods. Procedure

Identify the coarse aggregate(s), fine aggregate(s) and RAP selected for use in the mix designs.

Identify and record the actual percentages for each of the aggregate components used in the combined aggregate blend of the mix design.

Obtain a representative sample of the coarse aggregate, fine aggregate mineral filler and RAP in accordance with the AASHTO procedures.

Determine and record the bulk specific gravity of each of the coarse aggregate(s) in accordance with AASHTO T-85.

Determine and record the bulk specific gravity of each of the fine aggregate(s) in accordance with AASHTO T-84.

Determine and record the maximum specific gravity of the RAP in accordance with AASHTO T-209, Type C, D, or E container.

Determine and record the asphalt content of the RAP using AASHTO T164.

Calculate and record the effective specific gravity of the RAP aggregate in accordance with the following: Gse = (100 - Pbrap)/[(100/Gmmrap) - (Pbrap/Gbrap)]

Where:

Gse = Effective specific gravity of the RAP aggregate Pbrap = Percent binder of the RAP

Gmmrap = Maximum specific gravity of the RAP

Gbrap = Specific gravity of asphalt in the RAP (AASHTO T228)

Calculate and record the effective specific gravity of the combined aggregate blend as follows. GsbBlend = %CA1 + %CA2 + %FA1 + %FA2 + %BHF + %RAP

%CA1 + %CA2 + %FA1 + %FA2 + %BHF + %RAP

Gsb Gsb Gsb Gsb Gsb Gse

Where:

GsbBlend = Bulk specific gravity of the combined aggregate blend. Gsb = Bulk specific gravity of each respective aggregate.

Gse = Effective specific gravity of the RAP.

%CA1 = Percent of aggregate blend that is coarse aggregate #1.

%CA2 = Percent of aggregate blend that is coarse aggregate #2.

%FA1 = Percent of aggregate blend that is fine aggregate #1.

%FA2 = Percent of aggregate blend that is fine aggregate #2.

%BHF = Percent of aggregate blend that is bag house fines.

%RAP = Percent of aggregate blend that is RAP. Report

Report the Gsb of the combined aggregate blend to the nearest 0.001.

L. *MEASUREMENT AND PAYMENT*

Item 422 - 427 will be paid for by the ton. Item 428 – 432.1 will be paid for by the square yard.

ITEM 434.0000 SAWING PAVEMENT

A. *DESCRIPTION*

The work under this item shall conform to the relevant provisions of Section 120 of the Standard Specifications and the following;

The work shall include the saw cutting of existing pavements in areas where shown on the plans, and as directed by the Engineer.

B. CONSTRUCTION METHOD

The existing pavement shall be sawcut through its full depth, or to elevation of the abutting proposed pavement subgrade, whichever is lesser, to provide a uniform vertical surface for the proposed pavement joint with the existing pavement.

Sawcut edges which become broken, ragged or undermined as a result of the Contractor's operations shall be re-sawcut prior to placement of abutting proposed pavement.

Sawcut bituminous concrete surfaces shall be sprayed or painted with a uniform thin coat of RS-1 asphalt emulsion immediately before placement of new bituminous concrete material against the surface.

Mechanical breaking of joints will be prohibited where saw cutting pavements is needed and directed by the Engineer.

C. EQUIPMENT

The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing with a water cooled diamond edge saw blade or an abrasive wheel to the required dimensions.

D. MEASUREMENT AND PAYMENT

Sawing pavement will be measured and paid at the unit price per linear foot bid therefore in the proposal.

ITEM 435.0000 HOT POURED RUBBERIZED ASPHALT SEALER

A. DESCRIPTION

Item 435 will be used in conjunction with Item 422 when directed by the Contracting Officer. This item will be used on the base and top course.

B. MEASUREMENT AND PAYMENT

The method of payment for hot poured rubberized asphalt sealant shall be at the bid price per linear foot, complete in place.

ITEM 435.1000 RANDOM CRACK SEALING

ITEM 435.2000 RANDOM CRACK SEAL, FIBER METHOD

A. SCOPE OF WORK

The work covered by this section of the specification consists of furnishing all plant, labor, equipment and materials necessary to perform all operations in connection with the cleaning and sealing of construction and random cracks in bituminous concrete pavements, and vegetation removal and sterilization of cracks where necessary.

B. MATERIAL

Crack sealer shall be an asphalt-fiber compound designed especially for improving strength and performance of the parent asphalt sealant.

1. Asphalt Sealant shall be AC-10 or AC-20 with a penetration of 75-100.
2. Fiber reinforcing materials shall be short-length polypropylene or polyester fibers having the following properties.
   a. Length - 10mm.
   b. Denier - 15 dpf
   c. Color - Natural
   d. Crimp – none
   e. Tenacity - 4 gpd

Asphalt-fiber compound shall be mixed at a rate of 5-8% fiber weight to weight of asphalt cement. This compound having the same chemical base provides compatibility and exhibits excellent bond strengths. The fiber functions to redistribute high stress and strain concentrations that are imposed on the sealant by thermal sources, traffic leading, etc.

C. EQUIPMENT

Equipment used in the performance of the work required by this section of the specification shall be subject to the Contracting Officer and maintained in a satisfactory working condition at all times.

Air Compressor: Air compressors shall be portable and capable of furnishing not less than 100 cubic feet of air per minute at not less than 90 lbs. per square inch pressure at the nozzle. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water.

Manually operated, gas powered air broom or self-propelled sweeper designed especially for use in cleaning highway and airfield pavements shall be used to remove debris, dirt, and dust from cracks.

Hand tools shall consist of brooms, shovels, metal bars with chisel shaped ends, and any other tools which may be satisfactorily used to accomplish this work.

Melting Kettle: The unit used to melt the joint sealing compound shall be double boiler, indirect fired type. The space between the inner and outer shells shall be filled with a suitable heat transfer oil or substitute having a flash point of not less than 600 degrees F. The kettle shall be equipped with a satisfactory means of agitating the joint sealer at times. This may be accomplished by continuous stirring with mechanically operated paddles and/or by a continuous circulating gear pump attached to the heating unit. The kettle must be equipped with thermostatic control calibrated between 200 degrees F. and 500 degrees F.

D. *PREPARATION*

Debris Removal: All old material and other debris removed from the cracks shall be removed from pavement surface immediately by means of power sweepers, hand brooms or air brooms.

Vegetation: When cracks show evidence of vegetation it shall be removed and sterilized by use of propane torch unit, eliminating all vegetation, dirt, moisture, and seeds.

General: No crack sealing material shall be applied in wet cracks or where frost, snow, or ice is present, nor when ambient temperature is below 40 degrees F.

E. *PREPARATION OF SEALER*

Joint sealing material shall be heated and applied at a temperature specified by the manufacturer and approved by the Contracting Officer.

F. *WORKMANSHIP*

All workmanship shall be of the highest quality; any excess or spilled sealer shall be removed from the pavement by approved methods and discarded. Any workmanship determined to be below the high standards of the particular craft involved will not be accepted, and will be corrected and/or replaced as required by the Contracting Officer in charge.

G. *MEASUREMENT AND PAYMENT*

Measurement for this bid item shall be by the linear foot and shall be the actual number of feet of sealer applied to the pavement. Payment shall be at the unit price bid in the proposal and shall be complete payment for the entire item including furnishing, preparation and placing of materials, labor, and equipment to be used on this project.

ITEM 436.0000 RESURFACE TRENCHES TEMPORARY SQUARE YD

ITEM 436.0100 RESURFACE TRENCHES PERMANENT SQUARE YD

A SCOPE OF WORK

The work under this section shall include furnishing and installing hot plant mixed bituminous concrete as temporary or permanent resurfacing on the complete width of the trench. This work shall be as specified herein, as shown on the plans or as directed by the Contracting Officer.

B MATERIALS

All bituminous concrete shall conform to the requirements as set forth in the most recent edition and amendments thereto of the Commonwealth of Massachusetts Standard Specifications for Highways and Bridges (MSSHB). Bituminous concrete shall conform to Section M3.11.00, of the above-mentioned specifications.

C TEMPORARY REPAIRS

As soon as the excavation has been backfilled and compacted, a temporary repair shall be made. Temporary paving shall be binder course conforming to the above-mentioned specifications and shall be placed in two (2)-inch courses. The second course shall be compacted to match existing pavement so that it is hard enough and smooth enough to be safe for pedestrian travel over it. Likewise, it must be hard enough and smooth enough for vehicular traffic to pass safely over it at the legal rate of speed. The contractor shall maintain the temporary paving until the permanent paving is placed.

In the event there is unacceptable maintenance of temporary repairs, the Contractor will be notified of those

situations. Upon notification, the Contractor will make the required improvements within twenty-four (24) hours. In emergency situations, the City will make immediate repairs and the Contractor will be billed directly. All temporary material shall conform closely to the level of the adjoining paved surface and shall be compacted so that it is hard enough and smooth enough to be safe for pedestrian and vehicular travel.

The maximum length of time a trench or other excavation shall remain open without temporary pavement is five

(5) working days or as the Contracting Officer requests. In all cases, the Contractor shall complete the temporary paving before moving to another work location.

When trenches are one hundred (100) feet or more in length, temporary repair requirements are as follows:

The trench shall be saw cut in a straight line a minimum of (12) inches beyond each side of the trench and the saw cut areas shall be removed and disposed of.

When one side of the trench is within five (5) feet of the curb or berm line, the temporary patch shall extend to the face of the granite curb or one (1) foot from the bituminous berm. After the 95% compaction has been achieved, these trenches shall be paved with a self-propelled mechanical spreader and rolled with a power- driven steel wheel roller.

D. *PERMANENT SURFACE REPAIR*

Permanent repairs shall be completed within a period of not less than ninety (90) days but nor more than one hundred twenty (120) days from the date of the temporary patch in accordance with the following schedule, unless otherwise directed by the Contracting Officer:

E. *SCHEDULE OF PERMANENT PATCHING*

TEMPORARY PATCH	*PERMANENT PATCH*
April 1 - April 30	*August 1*
May 1 - May 31	*September 1*
June 1 - June 30	*October 1*
July 1 - July 31	*November 1*
August 1 - August 31	*November 15*
September 1 - September 30	*November 15*
October 1 - October 15	*November 15 May 15; Following year*
October 15 - December	*May 15*

The permanent patch shall be extended one (1) foot on all sides of the temporary patch area. The pavement shall be cut in a neat, straight line with a pavement saw only. The cut shall be square or rectangular with edges parallel and perpendicular to the trench line or as directed by the Contracting Officer. Cuts shall be straight and vertical.

A tack coat shall be applied to the vertical faces of the existing pavement before placing permanent patch. A permanent patch material shall be applied in two (2) courses in accordance with the following thickness chart:

F. *BITUMINOUS CONCRETE PAVEMENT COURSE THICKNESS CHART (IN INCHES)*

	Binder Course	*Top Course*
Roadway up to 12% grade	*2"*	*1.5" or As Directed*
Roadway from 12% to 16% grade	*2.25"*	*2" or As Directed*
Roadway 16% and over	*2.75"*	*2" or As Directed*
Driveway	*1.5"*	*1"*
Sidewalk	*1"*	*1"*

(NOTE: Thickness depths are measured after compaction.)

Where existing pavement thickness is greater than that indicated on the chart, the contractor shall match existing thickness or as directed by the Contracting Officer. However, the binder will be placed in courses NOT exceeding 2-1/2 inches. Multiple binder courses will be laid if the existing thickness conditions warrant.

When two (2) or more openings are made in sequence with fifteen (15) feet or less between the adjacent openings, the Contractor shall neatly cut out and remove the area of pavement between these adjacent openings and shall patch the entire area as one trench.

When trenches are one hundred (100) feet or more in length, permanent repair requirements are as follows: The minimum repair width shall be eight (8) feet.

When one side of the trench is within five (5) feet of the curb or berm line, the permanent patch shall extend to the face of the granite curb or one (1) foot from the bituminous berm.

These trenches shall be paved with a self-propelled mechanical spreader and rolled with a power-driven steel wheel roller per either of the following two (2) methods:

Method 1 – The trench shall be saw cut in a straight line a minimum of twelve (12) inches beyond each side of the trench to a minimum width of eight (8) feet. The temporary patch and saw cut area shall be removed and replaced with three and one-quarter (3.25) inches of hot mix asphalt pavement, 1.75 inches of binder course and 1-1/2 inches of top course. If any side of the trench is within five (5) feet of the curb or berm, the cut shall extend to the granite curbing or one (1) foot out from the berm. Trench ends shall be straight and square. The edges of the trench shall be thoroughly cleaned and shall be completely coated with an approved emulsion.

Method 2 – If, in the opinion of the City inspector, the three and one-quarter (3.25) inch hot mix temporary patch has remained structurally sound, an area within the limits prescribed in Method 1 shall be milled to a depth of 1-1/2 inches. A tack coat or CRS-1 of RG-1 asphalt emulsion shall be applied and 1-1/2 inches of hot mix top course shall be laid and rolled to meet the pre-existing grades and the original profile of the street.

The contractor shall be required to correct any trench settlements and/or faulty pavement patches for a period of five (5) years after the permanent patch is placed, at the direction of the Contracting Officer.

In the event of a failed permanent patch, the Contractor shall be responsible for fully removing the patch, regrading the subgrade and recutting the trench edges, if necessary, prior to installing a new permanent patch. Spot repair of a failed permanent patch will not be acceptable.

If, during construction, break backs occur, the bituminous concrete shall be cut back to a sufficient point where the edges are smooth and straight. Where, in the opinion of the Contracting Officer, the break backs are extensive, the ENTIRE TRENCH LENGTH shall be evenly cut back so to insure two parallel edges.

Granite curb requiring resetting shall be excavated so that the present curb can be removed without damage. When resetting the length of any section of curb or edging, the pavement shall be cut neatly and straight in order to accommodate curb installation.

Settlement of curbing shall be repaired by the contractor at no cost to the City.

Where cement concrete or paving block is encountered in roadways (either as wearing surface or as base for bituminous concrete), it shall be replaced with binder at a thickness equal to the existing rigid road base to a maximum depth of eight (8) inches. When replaced as the base paving, the binder shall be so placed as to allow for the subsequent permanent paving courses to be placed over it.

Where cement concrete is encountered in sidewalks, it shall be replaced at a minimum thickness of four (4) inches. The concrete shall be poured and finished to meet and match the adjacent panels. All sidewalks shall be poured on an eight (8) inch gravel base. All cuts in concrete sidewalks shall be from the nearest joint or pour line for the full width of the sidewalk. Expansion joint filler, ½ inch thick, shall be placed at all

points where the sidewalks abut buildings or permanent structures at thirty (30) LF intervals unless otherwise directed by the Contracting Officer.

All work shall be in compliance with the City of Worcester Standard Specifications and Details.

After completion of permanent patch repairs, the Contractor will file a Certificate of Permanent Restoration Form attesting that the pavement repair has been completed in full compliance with these regulations.

G. *SPECIAL CONDITIONS FOR PERMANENT RESTORATION FOR STREETS PAVED FIVE (5) YEARS OR LESS*

Upon completion of the water, sewer and/or utility work and the placement of the protective envelope, the trench shall be filled with excavatable Control Density Fill (CDF), Type 2E. For rigid base roads, the trench shall be filled with CDF to the bottom of the rigid base. Binder in two (2) inch lifts shall be placed through the concrete up to the 1-1/2 inch top course to a maximum depth of eight (8) inches. For non-rigid base roads, CDF shall be poured to a depth of three and one-quarter (3.25) inches below the road surface, 2 inches of compacted binder and 1-1/2 inch of top course shall then be installed.

After one (1) seasonal movement, the permanent patch shall be infrared treated by a contractor certified by the City of Worcester in the infrared process. Upon completion, the Contractor shall provide a certificate to the

D.P.W. as proof of infrared treatment.

All sidewalks excavated must be replaced entirely, in kind, in accordance with City Standards and Specifications. Pedestrian ramps must be installed where applicable, in accordance with Federal law.

H. *MEASUREMENT AND PAYMENT*

These items shall be paid the unit price per square yard.

ITEM 436.0150 RESURFACING WATER, SEWER TRENCHES TEMPORARY LINEAR FT

Refer to ITEM 436.0100 Section A, B, C, D, E, F, G.

e. MEASUREMENT AND PAYMENT

Those items shall be paid for by linear feet.

ITEM 436.0151 RESURFACING WATER, SEWER TRENCHES PERMANANT LINEAR FT

Refer to ITEM 436.0100 Section A, B, C, D, E, F, G.

A. MEASUREMENT AND PAYMENT

Those items shall be paid for by linear feet.

ITEM 436.1000 MISCELLANEOUS INFRARED BITUMINOUS CONCRETE

A. *SCOPE OF WORK*

The work to be done under this section consists of the miscellaneous infrared repair of bituminous concrete surfaces. This item includes cleaning and heating of the work area, scarification, placement of the specified materials, compaction, joint and surface sealing of heated areas.

B. *GENERAL*

The bituminous concrete patching material used for various applications required under the contract shall conform to the following:

Massachusetts Highway Department Standard Specifications for Highways and Bridges (MSSHB), SUPERPAVE, bituminous concrete mix.

All mix formulation must consist of 100% virgin materials. Reclaimed asphalt pavement (R.A.P.) and/or reheating of bituminous concrete mixes are unacceptable in the performance of work under this concrete.

Consistency of bituminous concrete must be maintained. The Contractor will periodically be required to submit samples to be obtained from the job sites.

C. *CONSTRUCTION METHODS*

This work shall be performed in the following manner:

1. Using appropriate methods, prior to the commencement of any work, the Contractor shall adequately clean the area to be repaired.
2. The Contractor shall then heat the entire section to be repaired in conjunction with the adjacent area by carefully positioning a pre-approved infrared heater, not to exceed 15,000 BTU's per square foot, per hour, to achieve a consistent plasticized surface condition. Excessive heating of the pavement shall be avoided. The Contractor shall remove all unsuitable oxidized material and replace same with "virgin" bituminous concrete.
3. A suitable proven recycling agent additive of a sufficient amount as approved will be introduced to the softened area. Scarification will then be performed to produce a workable mix condition uniformly incorporating the recycling agent.
4. Specified bituminous concrete mixes must be obtained from an on site infrared heated storage unit capable of maintaining the stored asphaltic material(s) at a near constant temperature throughout

the working day. Under no circumstances shall any asphalt mix be used that registers a temperature of less than 250 degrees F.

5. After the proper consistence of the paving material and recycling agent has been properly attained, the

combined mixture shall be raked to the desired grade and compacted. Compaction shall be accomplished by use of a designated static and/or vibratory steel wheeled roller of adequate weight to establish a uniform density comparable to that of the adjacent surface within the work area. The repaired section shall be smooth and even with the surrounding pavement.

6. A penetrating asphalt emulsion will be applied by hand to the edges of the entire perimeter of the finished area.

D. *MEASUREMENT AND PAYMENT*

Infrared repair of bituminous concrete roadway shall be measured in place and shall be paid at the unit price per square yard bid in the proposal.

ITEM 437.0000 SPEED HUMPS & RAISED CROSSWALKS

ITEM 437.1000 INSTALLATION OF SPEED HUMPS ON THE PUBLIC WAY

A. *GENERAL*

The scope of work to be performed under this section shall consist of the installation of speed humps using bituminous concrete. This item includes cleaning, scarification of existing pavement along gutter lines, replacement of bituminous concrete, compacting and joint and surface sealing using tack coat as shown on the typical Speed Hump.

The bituminous concrete material used for the installation of speed humps required under this contract shall conform to the following:

1. Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, SUPERPAVE bituminous concrete mix.
2. All mix formulations must consist of 100% virgin materials. Reclaimed asphalt pavement (R.A.P.) and/or reheating or bituminous concrete mixes are unacceptable in the performance of work under this contract.
3. Consistency of bituminous concrete must be maintained. The Contractor will periodically be required to submit samples to be obtained from the job site.

B. *METHOD OF CONSTRUCTION*

The work shall be performed in the following manner:

1. Using appropriate methods, prior to the commencement of any work, the Contractor shall clean the area in which speed humps are to be installed.
2. The Contractor shall then cold plane the street with an approved cold planning machine or grinder to the appropriate depth, width and length. The excavated area will then be filled with SUPERPAVE bituminous concrete top course placed in two lifts and thoroughly compacted with a steel wheeled roller, as shown on the typical detail or directed by the Contracting Officer. Excavated materials resulting from the operation shall be removed and disposed of by the Contractor or as otherwise directed by the Contracting Officer.
3. All grinding shall be done during daylight hours unless otherwise specified.
4. After the proper consistence of the paving material has been attained, the combined mixture shall be raked to the desired grade and compacted. Compaction shall be accomplished by use of a designated static and/or vibratory steel wheeled roller, with a weight not to exceed ten ton, to establish a uniform density comparable to that of the adjacent surface with the work area.
5. The Contractor shall exercise due care in not to disturb or break existing manholes, valve boxes, catch basins, monument boxes, castings, etc. All castings broken shall be replaced or repaired at the Contractor expense.
6. Tack coat shall be applied to the edges of the entire area designated for installation of the speed humps.

C. *MEASUREMENT AND PAYMENT*

Item 437.1 will be paid for by the linear foot for speed humps complete in place across the roadway.

ITEM 437.2000 INSTALLATION OF ADVANCE PAVEMENT MARKINGS FOR SPEED HUMPS AND RAISED

CROSSWALKS INSTALLED ON THE PUBLIC WAY

A GENERAL

The scope of work to be performed under this section shall consist of the installation of white thermoplastic, MUTCD compliant pavement markings for speed humps installed on the public way.

B MATERIALS

The materials used for this section shall be white thermoplastic paint that conforms to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and Pavement Markings.

C INSTALLATION

1. Surface Preparation

   The pavement shall be dry and free of sand, grease, oil or other foreign substances. Bituminous concrete shall have been in place for at least 48 hours prior to paint application.

2. Application

   In accordance with the manufacturer's specification and with good painting practices, markings shall be applied at locations and at specified dimensions as designated on the drawings. All applicable requirements of Section 860 (MSSHB) shall be met for work in this section.

3. Protection

   The Contractor shall protect pavement markings until sufficiently dry to bear traffic. Cones or like barriers shall be used to protect markings.

D MEASUREMENT AND PAYMENT

Item 437.2 are paid for by the linear foot. The price shall include all work necessary to successfully perform all tasks associated with these specifications and to the satisfaction of the Contracting Officer and the Department of Transportation & Mobility.

ITEM 437.3000 INSTALLATION OF ADVANCE WARNING SIGN AND POST FOR SPEED HUMPS AND RAISED

CROSSWALKS INSTALLED ON THE PUBLIC WAY

A GENERAL

The scope of work to be performed under this section shall consist of the installation of a MUTCD compliant advance "SPEED HUMP" sign and advisory "15 MPH" supplemental plaque for speed humps installed on the public way.

B MATERIALS

The SPEED HUMP sign shall comply with the MUTCD and shall be 30" by 30" with black lettering on fluorescent yellow, high intensity prismatic backing. The "15 MPH" supplemental plaque shall comply with the MUTCD and shall be 18" by 18" with black lettering on fluorescent yellow, high intensity prismatic backing.

Poles shall be a 2" black (Paint/Powder coat finish) quick punch square galvanized pole that is secured to 2.25" galvanized anchor.

ITEM 438.0000 BITUMINOUS CONCRETE BERM MACHINE PLACED

ITEM 438.5000 BITUMINOUS CONCRETE BERM REPAIR

A. GENERAL

Work to be done under this item shall conform to the applicable provisions of Section 470, (MSSHB), Berm Worcester Standard as shown on detail titled Typical Half Section thru Bituminous Concrete and Berm and is to be made of bituminous concrete, as specified for payment, SUPERPAVE, dense mix carefully placed by machine.

All surfaces and angles of the template used with the berm to be smooth and straight, carefully formed, all as shown in Typical Section with Berm Detail.

The bituminous concrete berm shall be well consolidated.

B. MEASUREMENT AND PAYMENT

Bituminous concrete berm machine placed shall be measured in place and shall be paid at the unit price per linear foot bid therefore in the proposal.

ITEM 440.0000 DECORATIVE CROSSWALK

A GENERAL

This decorative crosswalk shall be TrafficPatternsXD™ or approved equal. It is a durable imprinted aggregate reinforced preformed thermoplastic pavement marking system (herein "System") that provides a textured, highly attractive, and durable topical treatment to the surface of asphalt pavement. Typically, the system replicates, in relief, the grout lines common to brick or other types of unit pavers.

B MATERIALS

1. The aggregate reinforced preformed thermoplastic shall be supplied in panels typically measuring 2' x 2' (+-1/8').
2. The System must be able to be applied to asphalt surfaces without preheating the application surface to a specific temperature. The System shall be able to be applied in temperatures down to 45°F without any special storage, preheating or treatment of the material before application.
3. 3Preformed Thermoplastic Material shall be composed of an ester modified rosin impervious to degradation by motor fuels, lubricants, etc. in conjunction with aggregates, pigments, binders, and anti-skid/anti-slip elements. Pigments and anti-skid/anti-slip elements must be uniformly distributed throughout the material. Material shall conform to AASHTO designation M249, with the exception of the relevant differences due to the material being supplied in a preformed state, being non-reflective, and potentially being of a color different from white or yellow.
4. Pigments:

a. White: The material shall be manufactured with sufficient titanium dioxide pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected.

b. Other Colors: The pigment system must not contain heavy metals nor any carcinogen, as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant Federal Regulations.

5. Skid Resistance: The surface of the material shall contain factory applied anti-skid/anti-slip elements with a minimum hardness of 6 (Mohs scale). Upon application the material shall provide a minimum skid resistance value of 60 BPN when tested according to ASTM E 303.
6. Slip Resistance: The surface of the material shall contain factory applied anti-skid/anti-slip elements with a minimum hardness of 6 (Mohs scale). Upon application the material shall provide a minimum static friction of coefficient of 0.6 when tested according to ASTM C 1028 (wet and dry), and a minimum static coefficient of friction of 0.6 when tested according to ASTM D 2047.
7. Thickness: The material must be supplied at a minimum thickness of 150 mil (3.8mm).
8. Environmental Resistance: The material must be resistant to deterioration due to exposure to sunlight, water, salt, or adverse weather conditions and impervious to oil and gasoline.
9. Storage Life: The material may be stored for 12 months, if stored indoors and protected from the elements.

10. PreMark® Transverse Lines, or approved equal, to Supplement System Application: Supplied as white, retroreflective preformed thermoplastic line stripe material in 90 mil (2.3 mm) or 125 mil (3.2 mm) thicknesses, material is available in 6 in. (.15m), 8 in. (.20m) or 12 in. (.30m) widths. This preformed thermoplastic material may be supplied and applied by the certified applicator in conjunction with the System. (Consult the manufacturer's published application instructions for the preformed thermoplastic line stripe material selected, for proper application methods.)

C INSTALLATION:

The System shall be applied to asphalt pavement using approved reciprocating infrared heating equipment. A two-part epoxy sealer specified by the manufacturer must be applied to the substrate prior to preformed thermoplastic application to ensure proper adhesion, and to provide reinforcement for larger volumes of material. Immediately following sealer application, panels of aggregate reinforced preformed thermoplastic are positioned properly on the asphalt substrate.

The preformed thermoplastic is then heated to the required melting temperature. Additional aggregate may be applied to the preformed thermoplastic surface as needed following the melting process, to achieve added friction properties and a uniform surface appearance. As the material is cooling, it is imprinted with a vibratory plate compactor and a template made from 3/8 in. flexible wire rope in the required design to create crisp, clean lines which define the pattern. Pattern and color shall be "Offset Brick" pattern in "Heritage Red" color or specified alternative by the City of Worcester. The selected system shall be available in a variety of standard colors and patterns. White preformed thermoplastic transverse lines shall be installed on both sides of the crosswalk installation as directed.

The System shall utilize a resilient, aggregate reinforced preformed thermoplastic product which contains a minimum of thirty percent (30%) intermixed anti-skid/anti-slip elements and where the top surface contains anti-skid/anti-slip elements. These anti-skid/anti-slip elements must have a minimum hardness of 6 (Mohs scale).

The System must be resistant to the detrimental effects of motor fuels, antifreeze, lubricants, hydraulic fluids, etc.

The System manufacturer must be ISO 9001:2008 certified for design, development and manufacturing of preformed thermoplastic, and provide proof of current certification.

Specialized Application Equipment:

A. Stamping Templates: A wire rope template is required in the execution of the System. The template is used for imprinting the defined pattern once the preformed thermoplastic has been applied. The wire rope diameter for the imprinting template used for the specified pattern is 3/8 in. The stamping templates for imprinting shall be TrafficPatternsXD™ or approved equal.

B. Heating Equipment: The System manufacturer shall distribute reciprocating infrared heating equipment designed specifically to elevate the temperature of the preformed thermoplastic material and asphalt pavement without adversely affecting it. The primary heating unit must employ a bank of propane-fired infrared heaters, mounted on a track device that allows the heater bank to reciprocate back and forth over a designated area, thereby allowing the operator to monitor the temperature of the preformed thermoplastic at all times during the pavement heating process.

   a. A smaller, mobile infrared heater distributed by the System manufacturer is designed specifically to heat areas such as borders and narrow areas that are inaccessible to the primary heaters. This secondary heater also allows the operator to monitor the temperature of the preformed thermoplastic at all times during the heating process.

   b. An approved hand-held propane heat torch distributed by the System manufacturer shall be used to heat isolated areas of the preformed thermoplastic.

C. Epoxy Sealer: A two-part epoxy sealer specified and distributed by the System manufacturer must be applied to the substrate prior to material application to ensure proper adhesion, and to provide reinforcement for larger volumes of material.

D. A specialized sealer dispensing gun shall be used to dispense the required two-part epoxy sealer onto the substrate.

The sealer dispensing guns shall be as distributed by the System manufacturer.

E. Handheld Finishing Tools: Completion of the imprinting of the thermoplastic in areas around permanent structures, such as curbs and manholes covers, which may be inaccessible to the stamping template, shall be accomplished using a hand held finishing tool. Hand held finishing tools shall be as distributed by the System manufacturer.

F. Aggregates: Supplemental anti-skid/anti-slip elements (aggregates) shall be applied to the surface of the molten thermoplastic as needed, if the factory applied anti-skid/anti-slip elements embed too deeply into the surface of the molten thermoplastic material during the heating process. (Embedded aggregate is exposed upon wear for extended skid resistance.) The aggregate shall be supplied by the System manufacturer.

G. Air Powered Spray Hopper: Supplemental anti-skid/anti-slip elements (aggregate) on the surface of the molten preformed thermoplastic shall be applied in a uniform manner using an air powered spray hopper. The air powered spray hoppers shall be as distributed by the System manufacturer.

H. Vibratory Plate compactor: Pressing the 3/8" wire rope stamping templates into the thermoplastic and asphalt substrate to create the specified pattern shall be accomplished using a vibratory plate compactor (700-900 lb.). Plate compactors shall not damage the thermoplastic during pressing of the wire rope template.

Manufacturer's representative shall be available to provide technical assistance prior to, during and after the installation.

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D MEASUREMENT AND PAYMENT

Item 440 shall be measured by the actual number of square feet installed. Stamped Asphalt Crosswalk with Thermoplastic Pavement Marking System shall be paid for at the contract unit bid price per square foot, which price shall include furnishing all labor, materials and equipment including, but not limited to, Thermoplastic Pavement Marking System, imprinting template, heating equipment, supplemental aggregates, compaction equipment and any other incidental work necessary to provide a complete crosswalk surface installation acceptable to the City of Worcester

The work to be done under Items 440 through 446 shall conform to the applicable provisions of Section 701 and M4, (MSSHB), Cement Concrete (Air Entrained, 4,000 p.s.i., 3/4", 610).

ITEM 441.0000 REPLACING BITUMINOUS CONCRETE SIDEWALK W/ CEMENT CONCRETE SIDEWALK 4 INCH

A. GENERAL

The work under this item shall conform to the relevant provisions of Sections 701 (MSSHB) and the following:

Payment for Items 441 shall constitute full payment for all labor and materials required to remove bituminous concrete sidewalks and construct new cement concrete sidewalks, including all gravel, excavation, fine grading, compacting and brooming to the grade specified by the Contracting Officer. No additional payments for these items will be made under their individual bid item prices.

All new concrete sidewalk surfaces shall be coated with *Salt Guard*, or equivalent.

B. MEASUREMENT AND PAYMENT

This item will be paid for at the contract unit price per square yard. This price shall include all labor, materials, equipment, and incidental costs required to complete the work.

ITEM 442.0000 CONCRETE SIDEWALK REPAIR

ITEM 442.1000 CONCRETE SIDEWALK REPAIR < 25 L.F.

ITEM 443.0000 REPLACING BITUMINOUS CONCRETE DRIVEWAY W/ CEMENT CONCRETE DRIVEWAY 6 INCH

A. GENERAL

The work under this item shall conform to the relevant provisions of Sections 701 of the Standard Specifications and the following:

Payment for Items 443 shall constitute full payment for all labor and materials required to remove bituminous concrete driveways and construct new cement concrete driveways, including all gravel, excavation, fine grading, compacting and brooming to the grade specified by the Contracting Officer. No additional payments for these items will be made under their individual bid item prices.

Any walks or drives outside the limits of work and damaged by the Contractor shall be repaired by the Contractor and he shall not receive any compensation for this work.

The concrete walks shall be four (4) inches thick.

Expansion joints 1/2 inch thick shall be placed at all points where the sidewalk abuts buildings or other permanent structures and at 30 linear foot intervals or as directed by the Contracting Officer.

The expansion joint material shall be installed from just below the finished grade and shall extend to the sub- grade.

Joints shall be scored at intervals at the discretion of the Contracting Officer. For normal sidewalk work, these joints shall be installed at intervals equal to the width of the sidewalk but not to exceed five (5) feet.

Finished concrete surface shall be adequately protected for curing and defacement by a method approved by the Contracting Officer.

Under Item 442 & 446 any unsatisfactorily sub-base in the sidewalk area, as directed by the Contracting Officer, shall be removed and paid under Item 116 excavation. Said voids or substantial grade changes shall be filled with gravel and paid under Item 126 gravel. Said areas shall be fine graded, rolled and finished and paid under Item 402 fine grading, rolling and finishing.

Any sub-base disturbed by the Contractor without the Contracting Officer's direction shall become the Contractors responsibility to replace with approved gravel (graded and compacted).

Payment for Items 440 thru 446 shall constitute full payment for all labor and materials required to construct new concrete sidewalks or driveways, including all gravel, excavation, fine grading, compacting, and broom finish to the grade specified by the Contracting Officer or his designated representative. No additional payments for these items will be made under their individual bid item prices.

The contractor will be responsible for installing tree pits, where sidewalk width and conditions allow. All tree pits are to have the following minimum dimensions; 6 feet in length by 3 feet in width. All tree pit dimensions shall be approved by the contracting officer. The tree pit shall be back filled with loam borrow, complying with ITEM 128 SCREENED LOAM BORROW, to a minimum depth of 30” for the entire area of the tree pit, Tree pits shall be free of and construction debris or litter throughout their depth. This applies to items 440 thru 442.1.

All new concrete sidewalk surfaces shall be coated with *Salt Guard*, or equivalent.

B. MEASUREMENT AND PAYMENT

This item will be paid for at the contract unit price per square yard. This price shall include all labor, materials, equipment, and incidental costs required to complete the work. No consideration will be given for additional payment for small areas of sidewalk left incomplete during construction.

ITEM 444.0000 NEW CONCRETE DRIVEWAY 6 INCH

Finished concrete surface shall be adequately protected for curing and defacement by a method approved by the Contracting Officer. Any unsatisfactorily sub-base in the driveway area, as directed by the Contracting Officer, shall be removed and replaced. Any sub-base disturbed by the Contractor without the Contracting Officer's direction shall become the Contractors responsibility to replace with approved gravel (graded and compacted). Contractor to reference ITEM 443 for additional specification requirements. Precautions shall be taken in cold weather to prevent various forms of damage. No pouring or stamping of cement shall take place in temperatures under 40 degrees. pouring and stamping of cement concrete shall take place in temperatures of 40 degrees and rising. Contractor to notify Engineer of intent to pour cement concrete.

Driveway aprons shall contain a lip along the gutter line that shall not exceed 1-inch high. Driveway apron slopes

shall not exceed 15%. Concrete Driveways shall be poured to be 6" thick in depth. During driveway and/or sidewalk construction, temporary gravel shall be used at, on, or near driveway work to accommodate entering and exiting vehicles as well as at, on, or near sidewalk vicinities to accommodate pedestrian travel crossing driveways along sidewalks.

Payment for Items 440 thru 446 shall constitute full payment for all labor and materials required to construct new concrete sidewalks or driveways, including all gravel, excavation, fine grading, compacting, and broom finish to the grade specified by the Contracting Officer or his designated representative. No additional payments for these items will be made under their individual bid item prices.

ITEM 445.0000 STAMPED CEMENT CONCRETE ACCENT STRIP

A. *GENERAL*

The work under this item shall conform to the relevant provisions of Sections 701 and M4 of the Standard Specifications and the following:

Stamped cement concrete accent strips shall consist of red brick integrally colored (i.e., incorporated through- out the mix) stamped cement concrete as shown on the plans.

Prior to ordering materials, the Contractor shall submit color samples of each cement concrete type to the Engineer and the City of Worcester for approval. Samples of other materials to be used and samples for testing shall be submitted as requested by the Engineer.

All new concrete sidewalk surfaces shall be coated with *Salt Guard*, or equivalent.

B. *MATERIALS*

Colored Admixture for integrally colored concrete shall be:

1. Colored, water-reducing, admixture containing no calcium chloride with coloring agents that are lime proof and UV resistant. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494, and AASHTO M194.
2. Color to be selected by Engineer.

Curing Compound for Integrally Colored Concrete: Curing compound shall comply with ASTM C309, be suitable for exterior use and of same manufacturer as colored admixture, for use with integrally colored concrete.

C. *CONCRETE COLOR:*

Cement: Color shall be white.

Sand: Color shall be locally available natural sand

Colored Admixture: Deep Red Color Base as selected by the Engineer in consultation with the City of Worcester.

Colored Hardener: Deep Red Color Hardener as selected by the Engineer in consultation with the City of Worcester.

Stamp/Imprinting Pattern: Used brick pattern as selected by Engineer in consultation with the City of Worcester.

Powder Antiquing Release Agent: As selected by Engineer from manufacturer's standard colors.

Curing Compound: Curing & sealing shall be as per the manufacturer's recommendations.

D. *APPLICATION*

Concrete mix design:

Minimum Cement Content: 5 sacks per cubic yard of concrete.

Slump of concrete shall be consistent throughout Project at 4-inches or less. At no time shall slump exceed 5- inches. If super plasticizers are allowed, slump shall not exceed 8-inches.

Do not add calcium chloride to mix as it causes mottling and surface discoloration. Supplemental admixtures shall not be used unless approved by manufacturer.

Add colored admixture to the mix according to manufacturer's written instructions in premeasured bags, not by weight of cement content.

E. *INSTALLATION*

Install concrete according to requirements of Division 3 Section M4.02.00 Cement Concrete.

Do not add water to the mix in the field. Surfaces shall be uniformly stamped/ imprinted, applying the pattern according to the tool manufacturer's instructions. Touch-up pattern and finish edges with hand tools as necessary.

Apply curing and sealing compound for integrally colored concrete according to manufacturer's instructions using manufacturer's recommended application techniques. Apply curing and sealing compound at consistent time for each pour to maintain close color consistency. Curing compound shall be same color as the colored concrete and supplied by same manufacturer of the colored admixture.

Precautions shall be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at surface as described in CIP 5 *Plastic Shrinkage Cracking* published by the National Ready Mixed Concrete Association. Do not cover concrete with plastic sheeting. Precautions shall be taken in cold weather to prevent various forms of damage. No pouring or stamping of cement shall take place in temperatures under 40 degrees. Pouring and stamping of cement concrete shall take place in temperatures of 40 degrees and rising. Contractor to notify Engineer of intent to pour cement concrete.

Minor variations in appearance of colored concrete, which are similar to natural variations in color and appearance of uncolored concrete, are acceptable.

F. *MEASUREMENT AND PAYMENT*

Stamped cement concrete accent strips will be paid for at the Contract unit price per square yard, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for the joint sealer or backer rods, but all costs in connection therewith shall be included in the unit price bid. No consideration will be given for additional payment for small areas of sidewalk left incomplete during construction.

ITEM 446.0000 CONCRETE DRIVEWAY REPAIR

A. *GENERAL*

Any walks or drives outside the limits of work and damaged by the Contractor shall be repaired by the Contractor and he shall not receive any compensation for this work.

The concrete drives shall be six (6) inches thick.

Expansion joints 1/2 inch thick shall be placed at all points where the sidewalk abuts buildings or other permanent structures and at 30 linear foot intervals or as directed by the Contracting Officer.

The expansion joint material shall be installed from just below the finished grade and shall extend to the sub- grade.

Joints shall be scored at intervals at the discretion of the Contracting Officer. For normal sidewalk work, these joints shall be installed at intervals equal to the width of the sidewalk but not to exceed five (5) feet.

Finished concrete surface shall be adequately protected for curing and defacement by a method approved by the Contracting Officer.

Under Item 442 & 446 any unsatisfactorily sub-base in the sidewalk area, as directed by the Contracting Officer, shall be removed and paid under Item 116 excavation. Said voids or substantial grade changes shall be filled with gravel and paid under Item 126 gravel. Said areas shall be fine graded, rolled and finished and paid under Item 402 fine grading, rolling and finishing.

Any sub-base disturbed by the Contractor without the Contracting Officer's direction shall become the Contractors responsibility to replace with approved gravel (graded and compacted).

Payment for Items 440 thru 446 shall constitute full payment for all labor and materials required to construct new concrete sidewalks or driveways, including all gravel, excavation, fine grading, compacting, and broom finish to the grade specified by the Contracting Officer or his designated representative. No additional payments for these items will be made under their individual bid item prices.

All new concrete sidewalk surfaces shall be coated with *Salt Guard*, or equivalent.

B. *MEASUREMENT AND PAYMENT*

This item will be paid for at the contact unit price per square yard. This price shall include all labor, materials, equipment, and incidental costs required to complete the work.

Under Items 446.1 and 446.2 the Contractor shall furnish and place all concrete not included in other items of this contract. The concrete will be Class A or Class B as directed by the Contracting Officer. Under the appropriately designated item of miscellaneous work the Contractor shall furnish and place all concrete reinforcement as indicated on the drawings or herein specified. Concrete reinforcements in the various

sizes shall be reinforcing bars on wire mesh of the shape and size indicated on the drawings and as specified under the section titled Method of Payment.

ITEM 446.1000 CLASS B CONCRETE FOR ROADWAY BASE (3,500 P.S.I., 1-1/2", 520)

ITEM 446.2000 CLASS A CONCRETE (4,000 P.S.I. 1-1/2", 565)

A. GENERAL

Under Item 446.1 the work shall include all Class B concrete for structure support backfill, and backing on granite curb as required and not included under other items of this contract. The work to be done under this item shall conform to the pertinent provisions of Section 430 and M4, (MSSHB).

Six inches of high early strength concrete base will be placed in all defective granite blocking paving areas or to provide a concrete collar around water castings, catch basin frames and manhole frames where required by the Contracting Officer.

Under Item 446.2 the work shall include Class A concrete as required and not included under other items of this contract.

All concrete reinforcement required for Class A concrete shall be included in the unit price per cubic yard.

B. CONCRETE REINFORCEMENT

The steel shall be newly rolled stock, substantially free from mill scale, rust, dirt, grease, or other foreign matter.

Bars shall be billet steel.

Billet steel bars shall be grade 40 conforming to the ASTM Standard Specifications for Deformed and Plan Billet Steel Bars for Concrete Reinforcement Designation A615.

Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings, including ice that reduces or destroys bond. Where there is delay in depositing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.

Reinforcement shall be accurately positioned, as indicated on the drawings, and secured against displacement, by using annealed iron wire ties or suitable clips at intersections. Reinforcements shall be supported by concrete or metal supports, spacers, or hangers. Wood blocks, stones, brick chips, etc. shall not be used.

Reinforcements that are to be exposed for a considerable length of time after having been placed shall be painted with a heavy coat of cement grout if required.

The quantity of concrete reinforcement to be paid for shall be the number of pounds actually placed in accordance with the drawings or as directed. It shall not include waste material due either to the nature of construction or to the fact that the lengths supplied are too long or too short for their purpose. The quantity paid for shall however, include extra metal in laps where authorized due to the fact that a single bar would be unreasonably long.

Should the Contractor use shorter bars than directed, he shall provide the required lap and bear the expense of the extra steel and labor that are required.

The unit price herein agreed upon shall include all royalties.

The unit weight used in computing the tabulated in the above-mentioned ASTM Standard Specifications A615 is as follows:

STANDARD REINFORCING BARS

BAR DESIGNATION #	NOMINAL WEIGHT IN LBS. PER FOOT	BAR DESIGNATION #	NOMINAL WEIGHT IN LBS. PER

			FOOT
3	0.376	9	3.4
4	0.668	10	4.303
5	1.043	11	5.313
6	1.502	14	7.65
7	2.044	18	13.6
8	2.67		

Concrete and brick masonry used for manhole bases and concrete cradles and envelopes at manholes shall be included for payment under their respective items.

C. MEASUREMENT AND PAYMENT

Under Item 446.2 all Class A concrete required, not included in other items of this contract, shall be measured and paid for by the cubic yard in place, in accordance with the drawings or as directed.

Under Item 446.1 all Class B concrete required for structural support, backfill and backing on granite curb, except where paid for under items of this contract, shall be measured and paid for by the cubic yard in place.

ITEM 446.3000 EXCAVATABLE CONTROL DENSITY FILL (CDF)

A. GENERAL

Excavatable Control density Fill (CDF) shall conform to MHD Standard Specifications for Highways and Bridges, Section M4.08.0, Type 2E.

Controlled Density Fill	Type 1 & 2	Type 1E & 2E
Compressive Strength @ 28 days	30 -150 psi	30 - 80 psi
Compressive Strength @ 90 days	200 psi	100 psi
Slump	10 " - 12"	10" - 12"

B. METHOD OF PAYMENT

Excavatable Control Density Fill (CDF) shall be measured and paid for by the cubic yard in place in accordance with the project drawings or as directed by the Contracting Officer.

ITEM 447.0000 MODULAR UNIT (BRICK) PAVER SIDEWALK

A. GENERAL

Under this item, the Contractor shall construct pre-cast, concrete brick paver sidewalks and driveways on reinforced concrete and bituminous concrete base course in accordance with these specifications and in reasonably close conformity with the lines and grades as shown on the City of Worcester Typical Sidewalk Detail for Brick Pavers (Modular Unit).

B. DESCRIPTION OF WORK

The work of this section consists of furnishing all labor, materials, equipment, supervision and performing of operations required on the drawings to install pre-cast concrete pavers as directed by the Contracting Officer as herein specified and required to properly complete the work.

Furnish all labor, materials and equipment for site preparation including reinforcing steel, equipment, submittals and services necessary for and incidental to forming, and placing unit pavers.

Provide sufficient temporary bracing and shoring of new construction to permit the safe installation and completion of all work without damage to property and without jeopardizing the safety or health of any person or persons.

Provide joint materials including joint sealant specified herein. Provide bituminous concrete setting bed as specified.

Provide liquid asphalt adhesive as specified.

Furnish and install grout and joint sealants required for the intersecting of materials. Types of work included in this section are:

1. Pre-cast concrete pavers. New brick applications.
2. Salvaged brick. Existing brick walks reconstructed.

C. QUALITY ASSURANCE

All workmanship to conform to the latest requirements of the American Concrete Institute Building Code and all local building codes and ordinances.

Maintain quality control of batching, delivery and placement of all bituminous paving and unit pavers. Definition: Massachusetts Standard Specifications reference is abbreviation for Massachusetts Highway

Department Standard Specifications for Highways and Bridges, latest edition, as applicable.

D. *MATERIALS*

Modular paver definition shall be granite, salvaged brick, concrete pavers, pre-cast concrete, or cut stone as shown on the drawings and related details.

Fine aggregate to be used in the bituminous setting bed shall be clean, hard sand with durable particles and shall be free from adherent coating, lumps of clay, alkali salts, and organic matter. It shall be uniformly graded from "coarse" to "fine" and all passing the No. 4 sieve and it shall meet the gradation requirements of test or sieve or screen analysis of fine and coarse aggregates ASTM Designation C136-81.

Dried fine aggregate shall be combined with hot asphalt cement, and the mix shall be heated to approximately 300 degrees F. at an asphalt plant. The proportion of materials shall be seven (7) percent asphalt cement and ninety-three (93) percent sand. Each ton shall be by weight ratio of 145 lbs. asphalt to 1,855 lbs. sand. The Contractor shall determine the exact proportion to produce the best possible mixture for construction of the bituminous setting bed for the details shown.

Neoprene - Modified Asphalt Adhesive to be used under all unit pavers. MASTIC (asphalt adhesive).

1. Solids (base) 75 + 1%
2. Lbs. /Gal. 8-8.5 lbs.
3. Solvent - Mineral Spirits (over 100 F. Flash)
4. Base (2% Neoprene, 10% Asbestos-free Fibers, 88% Asphalt)
5. Melting Point - ASTM D36...150 F. min.
6. Penetration - 77 F. 100 Gram Load 5 second (.1mm).
7. Ductility - ASTM D113-44 @ 25 C.

Expansion joint material shall be 1/2 inch thick pre-molded joint filler strips conforming to ASTM D1751 or ASTM D1752 or resin impregnated fiber board conforming to ASTM D1752. All joints to have top 1/4" filled with a clear exterior silicone sealant that has a minimum of a 25 year guarantee.

E. *PRECAST CONCRETE PAVERS*

Paving Unit

1. Type: Boston Colonial Pavers
2. Nominal Dimensions: 4 inches by 8 inches
3. Thickness: 2 and three eights (2-3/8") inches
4. Weight: 27 lbs. per sq. ft.
5. Finishes: Red and brown color range Setting Bed

1. A bed of bituminous concrete of one inch compacted by roller/compactor to
2. 3/4 inch.
3. Neoprene Asphaltic Adhesive Paver Placement

1. Hand placed paving units with butt joints, unless otherwise shown on plans.
2. Hand tamp pavers to uniform/true level to grade.
3. Fill and sweep all joints with 3 sand 1 "Laticrete" cement mortar dry mix. Color to match pavers. Provide samples of color mortar.
4. Clean pavement surfaces.

The completed paving stone surface shall be swept clean and misted with water to provide a finished installation. Any stains that occur during construction must be removed at no cost to the City.

Any damaged paving units found prior to job acceptance shall be removed and replaced with new units of paver at no expense to the City.

F. *POURED IN PLACE CONCRETE*

Portland Cement: Conforming to ASTM, Specifications C-150, Type 1.

Aggregates: Clean and hard, free of loam, silt or clay, conforming to ASTM Specifications C33. Course aggregates

shall be size designated as No. 4 to one inch.

Concrete: Certified 3,500 pounds per square inch (28 day strength). Maximum allowable water content, 6 gallons per sack. Slump not to exceed 4 inches; Minimum cement factor, 5-1/4 sacks per yard; Ready mix concrete, conforming to ASTM Specifications C94.

Water: Potable

Air-Entraining Agents: Conforming to ASTM C260, containing 4 to 6 percent entrained air. Welded Steel Wire Fabric: 6" x 6" WWM conforming to ASTM A185.

Pre-molded Joint filler: Non-extruding and resilient bituminous type, conforming to ASTM D1752-67, Type 2, 1/2 inch in thickness.

Sand: Clean, hard, durable grains, free from foreign substance, uniformly graded with coarse particles predominating.

Forms: Clean, strong enough to resist pressure to concrete without springing, tight enough to prevent leakage, steel or wood forms acceptable.

Impervious Liquid Membrane Curing Material: Conforming to AASHTO = M148, Type 1 or 2.

G. *GRANITE BAND PAVING (CITY SUPPLIED WHERE REQUIRED)*

CS Material provided shall be granite of color and finish indicated complying with National Building Granite Quarries Association (NBGQA).

1. Type: Pink Granite (CS Material)
2. Type : Grey Granite (CS Material)
3. Nominal Dimensions: 12" x 12", 12" x 24" and 24" x 24"
4. Thickness: 1-1/4"
5. Finishes: Face shall be thermal sides and bottom shall be sawn.

Mortar Mix: Comply with ASTM C270 Proportion Specifications, except limit materials to those specified herein, and limit cement/lime ration to 1/4 part lime per part Portland Cement. Mortar to have latex adhesive added to the manufacturers recommendations.

1. Apply laticrete bonding agent or approved equal to all granite paving unit being installed on concrete.
2. All granite paving units have 1/16 - 1/8 inch laticrete mortar joint. Color of mortar to match granite pavers being installed. All surface joints are to be flush.

The completed paving stone surface shall be swept clean and misted down with water to provide a finished installation. Any stains that occur during construction must be removed at no cost to the City.

Any damaged paving units found prior to job acceptance shall be removed and replaced with new units of pavers at no expense to the City.

H. *GENERAL PAVING BASES*

Sub-bases: Prepared as specified under Earthwork Section to the depths below finished grade indicated. Base Courses: Six (6) inches of concrete poured in place per City of Worcester standard detail.

Bituminous Concrete Paving Leveling Course for Pre-cast Concrete Pavers:

1. Install bituminous concrete paving in one course; One (1") inch asphaltic mix finish course with total compressed thickness of 3/4 inch; Install bed as indicated on drawings and specifications.

I. *PRE-CAST CONCRETE PAVERS*

Paving subcontractor shall review site conditions and base pavement surface prior to commencing paving. A written approval of the base shall be supplied by the subcontractor to the Contracting Officer.

Install the bituminous concrete setting bed.

1. Install bituminous concrete paving in one course. One (1") inch asphaltic finish course with total compressed thickness of 3/4 inch. Install bed as indicated on drawings.
2. Transport to site, apply, spread and roll bituminous concrete conforming to Section 460, (MSSHB), as applicable.

Apply uniformly a neoprene modified asphaltic adhesive on top of compacted bituminous setting bed to a depth of no more than 1/16 inch.

Paving stones shall be plumb, level and true to line and grade. Starting at 90 degrees to the granite bands parallel to the street curb, set pavers in hand tight uniform joints in different patterns. The Contracting Officer shall direct the Contractor as to what pattern will be used where. In figuring the amount of material required to complete the work, use the designated pattern throughout those areas designed to receive pre- cast concrete pavers. Strings shall be used to hold pattern lines.

Full units shall be laid first and cut units subsequently. Cut pavers with a splitter designed for pavers or a masonry saw to ensure all cuts fit neatly and accurately without damaged edges. No slivers or cut units smaller than 3" wide and 7" long, except when starting. See detail.

Blend color variations.

After a substantial area of pavers has been placed.

1. Laticrete sand mix shall be spread and broomed over the installed paving stones and into any joints until flush to top of the paving stone. Remove excess from the paving surface. Spray paving with mist of water so concrete will set in joints.
2. All pavers installed that day shall be compacted in place by day's end.

J. *CEMENT CONCRETE PAVING*

Set forms to provide for depths as indicated, for concrete, firmly stake all forms in place, set tops to exact finish grade. Set forms for edging as indicated, oil forms with non-staining oil as required.

Install expansion joints, cut back 1/4 inch below finish grade of concrete. Install expansion joints where shown and around utility structures, buildings, steps, platforms and other structures in concrete paving. Install woven wire mesh lapped 6 inches.

Moisten gravel base course.

Pour concrete in alternate sections between expansion joints. Spade concrete thoroughly along forms and expansion joints. Tamp and screen to a dense mix.

Provide a street broom finish to concrete surfaces. Finishing to be done after surface has been troweled to a smooth even surface and sufficient mortar has been brought to the surface. Provide a hand rubbed finish for edging. All edging and scoring is to be done after the broom finishing has been completed.

Remove forms while concrete is still "green."

Cure concrete surfaces by covering with burlap, or other suitable material approved by the Contracting Officer.

Keep moist for 72 hours minimum after which covering shall be removed.

Apply liquid membrane curing material in strict conformance with manufacturer's directions. Protect by not allowing use for a minimum of 5 days after installation.

Place no concrete when 40 degrees F or below, or when expected to drop to 40 degrees F within 24 hours after placing concrete. Maintain mix at a minimum of 50 degrees F.

K. *GRANITE AND PAVING*

Clean concrete slab thoroughly of dust, dirt and foreign matter.

Set granite in full latex mortar setting bed true to line and grade. Remove excess mortar promptly as work progresses; Lay with 1/16 inch mortar joints between stones unless otherwise indicated; Level surface to elevations shown, with no deviation greater than 1/16 inch to 10 feet; Strike joints flush with top surface of abutting surface and tool slightly concave.

Set granite in pattern as indicated. Set so no unit will be cut less than 10 inches, unless approved. Cure granite paving work by covering with 2 layers of burlap and keep damp for 2 days.

L. *CLEAN UP*

The Contractor shall be responsible for a total clean up of paving on a daily basis. The Contracting Officer shall insist on the site being clean at the end of each work day.

During setting and curing, protect installed unit paver areas from heavy traffic by using planks or plywood panels for walkways and wheel ways.

M. *MEASUREMENT AND PAYMENT*

Payment for Item 447 shall constitute full payment for all labor and materials required to construct new Modular

Unit (Brick) Paver Sidewalks or Driveways, including all gravel, excavation, reinforced concrete and bituminous concrete base courses, fine grading, compacting and the salvage of any brick to be used when reconstructing existing brick sidewalks or driveways to the grade specified by the Contracting Officer or his representative. Payment shall be at the price per square yard bid in the proposal.

ITEM 447.0100 NEW BRICK SIDEWALKS AND DRIVEWAYS WITH GRAVEL BASE

A. *GENERAL*

Under this item the Contractor shall remove the existing asphalt or concrete sidewalk and/or driveways and replace with pre-cast concrete pavers as noted on the plans in accordance with these specifications and in reasonably close conformity to the lines and grades as shown on the plans or as established by the Contracting Officer.

B. *MATERIALS: PRECAST CONCRETE PAVER*

Paving Unit

Type: Boston Colonial pavers Nominal Dimensions: 4" x 8" Thickness: 2-3/8"

Weight: 27 lbs. per sq. ft.

Finishes: Red and brown color range

C. *GRAVEL BORROW*

The work to be done under this item shall conform to the applicable provisions of Section 401, (MSSHB).

D. *SAND BASE*

The work to be done under this item shall conform to the applicable provision of Section M4.02.02, (MSSHB).

E. *EXCAVATION*

Excavation shall be made to the required depth of 12 inches including the removal of the existing asphalt or concrete sidewalks and/or driveways.

F. *SUBGRADE*

The sub-grade of the sidewalks shall be shaped parallel to the proposed surface of the walks and shall be thoroughly compacted.

G. *FOUNDATION*

After the sub-grade has been prepared, a foundation of crushed gravel base course material shall be placed upon it. After being thoroughly compacted, the foundation shall have a thickness of 8 inches as shown on the plans or as established by the Contracting Officer.

H. *SAND BASE*

A layer of sand base course material 2 inches in thickness shall be spread upon the properly prepared foundation. This course shall be thoroughly compacted and present a hard smooth surface parallel to the proposed finish slope and grade of the walk.

I. *BRICK PLACEMENT*

After the sand base course has been properly prepared, the brick shall be placed in the pattern shown on said plans, or as directed by the Contracting Officer. The brick shall be placed as closely together as possible and the sand joints between the brick shall be no wider than that allowed by the natural texture of the brick itself. No open joints will be allowed.

J. *MEASUREMENT AND PAYMENT*

Payment for the construction of the brick sidewalks and driveways shall be made at the contract unit price bid per square yard for sidewalks and driveways. The price shall include the cost of the pre-cast brick paver and installation, excavation, gravel base, fine grading, compacting, sand base, and all labor and equipment necessary to satisfactorily complete the work.

ITEM 447.0200 EXISTING BRICK SIDEWALKS AND DRIVEWAYS WITH GRAVEL BASE – REMOVE & RESET

A. *GENERAL*

Under this item the Contractor shall remove and reset brick walks and driveways as noted on the plans in accordance with these specifications and in reasonably close conformity to the lines and grades as shown

on the plans or as established by the Contracting Officer.

B. *GRAVEL BORROW*

The work to be done under this item shall conform to the applicable provisions of Section 401, (MSSHB).

C. *SAND BASE*

The work to be done under this item shall conform to the applicable provisions of Section M4.02.02, (MSSHB).

D. *EXCAVATION*

Excavation shall be made to the required depth of 12 inches including the removal of the existing brick sidewalks.

E. *SUBGRADE*

The sub-grade of the sidewalks shall be shaped parallel to the proposed surface of the walks and shall be thoroughly compacted.

F. *FOUNDATION*

After the sub-grade has been prepared, a foundation of crushed gravel base course material shall be placed upon it. After being thoroughly compacted, the foundation shall have a thickness of 8 inches as shown on the plans or as established by the Contracting Officer.

G. *SAND BASE*

A layer of sand base course material 2 inches in thickness shall be spread upon the properly prepared foundation. This course shall be thoroughly compacted and present a hard smooth surface parallel to the proposed finish slope and grade of the walk.

H. *BRICK PLACEMENT*

After the sand base course has been properly prepared, the brick shall be placed in the pattern shown on said plans, or as directed by the Contracting Officer. The brick shall be placed as closely together as possible and the sand joints between the brick shall be no wider than that allowed by the natural texture of the brick itself. No open joints will be allowed. Any bricks that appear to be broken or severely damaged shall not be reused. Damaged bricks must be replaced with new bricks that follow same pattern as existing. Replacement brick shall match existing brick or new brick pattern design as closely as possible. Engineer shall approve replacement bricks.

I. *MEASUREMENT AND PAYMENT*

Payment for the construction of the brick sidewalks and driveways shall be made at the contract unit price bid per square yard for sidewalks and driveways. The price shall include the cost of the pre-cast brick paver and installation, excavation, gravel base, fine grading, compacting, sand base, and all labor and equipment necessary to satisfactorily complete the work.

ITEM 447.0300 MODULAR UNIT REMOVE AND REPLACE

A. *STREETSCAPE STANDARD*

Work under this item shall be to remove and replace existing modular unit materials. This work shall conform to the applicable provisions of Item 447.

B. *MEASUREMENT AND PAYMENT*

Payment shall be at the price per square yard bid in the proposal.

ITEM 448.0000 WORCESTER HIGHWAY MONUMENT

A. *GENERAL*

The work to be done under this item shall conform to the applicable provisions of Section 710, (MSSHB). Worcester standard highway monuments shall be as manufactured by H.E. Fletcher Company, West

Chelmsford MA or an approved equal.

The monument shall be set complete in place and shall conform to the specifications as shown on plans titles "Worcester Standard Highway Monument" included in this contract.

B. *MEASUREMENT AND PAYMENT*

The method of payment for this item is per each complete in place.

ITEM 450.0000 BOUNDS, REMOVE & RESET

A. *GENERAL*

The work to be done under this item shall conform to the applicable provisions of Section 710, (MSSHB). The

Contractor shall notify the Department of Public Works and Parks to have the existing bounds tied in prior to being removed and reset.

B. *MEASUREMENT AND PAYMENT*

The method of payment for this item is per each complete in place.

ITEM 451.0000 TEMPORARY PEDESTRIAN BRIDGE

A. *GENERAL*

The work under this item shall include fabricating, installing, removing and resetting temporary pedestrian bridges to maintain access to abutting properties and businesses during sidewalk construction.

B. *CONSTRUCTION*

During sidewalk construction it may be necessary for the contractor to provide a temporary pedestrian bridge across areas of excavated or newly poured sidewalk in order to maintain access to businesses and other properties. The Contractor shall be responsible to provide a safe and sturdy means of passage by pedestrians. The temporary pedestrian bridge shall be a minimum of 36" wide with a handrail on one side. The Contractor shall submit shop drawings of the temporary bridge for approval by the engineer.

C. *MEASUREMENT AND PAYMENT*

The method of payment for this item is per each complete in place. This price shall include all labor, materials, equipment and incidental costs required to complete the work. A maximum of three (3) temporary pedestrian bridges shall be constructed to maintain pedestrian access to businesses in construction areas. Any additional sidewalk bridges shall be fabricated only with the approval of the contract officer. The contractor will not be compensated for any temporary bridges fabricated without prior approval of the contract officer. The contractor shall not be paid to remove and reset the temporary pedestrian bridge to new locations throughout the duration of the project. The removal and resetting for reuse shall be considered incidental to the construction.

Work to be done under Items 452 thru 454 shall consist of building wheelchair ramps and installing detectable warning panels at street intersections where specified or directed by the Contracting Officer. Wheelchair ramps shall conform to plan entitled Handicap Ramp.

ITEM 452.0000 WHEELCHAIR RAMP BIT. CONCRETE - 2" THICK WITH DETECTABLE WARNING PANELS

ITEM 452.1000 INSTALLATION OF DETECTABLE WARNING PANEL ON EXISTING BITUMINOUS CONCRETE RAMP COMPLETE IN PLACE

ITEM 453.0000 REPLACING BITUMINOUS CONCRETE WHEELCHAIR RAMP W/ CEMENT CONCRETE WHEELCHAIR RAMP- 6" THICK WITH DETECTABLE WARNING PANELS

ITEM 454.0000 WHEELCHAIR RAMP CEMENT CONCRETE - 6" THICK WITH DETECTABLE WARNING PANELS

ITEM 454.1000 INSTALLATION OF DETECTABLE WARNING PANEL ON EXISTING CEMENT CONCRETE RAMP COMPLETE IN PLACE

A. *GENERAL*

The design will be dependent upon the width and type of existing sidewalk, conforming to 521 CMR, Architectural Access Board as shown in the City of Worcester Construction Details Book.

On sidewalks having curb, the curb will be reset for the whole length of the ramp. Any increase in thickness designated by the Contracting Officer shall be paid for at a pro-rated basis.

Expansion joints 1/2 inch thick shall be placed at all points where the concrete wheelchair ramp abuts sidewalks, buildings, curb or other permanent structures.

Whenever sidewalks, walkways, or curbs on streets and ways are constructed, or repaired, curb cuts are required. All curb cuts shall comply with the following:

B. *LOCATION*

Curb cuts shall occur wherever an accessible route crosses a curb and at the following locations:

Curb cuts are required at each corner of each intersection, located within the crosswalk and/or the pedestrian path of travel. Curb cuts shall be perpendicular to the curb at street crossings and each shall have a level landing at the top. At marked crossings, the bottom of the ramp run, exclusive of flared sides, shall be wholly contained with the marked crossing. Single (i.e. diagonal or depressed corner) curb cuts serving two street crossing directions are not allowed.

Exception: Where pedestrian right-of-way established width will not accommodate a perpendicular curb cut and landing, a parallel public sidewalk curb cut with a level landing at its bottom shall be provided instead of a perpendicular curb cut.

Reciprocal curb cuts: When curb cuts or sidewalks are being constructed or reconstructed on one side of the street, and when such curb cuts or sidewalks are connected to an opposite side of the street by one or more pedestrian paths of travel, then at least one curb cut shall be provided on the opposite side of the street where such side is controlled by the same owner.

Driveways: Curb cuts are required at driveways intersecting sidewalks when the driveway has side curbs.

Raised Islands: Any raised islands in crossings shall be cut through level with the street or have curb cuts at both sides and a level area at least 48 inches (48"=1219mm) long between the curb cuts in the part of the island intersected by the crossings.

Obstruction: Curb cuts shall be located or protected to prevent their obstruction by parked vehicles.

C. *SLOPE*

The maximum slope shall be one-in-12 (1:12) (8.3%). Where sidewalks are too narrow to install a straight-line curb cut at a slope of one-in-12 (1:12) (8.3%), the primary slope may be steeper than 1:12 (8.3%) but the sides of the curb cut shall not exceed one-in-12 (1:12) (8.3%). The maximum cross-slope for any curb cut shall be 1:48 (2.1%). (There is no tolerance allowed on slope requirements).

D. *TRANSITIONS*

Transitions from curb cuts to walks, gutters, or streets shall be flush with existing surfaces. Maximum slopes of adjoining gutters, road surface immediately adjacent to the curb cuts, or accessible route shall not exceed one-in-20 (1:20) (5%).

E. *DRAINAGE*

Grading and drainage shall be designed to minimize pooling of water, accumulation of ice, or flow of water across the base of the curb cut.

F. *WIDTH*

The minimum width of a curb cut shall be 48 inches (48"=1220mm), exclusive of flared side.

Landing width: Where a perpendicular curb cut is provided, a landing width of the curb cut shall be provided at the top of the curb cut. The landing shall be 48 inches (48"=1220mm) in length. The slope of said landing shall not exceed one-in-48 (1:48) (2.1%) in any direction.

G. *FLARED SIDES*

Sides of curb cuts shall extend at least 5 feet at the curb. The maximum slope of the flare is one-in-ten (1:10) (10%). Curbing at the flared sides must blend with the slope of the flared sides.

H. *RETURNED SIDES*

Curb cuts with returned sides are only permitted where they are protected by handrails pursuant to 521 CMR 24.5, Handrails or where pedestrian travel across the ramp is obstructed by permanently installed street hardware or landscaping.

I. *BUILT-UP CURB CUTS*

Built-up curb cuts are allowed only where they do not project into vehicular traffic lanes.

J. *PEDESTRIAN STREET CROSSINGS*

Where provided, pedestrian street crossings at, above, or below grade shall comply with the following:

Crossing controls shall be raised from or flush with their housings and shall be a minimum of two inches (2"=51mm) in the smallest dimension. The force required to activate controls shall be no greater than 5 ft.- lb. (22.2N).

Location: Controls shall be located as close as practicable to the curb cut serving the controlled crossing and shall permit operation from a clear ground space.

Mounting height: Pedestrian-actuated crossing controls shall be a maximum of 42 inches (42"=1067mm) above the finished sidewalk.

Clear ground space: A stable and firm area, complying with 521 CMR 6.5, Forward Reach, or 521 CMR 6.6, Side Reach shall be provided at the controls. Where a parallel approach is provided, controls shall be within ten inches (10"=254mm) horizontally of and centered on the clear ground space. Where a forward approach is provided, controls shall abut and be centered on the clear ground space.

K. *CONSTRUCTION*

All curb ramps shall be constructed in accordance with the standards set forth in the American's with Disabilities Act and by the Massachusetts Architectural Access Board in 521 CMR. The installation of apex ramps shall only occur if all other installation orientations are deemed impossible to construct by the Engineer. Installation of apex ramps shall require the approval of the Engineer.

L. *MEASUREMENT AND PAYMENT*

Wheelchair ramps shall be measured in place, including excavation, gravel foundation, grading, removing and resetting curb or berm, installing detectable warning panels and removal and replacing of disturbed roadway. Payment shall be at the price per square yard bid in the proposal.

Existing wheelchair ramps that need detectable warning panels shall be measured in place, including all necessary equipment needed for the installation. Payment shall be at the bid price per square foot in the proposal.

Where granite curb is missing the Contractor will be required to set granite curb. Payment for supply of such granite curb shall be through the appropriate Items 405 thru 420.

ITEM 456.0000 CONCRETE STEP (COMPLETE IN PLACE)

A. *GENERAL*

Work to be done under this item shall consist of removal, excavation, gravel base, wood forms, placing and finishing of cement concrete for new steps to conform to the proportion of existing steps.

When new steps are to be built they shall conform to the design on plan titled Typical Design for Cement Concrete Steps.

Class C (3,000 psi, 1-1/2", 470) concrete shall be used.

B. *MEASUREMENT AND PAYMENT*

Concrete steps shall be measured in place and paid for at the unit price bid for each contained in the proposal.

ITEM 457.0000 WOOD STEP

A. *GENERAL*

The work to be done under this item shall include furnishing all the materials, labor and equipment necessary to construct a wood step. Wood steps are to be dimensioned, sized and constructed to match existing steps where specified.

B. *MEASUREMENT AND PAYMENT*

Wood steps shall be measured in place and paid for at the unit price bid for each contained in the proposal.

The work to be done under Items 461 through 466 shall conform to the applicable provisions of Section 901, (MSSHB)

ITEM 461.0000 8' - 6" RETAINING WALL

A. *MEASUREMENT AND PAYMENT*

Payment under this item shall be at the unit price bid per linear foot, which shall include full compensation for delivery, labor, equipment, material, patching of roadway (if necessary), and all incidental work necessary to complete the work as specified or as specified by the Contracting Officer.

ITEM 462.0000 GRAVITY CONCRETE WALL

A. *GENERAL*

The work to be done under this item shall conform to the applicable provision of Section 901, (MSSHB).

B. *MEASUREMENT AND PAYMENT*

The work to be done under this item shall be paid by the cubic yard.

ITEM 464.0000 STONE MASONRY WALL (COMPLETE IN PLACE)

ITEM 465.0000 STONE MASONRY WALL, DRY

A. *GENERAL*

The work to be done under Items 464 and 465 shall conform to the applicable provision of Section 685, (MSSHB).

B. *MEASUREMENT AND PAYMENT*

Items 464 and 465 shall be paid per square foot, of visible wall face, complete in place.

ITEM 466.0000 HEADWALL CONCRETE, COMPLETE

A. *GENERAL*

The work to be done under this item shall include furnishing and placement of cement concrete for headwalls complete in place. This item shall include forms, reinforcement joints, and all equipment, labor and materials required to complete this work.

B. *MEASUREMENT AND PAYMENT*

Concrete for headwalls shall be measured, installed, in place and shall be paid at the unit price per cubic yard bid therefore in the proposal.

ITEM 467.0000 REMOVE AND REPLACE EXISTING GUARDRAIL

ITEM 468.0000 GUARDRAIL STEEL TYPE SS

ITEM 468.1000 WOODEN GUARDRAIL

ITEM 468.2000 WOODEN GUARDRAIL – REMOVE AND REPLACE

A. *GENERAL*

The work to be done under Items 467, 468, 468.1, and 468.2 shall conform to applicable provisions of Section 630, (MSSHB).

B. *DESCRIPTION OF WORK*

The work done under this item shall provide all materials, equipment, labor necessary to complete the work. The contractor will be required to submit a sample of each material to the owner for approval before ordering materials. The samples shall demonstrate the final surface color, finish and shape that will be provided throughout the project. All samples shall be full size.

C. *MATERIALS*

Wooden posts, wooden rails shall be made of southern yellow pine, CCA treated to retention level of .40.

Fasteners shall be hot dipped galvanized in accordance with ASTM A153.

D. *MEASUREMENT AND PAYMENT*

These items shall be paid for at the contract unit price per linear foot, complete in place, including post and steel

beam terminal sections.

ITEM 469.0000 PRECAST CONCRETE BARRIER

A. GENERAL

The work to be done under this item shall conform to the relevant provisions of Section 629, (MSSHB).

Pre-cast concrete barrier shall be supplied complete in place at the locations shown on the plans and/or as directed by the Contracting Officer.

B. MEASUREMENT AND PAYMENT

Payment under this item shall be at the contract unit price bid per linear foot that shall include full compensation for all necessary barrier location, labor, equipment, materials, and all incidental work necessary to complete the work as specified. All barriers under this item shall be retained by and will become the property of the City of Worcester.

ITEM 470.0000 WOOD FENCE, REMOVE AND RESET

ITEM 472.0000 WIRE FENCE, REMOVE AND RESET

ITEM 474.0000 CHAIN LINK FENCE, 48 INCHES

ITEM 475.0000 CHAIN LINK FENCE, 60 INCHES

ITEM 476.0000 CHAIN LINK FENCE, 72 INCHES

A. GENERAL

The work to be done under Items 470 & 472 shall conform to the applicable provisions of Section 665, (MSSHB). The work to be done under Items 474 through 476 shall conform to the applicable provisions of Section 644,

(MSSHB.

B. MEASUREMENT AND PAYMENT

Payment for these items shall be paid for at the contract unit price per linear foot (complete in place) including concrete base, line posts and gates.

ITEM 478.0000 METAL PIPE RAIL

A. GENERAL

The work under Item 478 shall conform to the applicable provisions of Section 660, (MSSHB).

B. MEASUREMENT AND PAYMENT

Payment for these items shall be paid for at the contract unit price per linear foot, measured along the ground, not foot of installed rail. (complete in place)

ITEM 480.0000 SWEEPING

A. GENERAL

All streets where existing hardened surface shall be utilized as a base, the pavement shall be cleared of all foreign matter and base material. These streets shall be dry before the prime coat is applied.

All streets that are pulverized and based or milled and leveled, sweeping shall be considered a subsidiary obligation of the Contractor.

B. MEASUREMENT AND PAYMENT

The method of payment for sweeping shall be at the bid price per square yard (overlays only).

ITEM 481.0000 ORNAMENTAL BOLLARD (COMPLETE IN PLACE)

A. *GENERAL*

This work shall consist of furnishing and installing Bollards on existing foundation in accordance with this specification and as shown on the plans and/or directed by the Engineer.

B. *MATERIALS*

Bollards shall be Charleston Series Cast Aluminum Bollard, Model Number BOL/CH47/12/BT-CA/BK (with ball top) as provided by HOLOPHANE, Inc. or approved equal. Finish shall be 2 coats polyurethane resin and 2 coats

2-component polyurethane paint, color black. All hardware shall be tamper proof. Concrete foundation shall be in accordance with the manufacturer's guidelines.

C. *SUBMITTALS*

The Contractor shall submit shop drawings to the Engineer for approval prior to ordering the Bollards.

D. *CONSTRUCTION METHODS:*

Prior to the installation of the concrete base for the Bollards, the Contractor shall field review the location of each bollard with the Engineer. Once the locations have been approved by the Engineer the Contractor shall make every effort to install the new ornamental bollard on the existing foundation utilizing the existing anchor bolts in accordance with the manufacturer's guidelines. If required, the contractor shall carefully realign any anchor bolts that prevent the ornamental bollard from being correctly and securely installed. Should it not be possible for any anchor bolt to be realigned to the Engineer's satisfaction, the contractor shall drill and grout new anchor bolts to receive the new ornamental bollard. No additional payment shall be made to the contractor for this effort.

E. *MEASUREMENT AND PAYMENT*

This item of work shall be paid for at the contract unit price bid per each, which price and payment shall constitute full compensation for furnishing and installing all materials including transition plates, new anchor bolts, drilling and regrouting new bolts and all other materials, connections, labor, equipment, tools, appurtenances, and incidentals necessary to satisfactorily complete this item of work complete and accepted by the Engineer.

ITEM 481.1000 ORNAMENTAL BOLLARD (REMOVE AND RESET)

A. *GENERAL*

This work shall consist of removing and resetting existing ornamental bollards on existing foundations in accordance with this specification and as shown on the plans and/or as directed by the Engineer.

B. *CONSTRUCTION METHODS*

Prior to the installation of the ornamental bollard the Contractor shall field review the location of each Bollard with the Engineer. Once the locations have been approved by the Engineer the Contractor shall make every effort to install the existing ornamental bollard on the existing foundation utilizing the existing anchor bolts in accordance with the manufactures guidelines. If required, the Contractor shall carefully realign any anchor bolts that prevent the ornamental bollard from being correctly and securely installed. Should it not be possible for any bolt to be realigned to the Engineer's satisfaction, the Contractor shall drill and grout new anchor bolts to receive the existing ornamental bollard. No additional payment shall be made to the Contractor for this effort.

C. *MEASUREMENT AND PAYMENT*

This item of work shall be paid for at the contract unit price bid per each, which price and payment shall constitute full compensation for furnishing and installing all materials, connections, labor, equipment, tools, appurtenances, and incidentals necessary to satisfactorily complete this item of work complete and accepted by the Engineer.

ITEM 481.2000 ORNAMENTAL BOLLARD (REMOVE AND DISPOSE)

A. *GENERAL*

The Contractor shall furnish all additional labor, materials and equipment required to remove and dispose of existing ornamental bollards as directed by the Contracting Officer.

B. *MEASUREMENT AND PAYMENT*

The unit bid price per each shall be full compensation for all work required including salvage and delivery to the City's Department of Public Works and Parks – 1065 Millbury Street Yard of any castings as directed by the Contracting Officer.

ITEM 482.0000 STANDARD 6 INCH STEEL BOLLARD (COMPLETE IN PLACE)

A. SCOPE OF WORK

This work shall consist of furnishing and placing bollards at the direction of the Contracting Officer.

B. MATERIALS

Bollards shall be a 6 inch diameter galvanized steel pipe filled with concrete.

C. DESIGN AND CONSTRUCTION

Bollard shall be a 6 inch iron pipe filled with cement concrete. Exposed length shall not be less than 4 feet from final grade and shall be buried for not less than 4 feet. The base around the indicator post will be secured and centered in poured concrete no less than 12 inches in diameter. The bollard shall be painted according to the Contracting Officer's instructions, typically black or yellow.

Bollards shall be located at certain points to serve as a visual and physical barrier for protection from vehicle traffic.

Bollards shall be located within the City right-of-way but not in the traveled way.

D. MEASUREMENT AND PAYMENT

Bollards will be paid for by EACH complete and installed, including all materials, tools, labor, equipment, and incidentals necessary to complete the work as specified herein.

ITEM 483.0000 REPLACING GAS BOX, GRAVEL BASE

ITEM 484.0000 REPLACING GAS BOX, RIGID BASE

A. SCOPE OF WORK

The work to be done under Items 483 and 484 shall consist of the replacement of existing GAS boxes with a gate valve box provided by the gas company of record (Currently Eversource). This work shall include furnishing all necessary labor, materials and equipment, backfilling with bituminous concrete, power tamped in 6" layers, set to designated line and grade, and patching the base course with SUPERPAVE binder course without extra cost to the City. The contractor will also be required to dispose of all old GAS castings, unless otherwise directed by the Contracting Officer. All GAS boxes shall be set in bituminous concrete. The bituminous concrete shall extend a minimum 18" beyond the outside of the GAS box to a depth of 12" so the area can be packed with a plate compactor.

As part of this work, each GAS box and riser will be cleaned of soil and debris with an “air-lance” or equivalent, to accommodate the proper access to the valve. This work will be completed at no additional cost to the City.

B. MEASUREMENT AND PAYMENT

Measurement shall be at the number of units installed in place and paid for at the unit price for each bid therefore in the proposal. No additional payment will be made for bituminous concrete used in this item.

ITEM 485.0000 REMOVE AND RETAIN GAS BOX

ITEM 486.0000 RETURN AND RESET GAS BOX

A. SCOPE OF WORK

Under Item 485 the contractor will remove all GAS boxes from the roadway prior to the excavation and store such boxes in a manner to insure their safe keeping from theft or damage. All excavated areas shall be suitably backfilled by approved compaction methods and the work site shall be left in a neat and clean state.

Under Item 486 the Contractor shall return to the job site all undamaged top boxes and covers previously removed under Item 485. It will be the contractor's responsibility to then reset the top boxes as indicated in the specifications of Items 487 & 488 of the contract, taking care as to the clearing of all debris from the bottom box. It will be the Contractor's responsibility to neatly trim or cut the new binder course, excavate, compact and repave the excavated area with SUPERPAVE bituminous concrete binder. Water boxes shall be adjusted to specific line and grade given by the Contracting Officer and shall be set prior to the laying of the top course.

As part of this work, each valve box and riser will be cleaned of soil and debris with an “air-lance” or equivalent, to accommodate the proper access to the valve. This work will be completed at no additional cost to the City.

B. MEASUREMENT AND PAYMENT

Measurement shall be at the actual number of water boxes removed and retained and returned and reset as applicable. Payment shall be at the respective item bid for each in the proposal.

ITEM 487.0000 GAS BOX ADJUST TO GRADE, GRAVEL BASE

ITEM 488.0000 GAS BOX ADJUST TO GRADE, RIGID BASE

A SCOPE OF WORK

The work under Items 487 and 488 shall consist of the resetting of the existing GAS boxes and supplemented by the Materials section below.

B CONSTRUCTION METHODS

The pay item for this work shall be GAS Boxes Adjust to Grade and shall be full payment for all excavation, trimming or cutting of existing box, bituminous concrete backfill, and placing SUPERPAVE bituminous concrete binder course collar for all labor, equipment, tools and incidental expenses required to locate, maintain in proper working order, and set to finished grade complete in place.

GAS boxes shall be adjusted to line and grade before the top course has been laid. The bituminous concrete binder course shall be thoroughly compacted with a plate compactor.

It shall be the Contractor's responsibility to mark locations of each box and to maintain each and every box in proper working order, free of all dirt and/or debris and in true alignment at all times.

The Contractor shall notify the Contracting Officer immediately of any boxes found in poor, broken or leaking condition. The locations given at start of work in each street shall be preserved by the contractor for use in establishing water box locations after SUPERPAVE base course has been laid. The Contractor shall be responsible for location of all visible GAS boxes at all times during the construction period.

All GAS boxes shall be set in bituminous concrete binder. The bituminous concrete shall extend a minimum of 18" beyond the outside of the valve box to a depth of 12", and compacted in two 6" lifts with a plate compactor.

GAS boxes shall be carefully fitted together and to the valve with minimum overlap of six (6) inches between the box sections when in the most extended position. The soil shall be firmly compacted around bonnet of the valve to prevent settling.

The Contractor shall adjust all existing GAS boxes where indicated on the drawings and detail sheets (If available). When adjusting a GAS box, the Contractor shall be responsible to clear all debris from the bottom box.

Some GAS boxes that are called out to be adjusted may not be able to be adjusted as described above. There may be grade changes that exceed the range of adjustment within the existing box; or the top and bottom sections of the existing box have been fused together due to age and corrosion and cannot be separated or there may be damage to the box sections that is not visible from the surface. If one or more of these conditions exists, the Contracting Officer may deem it necessary to remove and stack the existing box and a new GAS box will be installed. The contractor shall make every effort to separate the sections of the existing box to be adjusted prior to the Contracting Officer contacting the gas company to make the repair.

GAS boxes shall not be trimmed and/or cut. If a new GAS box is required, the contract officer will contact the GAS company to make arrangements to obtain a new GAS box.

The GAS box shall be adjusted to 18 inches below finish grade unless a cement concrete road base exists, in which case the GAS box shall be set in the finished grade of the cement concrete road base. If the Contracting Officer determines that the GAS box to be adjusted is not suitable for re-use, the contract officer will contact the GAS company to make arrangements to obtain a new GAS box.

C MEASUREMENT AND PAYMENT

GAS boxes that are set, removed and stacked or adjusted shall be paid for at the contract unit price per each complete in place. All equipment, tools, Superpave bituminous concrete binder course materials, labor and transportation required to complete all of the above items as specified shall be considered as incidental to the

construction and be included in the contract price per each item.

MEASUREMENT SHALL BE FOR WORK COMPLETED IN PLACE AND PAID FOR AT THE UNIT PRICE EACH BID THEREFORE IN THE PROPOSAL. NO ADDITIONAL PAYMENT WILL BE MADE FOR BITUMINOUS CONCRETE USED IN THIS TIME.

ITEM 490.0000 CRACK SEALANT

A GENERAL

Worked performed under this item shall conform to all relevant provisions of MassDOT Standard Specification Division II Section 400, MassDOT Standard Specification Division III Section M3 and the following:

Work under this item shall include furnishing all personnel, equipment, and materials necessary to perform bituminous-concrete asphalt crack sealing. Crack sealing shall consist of cleaning and sealing of cracks in bituminous concrete pavement roadways, including removing debris and vegetation from cracks via air torch, supplying heated asphalt fiber compound, and applying heated asphalt-fiber compounds to cracks. Work under this item also includes furnishing all personnel, equipment, and materials necessary to adequate illuminate the work zone during night-work activities.

B MATERIALS

Crack sealant shall be a modified asphalt-fiber compound designed specifically for improving the strength and performance of the parent asphalt sealant.

1. Asphalt Binder

   Asphalt binder shall consist of a blend of neat asphalt binder, chemically modified crumb rubber (CMCR), and a polymer package. The components of the binder shall meet the below requirements:

a. Binder shall meet PG 64-28E requirements after modification including:
   i. PG grade requirements of AASHTO M320
   ii. Requirements of AASHTO TP7-/MP19

b. Modification shall consist of a minimum of 7% crumb rubber.

c. Maximum particle size for recycled tire rubber shall be #80 sieve (80 mesh).

d. Asphalt binder shall meet the following testing requirements:

DRS Original
kPa > 1.00 @ 64˚ C
Fail Temp ≤76˚ C

DRS RTFO
kPa > 2.20 @ 64˚ C
Fail Temp ≤ 76˚ C

MSCR
JNR (MSCR unit of measure) = 3.2 E < 0.5% @ 64˚ C
R3200 (Average % Recovery) > 70%

DSR PAV
kPa < 6000 @ 64˚ C

BBR
Stiffness < 300 @ -18˚C
M-Value > 0.300 @ -18˚C

2. Fiber Reinforcing Materials

Fiber reinforcing materials shall be short-length polyester fibers with the following properties:

Length
0.25 in ± 0.02 in

Elongation at Break (ASTM D2256-90)
35% ± 3%

Melting Point (ASTM D3418-82)
> 246˚C (475˚F)

Crimps/Inch (ASTM 3937-90)
None

Cross Section
Round

Denier (ASTM D1577-90)
4.5 Nominal dpf

Tensile Strength (ASTM D2256-90)
> 70,000 psi

Diameter
0.0008 in

Specific Gravity (ASTM D792-91)
1.32 to 1.40

3. Modified Asphalt Fiber Compound

Modified asphalt fiber compound shall be mixed at a rate of 8% fiber weight to weight of asphalt cement. Modified asphalt fiber compound shall consist of a uniform chemical base and exhibit adequate bonding strength. Fibers shall function in such a fashion as to re-distribute high stress and strain concentrations imposed on the sealant by thermal sources and traffic loading.

C EQUIPMENT

Equipment used in the performance of the work under this item shall be subject to approval by the Engineer. All equipment used in the execution of work under this item shall at all times be kept in good repair and satisfactory working condition.

1. Air Compressor

Air compressor shall be capable of producing equal to or greater than 100 cubic feet of air per minute and equal to or greater than 90 lbs/in^2 of pressure at the nozzle tool outlet. For the purpose of maintaining a moisture free air supply, the air compressor shall be equipped with traps and/or filters which accumulate water, oil, and other liquids.

2. Broom/Sweeper

A manually operated, gas-powered air broom or self-propelled sweeper specifically designed for use in cleaning roadways, highways, and airfield pavements shall be utilized to remove debris, dirt, dust, and other solids from cracks to be sealed.

3. Heating Unit

The Contractor shall utilize an indirect fired heating unit to heat the crack sealing compound to the required application temperature. The heating unit shall be capable of maintaining the temperature of the crack sealing compound at the application temperature for the duration of daily work activities. The heating unit kettle shall have a minimum volume of 1,000 gallons. The heating unit shall be equipped with a remote heat exchanger and hot oil circulation pump capable of maintaining the heat transfer oil at a constant temperature. Heat transfer oil shall circulate through the sides and bottom of the kettle, flowing in a continuous loop from the heat exchanger through the kettle. The heat transfer oil shall have a flash point of 600˚F or greater. The heating unit shall be equipped to continuously agitate the crack sealing compound during heating and application. Agitating of the crack sealing compound shall be performed by either mechanically operated paddles or a circulating gear pump attached to the heating unit. The heating unit shall be equipped with a thermostatic control which is capable of pumping an 8% fiber blend. The thermostatic control shall be calibrated between 200˚F and 550˚F.

4. Work Zone Illumination

The Contractor shall be responsible for providing equipment to illuminate work areas during night operations. The Contractor should refer to the “Work Zone Illumination” section of the Special Provisions for work zone illumination standards and requirements.

D QUALIFICATIONS

To be considered a responsive bidder qualified to bid on the work described in this specification, the Contractor must possess and present evidence to the City of the following qualifications:

1. Ten (10) or more years of experience performing polymer and modified crumb rubber asphalt crack sealant on municipal projects. The Contractor shall submit a list of six (6) municipal crack seal projects completed in the last five (5) years including location, volume of crack sealant applied, equipment utilized, and reference from the municipality served.
2. Prequalification by the Massachusetts Department of Transportation under the “Crack Seal” classification.

3. Possession of all equipment described in Section C of this specification. Contractors not in possession of equipment meeting the minimum requirements set forth in Section C shall be considered unqualified to perform the work and classified as an unresponsive bidder. The contract shall submit a list of all equipment to be used in the execution of the work including type, make, model and quantity.

E EXECUTION OF WORK

1. General

No crack sealant material shall be applied in wet cracks or cracks where frost, snow, ice, or other frozen liquids are present. Crack sealant shall not be applied when the ambient air temperature is below 25˚F.

2. Schedule

Prior to the start of work, the Contractor shall provide the Engineer with a proposed work schedule. The Contractor shall be responsible for coordinating changes in the work schedule with the Engineer. To ensure that the Contractor and Engineer agree on the time and duration of upcoming work, the Contractor shall communicate their anticipated work schedule to the Engineer for the coming week by noon on Thursday of the week before. If for any reason the Contractor must cancel previous scheduled work, the Contractor must provide the Engineer notice of cancellation a minimum of five (5) hours before the start of daily work activities. If required by the Engineer, the Contractor shall perform their operations during nighttime hours (7pm through 5am). The Engineer shall provide the Contractor with five (5) days notice if night operations will be required.

3. Police Details

The cost of police details shall be borne and paid for by the City. Based on the Contractors provided work schedule, the Engineer will coordinate and secure police details. The Contractor shall be responsible for the cost of any police detail expenses incurred due to failure to cancel or cancelling.

4. Test Strip

The Contractor shall perform a 200ft test strip at a location within the City prior to commencing work under this contract. The crack sealant shall be applied to the test strip following the procedures and standards outlines in this specification. Following inspection and acceptance of the test strip, the Engineer shall issue written approval to the Contractor to commence work.

5. Debris and Vegetation Removal

Prior to placing crack sealant, cracks shall be blown clean and sterilized by use of a propane air torch generating compressed air at a temperature of 2,000˚F and velocity of 3,000 ft/s. All vegetation, soil, debris, loose solids, moisture, and liquid shall be removed from the crack prior to placing crack sealant. All material removed from cracks shall be swept from the roadway, collected, and disposed offsite by the Contractor.

6. Preparation of Sealant

The asphalt-fiber compound shall be thoroughly mixed for a minimum of one hour before application can begin. Prior to application, the Contractor shall heat the crack sealant to a minimum temperature of 320˚F. The crack sealant shall be maintained at or above this temperature for the entirety of the workday. To ensure a uniform fiber distribution in the sealant, limit fluctuations in the application temperature of the crack sealant, and prevent delays in daily work activities, the Contractor shall arrive to the site with a full kettle of a minimum of 1,000 gallons of crack sealant which has been mixed and heated in accordance with the standards presented above and is ready for testing and application. To prevent fluctuations in crack sealant temperature and consistency, additional materials shall not be added to the kettle during working hours. Upon exhausting crack sealant in the kettle, crack sealing operations shall cease for the day.

7. Placement of Sealant

The minimum application temperature of crack sealant shall be 320˚F. Crack sealant material shall be applied to pavement cracks via a high-pressure hose line and applicator shoe. The applicator shoe shall be a metal disc of not more than 3.5 inches in diameter. The Contractor shall take care to ensure all cracks addressed as part of the work are completely filled with crack sealant. The Contractor shall apply crack sealant material in such a fashion as to eliminate waste or prevent application of excess crack sealant. Following sealing of pavement cracks, the width of sealant on the surface of the asphalt pavement (over banding) shall not exceed 3 inches. If traffic must be immediately returned to a roadway which was crack sealed, a liquid crack sealant barrier material or furnace slag aggregate shall be evenly broadcast over the entirety of the cracks to be subject to vehicular traffic. Stone dust shall not be considered an acceptable substitution for furnace slag aggregate. The Contractor shall be responsible for sweeping, removal, and disposal of excess furnace slag aggregate.

F SUBMITTALS

The contractor shall submit the following documents with their bid:

1. List of all equipment, including type, make, model and quantity, to be utilized in the execution of the work.
2. A statement describing the Contractor's anticipated average daily production rate.
3. The trade name and manufacturer of the crack sealant to be utilized.
4. Manufacturer's certificate of material compliance for the crack sealant material certifying compliance with the standards:
    a. Performance Grade of Unmodified Asphalt: PG 64-28S
    b. AASHTO M-320, Table 1
    c. 7% Chemically modified crumb rubber (CMCR) composed of 100% 80-mesh recycled tire rubber
    d. 3-4% specially formulated polymer package
    e. Performance Grade of Modified Asphalt: PG 64-28E
    f. AASHTO M-320 Table 1
        i. "E" Jnr 3.2kPa @ 64˚C: <0.5%
        ii. R3200 (Average % Recovery) @ 3.2 kPa: > 70%
    g. 8% polyester reinforcing fibers

G METHOD OF AWARD

The City shall award the work under this bid to a single contractor. Accordingly, contractors must bid on all items of work described in the contract. The low bidder shall be considered the contractor which provides the lowest bid price for the work described in this contract as is considered responsive per the stipulations of this contract. Bid quantities are not guaranteed and their primary purpose is the determination of the low bidder.

H PRICING ADJUSTMENTS

The Contractor's bid price shall be based on the MassDOT asphalt cement price index posted exactly two (2) weeks prior to the due date for receipt of bids for this contract ("Bid Index"). If the posted MassDOT asphalt cement price in place when the work under this contract is performed differs from the Bid Index, either increasing or decreasing, the Contractor invoice shall include price adjustments for the asphaltic materials. Price adjustments shall be calculated based on the actual tons of liquid asphalt cement incorporated into the materials utilized during the execution of the work under this contract.

I MEASUREMENT AND PAYMENT

Payment for work under this specification shall be made at the unit contract price per gallon of crack sealant applied. The quantity of crack sealant actually applied during work activities shall be measured, verified, and recorded daily by the Engineer and Contractor. Payment for work under this specification shall be full compensation for furnishing all necessary labor, equipment, and materials required to satisfactorily complete the work including heating and mixing the crack sealant, transporting the seal to the work locations, providing adequate illumination for night work activities, preparing cracks for application of sealant, removal and disposal of debris generated during crack preparation, and application of crack sealant.

ITEM 491.0000 RUBBERIZE CHIP SEAL

A GENERAL

Worked performed under this item shall conform to all relevant provisions of MassDOT Standard Specification Division II Section 400, MassDOT Standard Specification Division III Section M3 and the following:

Work under this Item shall consist of furnishing all personnel, labor, equipment, and materials necessary to perform application of 20% asphalt rubber chip seal surface treatment on bituminous asphalt roadways including vacuum sweeping to prepare work areas, blending and reacting the asphalt rubber mixture, applying the asphalt rubber mixture and aggregate to the roadway surfaces to be treated, compaction and rolling activities, final sweeping, and transportation and disposal of material generated during all vacuum sweeping operations. The bid quantity for this item is approximate and for comparative purposes only. Payment shall be for actual quantities applied to roadways. Measurements of roadways to be treated shall be made by the Contractor and the Director or their Designee prior to beginning work and confirmed by the same parties at the completion of work.

B MATERIALS

1. Asphalt Cement

Asphalt cement for the asphalt-rubber mixture shall be PG 58-28 or PG 64-28, whichever is appropriate as per the requirements of MassDOT and City of Worcester Standard Specifications. The grade selected shall be based on laboratory testing performed by the asphalt-rubber supplier.

2. Anti-stripping Agent

If required by the job-mix formula to produce appropriate water resistance, a heat-stable antistripping agent approved for use by the City shall be incorporated into the asphalt-rubber material at the dosage required by the job-mix formula (up to 1.0% by weight of asphalt). The anti-stripping agent shall be added to the asphalt cement prior to blending with granulated rubber.

3. Rubber

Granulated rubber utilized in the work shall be vulcanized rubber product obtained from ambient temperature mechanical processing of scrap pneumatic tires. Granulated rubber material shall not be obtained from operations which utilize heat and/or chemical processes. The use of rubber from multiple sources is acceptable provided the overall blend of rubber meets the gradation requirements of this specification. The length of individual rubber particles shall not exceed 2 mm. Granulated rubber shall meet the following gradation:

SIEVE SIZE	***% PASSING***
#10 (2.00 mm)	***100***
#16 (1.18 mm)	***90 – 100***
#30 (0.60 mm)	***25 – 75***
#80	***0 – 20***

Substitutions or modifications to the above gradation are not acceptable and will not be approved by the City. Rubber utilized in the execution of this work shall have written, producer provided certification that the material to be used meets the requirements of this specification.

4. Aggregate

Aggregate shall conform to the requirements of relevant MassDOT and City of Worcester specifications for crushed stone. Crushed gravel stone is not acceptable and shall not be used. The percentage of wear of the aggregate material as determined by the Los Angeles Abrasion Test (AASHTO-T96) shall be a maximum of 30. Aggregate shall be pre-heated to a temperature between 200˚F and 300˚F (93˚C and 149˚C) and be pre-coated with 0.4% to 0.8% (by weight of aggregate) of AC-10 or AC-20 asphalt cement prior to application. The gradation of the aggregate material shall meet the following requirements:

SIEVE SIZE	***AADT >1,000***	***AADT < 1,000***
	% PASSING – NOMINAL SIZE	
	3/8" CHIP SEAL (9.5 mm)	***1/2" CHIP SEAL (12.5 mm)***
5/8" (15.8 mm)	***100***	***100***
1/2" (12.5 mm)	***100***	***85 – 100***
3/8" (9.5 mm)	***85 – 100***	***15 – 45***
#4 (4.75 mm)	***0 – 8***	***0 – 25***
#8 (2.36 mm)	***0 – 4***	***0 – 5***
#50 (0.30 mm)	***0 – 2***	***0 – 2***
#200 (0.075 mm)	***0 – 2***	***0 – 2***

C EQUIPMENT

1. Vacuum Sweeping Truck

The Contractor shall utilize negative air pressure vacuum sweeping trucks to prepare the roadway surface for the application of the rubberized chip seal material and to remove excess aggregate material from the roadway following compaction operations. A minimum of two (2) vacuum sweeping trucks shall be utilized to perform the work under this specification. The vacuum sweeping trucks shall have a minimum sweeping width of 10 feet (3.05 meters) and a minimum dustbin volume of 10 cubic yards (7.65 cubic meters). The minimum negative air pressure measured at the sweeping intakes shall be equal to or greater than 46 inches of negative air pressure. Vacuum sweeping trucks shall feature membrane filters for the purpose of capturing dust and other particles generated during sweeping operations. The operation of vacuum sweepers shall produce no dust and no emissions of PM2.5 particles. All vacuum sweeping shall be performed dry. No mechanical sweeping or wet sweeping shall be performed. The use of mechanical pick-up brooms is prohibited.

2. Hauling Equipment

Trucks for hauling aggregate material shall be rear discharge conveyor-fed or “live bottom” trucks and shall be equipped with a device to lock onto the hitch at the rear of the chip spreader to prevent aggregate spillage. The Contractor shall utilize a quantity of hauling vehicles sufficient to ensure continuous operation of the distributor and chip spreader.

3. Mechanical Blender

The Contractor shall utilize a mechanical blender for proper proportioning and thorough mixing of the asphalt cement and granulated rubber. This unit shall be equipped with an asphalt totaling meter (reading in gallons), a flow rate meter (reading in gallons per minute), a positive displacement auger capable of feeding the rubber to mixing chamber at the specified rate, and a static motionless mixer. In order to meet varying project conditions, the blender rate shall be adjustable. To maximize production, the blender shall have a separate asphalt cement feed pump and finished product pump. The blender shall be capable of providing a 100% proportional mix at any given time during the blending cycle and documentation from the manufacturer supporting this shall be submitted to the City.

4. Distributor Truck

The Contractor shall utilize a pressure-type bituminous distributor truck to apply the asphalt-rubber mixture to the roadway. On projects exceeding 35 tons (31.8 metric tons) of liquid asphalt rubber, at least two (2) trucks in good working order shall be required. The distributor shall be equipped with an internal heating device capable of heating the material uniformly to a temperature of up to 425˚ (218˚C), an internal mixing unit capable of maintaining the prescribed mixture of asphalt cement and granulated rubber, a pump with adequate capacity to maintain a high rate of circulation within the tank and to spray the asphalt-rubber at a viscosity of 1,000 to 3,500 centipoise, and sufficient pressure devices and appropriate manifolds to provide constant positive cut-off to prevent dripping from the distributor nozzles. The distributor shall be equipped with an electronically controlled computerized compensation unit for controlling application rates at various width and speed changes. The application unit shall have electronic controls and a digital read out installed in and operated from the inside of the cab of the distributor. The distribution bar on the distributor shall be fully circulating. Any distributor that produces a streaked or irregular distribution of the material shall be promptly removed from use and repaired. Ancillary distributor equipment shall include a tachometer, pressure gauges, volume measuring devices, and a thermometer for reading the temperature of the tank contents. Spray bar controls, including controls for width and rate of product application, shall be located inside the cab of distributor. The distributor shall function in such a fashion that uniform applications may be made at the specified rate per square meter with a tolerance of plus or minus 0.05 gallons per square yard (0.2 liters per square meter).

A “bootman” shall accompany the distributor and ride in a position so that all spray bar nozzles are in his full view and readily accessible for unplugging.

5. Aggregate Spreader

A mechanical aggregate spreader shall be utilized to cast aggregate across the asphalt-rubber mixture applied to the work area. The aggregate spreader shall be hydrostatically driven and self-propelled. The aggregate spreader shall be equipped with a hydraulically controlled, variable, adjustable head that is capable of spreading stone in widths from 4.5 to 18 feet (1.4 to 5.4 meters). The aggregate spreader shall be mounted on pneumatic tires and shall apply the stone on the roadway surface in a manner that ensures that the tires do not contact the roadway surface until after the stone has been applied. The aggregate spreader shall be equipped with an electronic radar type sensor used to measure ground speed and automatically adjust the stone application rate depending on the prescribed width of application and speed of chip spreader. The aggregate spreader shall have the capability to apply stone on any grade from 0 - 8%. The aggregate spreader shall be equipped with an integral hopper with a minimum capacity of 5 tons (4.5 metric tons) of stone. The aggregate spreader shall be filled by hauling trucks in a manner such that the hauling truck tires do not come in contact with asphalt-rubber mixture treated road surfaces until the stone has been properly applied. To maintain continuous stone application, a self-locking truck hitch will permit towing of hauling trucks without stopping the aggregate spreader. The aggregate spreader shall be capable

of maintaining positive engagement over irregular terrain.

6. Pneumatic Tire Roller

Two (2) self-propelled, multiple-wheel, pneumatic tire rollers shall be utilized to compact the aggregate into the asphalt-rubber mixture. The pneumatic tire rollers shall weigh between 7 and 12 tons (6.5 and 10.9 metric tons). The pneumatic tire rollers shall have a minimum total compacting width of at least 4.67 feet (1.4 meters), a minimum tire pressure of 60 psi (414 kPa), and be equipped with a watering system.

7. Steel-Wheel Roller

One (1) self-propelled, 2-axle (tandem) steel-wheel roller shall be utilized to perform follow up and final rolling of the applied chip seal material. The steel-wheel roller shall weigh between 8 and 12 tons (7.3 and 10.9 metric tons) and be equipped with scrapers, wetting pads, and watering system. Single-unit combination pneumatic and steel drum-type rollers shall be considered acceptable for use with prior written notification to and permission from the Director.

D EXECUTION OF WORK

1. Seasonal and Weather Limitations

Chip sealing operations shall not be performed when weather conditions are unfavorable to obtaining a uniform spread of material. Chip seal operations shall proceed only when the roadway surface and atmospheric temperature are at least 50˚F (10˚C) and rising. Chip sealing operations shall not be performed on wet roadways or roadways with standing water present.

2. Traffic Control

Unless otherwise specified by the Director, roadways being treated shall be kept open to traffic at all times, with traffic discontinued on the lane being surface treated. Controlled traffic may be permitted as soon as the final layer is applied and rolled. A maximum speed of 20 mph (30km/h) should be maintained for a period of a minimum four (4) hours following completion of rolling and compacting operations.

3. Preparation of Work Area

Potholes, other areas of pavement failure, and major depressions in the existing roadway surface shall be repaired by the City prior to chip sealing operations. If required, the roadway surfaces to be treated shall also be crack sealed by the City prior to chip seal application.

The Contractor shall be responsible for all measures required to provide a thoroughly clean and dry pavement surface for chip seal application including vegetation removal and vacuum sweeping of the work area prior to the start of chip seal application. Preparation of the work area shall be performed immediately prior to the start of asphalt rubber mixture application for any given work area. All work areas shall be thoroughly cleaned via vacuum sweeping. Any areas within or adjacent to the work area that a vacuum sweeping truck cannot access shall be cleaned of debris material and excess aggregate through the use of a backpack style leaf blower. The Contractor shall assume ownership of all materials generated during preparation and sweeping activities and shall be responsible for removing such material from the project locations as well as its offsite disposal.

The Contractor shall be responsible for covering all utility castings prior to application of the asphalt rubber mixture as well as uncovering all castings after the aggregate is spread and completely compacted.

4. Asphalt Rubber Mixing and Reaction

a. Blending and Reaction

The percent of rubber in the asphalt rubber mixture shall be 20% (+/- 3%) by weight of total mixture (equal to the total weight of asphalt cement plus granulated rubber), as indicated by the mixture design for specific project requirements. The exact granulated rubber content shall be determined by the mix design submitted by the asphalt-rubber supplier and shall be based on laboratory testing performed by the supplier. The asphalt and rubber shall be combined and mixed together in a blender unit and reacted in the distributor for a period of time as required by the mix design. The temperature of the asphalt shall be between 350˚F and 425˚F (177˚C and 218˚C) at the time of addition of the granulated vulcanized rubber. The temperature of the asphalt-rubber mixture shall be maintained above 325˚F (163˚C) during the reaction period.

b. Delays

If a job delay occurs after full reaction of the asphalt rubber material, the material may be allowed to gradually cool as influenced by the local atmospheric temperature.

If the material is to be utilized later in the workday, the cooled asphalt rubber mixture shall be slowly reheated to a temperature equal to or below 375˚F (191˚C) immediately prior to application. An additional quantity of granulated rubber or additive not exceeding 3% by volume of the hot asphalt-rubber mixture may be added after reheating. Material mixed and reacted during a prior workday shall not be permitted for use.

c. Viscosity Confirmation

The viscosity of each blended load of asphalt rubber material shall be analyzed in the field by the Contractor using a Haake-type field viscometer. The viscosity of the final product immediately prior to application shall be in the range of 1,000 to 3,500 centipoise.

5. Asphalt Rubber Mixture Application

The asphalt rubber mixture shall be applied at a temperature of 338˚F to 419˚F (170˚C to 215˚C) and rate of 0.55 to 0.65 gallons per square yard (2.5 to 2.9 liters per square meter). The exact application rate shall be determined by the aggregate gradation, traffic volume, and pavement condition. Variations in material quantities due to fluctuations in application rates shall be made without adjustment to contract unit price.

All longitude joints created as part of the work shall be reasonably straight and parallel to the roadway centerline. Where any construction joint occurs, the joint edges shall be broomed back and blended so there no gaps between edges, all adjacent edge elevations are the equal, and the edges are free from ridges and depressions. Longitudinal joints shall be overlapped by 4 to 6 inches (10.2 to 15.2 centimeters).

During application, the Contractor shall take adequate measures to prevent marring and discoloration of adjacent pavements, structures, vehicles, foliage, or private property.

6. Aggregate Application

Aggregate application shall follow as close as possible behind the application of the hot asphalt rubber mixture. The asphalt rubber mixture shall not be spread further in advance of the aggregate spreader than can be immediately covered. Construction equipment or other vehicles shall not drive on the uncovered asphalt rubber mixture prior to aggregate application. The hot, pre-coated aggregate shall be spread uniformly across the applied asphalt rubber mixture by a self-propelled aggregate spreader at a rate of spread determined to be appropriate by the Contractor. The aggregate spread rate shall in the range of 30 to 40 pounds per square yard (16.3 to 21.7 kilograms per square meter). Any areas with insufficient aggregate shall be covered with additional material as necessary to satisfactorily complete the work.

7. Compaction and Rolling

Compaction and rolling operations shall commence immediately following the spread of aggregate. The Contractor shall utilize a minimum of three (3) rollers to compact the aggregate into the hot asphalt rubber mixture. Two of the rollers shall be pneumatic tire and one shall be steel- wheel. In order to embed the aggregate particles properly and firmly into the asphalt rubber mixture, the pneumatic-tired rollers shall perform a minimum of three coverages across the entirety of the work surface on which chip seal material was applied. A coverage shall be as many passes as are necessary to cover the entire roadway width being treated, with a pass being one movement of a roller in either direction. Following pneumatic tire rolling, a minimum of one coverage of the entirety of the work surface on which chip seal material was applied will be performed utilizing the steel- wheel roller. Water shall be applied to the tires or wheels as required to limit sticking of the asphalt-rubber and aggregate to the rollers.

8. Sweeping

Following the completion of compaction and rolling activities and adequate cooling of the roadway surface on which chip seal material was applied, all loose material shall be vacuum swept or otherwise removed. Vacuum sweeping will be done at a time and in a manner as to not displace, remove, loosen, or otherwise damage or degrade the embedded aggregate or the asphalt rubber mixture. The Contractor shall be responsible for all roadway sweeping prior and subsequent to chip seal application operations. Any areas within or adjacent to the work area that a vacuum sweeping truck cannot access shall be cleaned of debris material and excess aggregate through the use of a backpack style leaf blower. The Contractor shall assume ownership of all materials generated during preparation and sweeping activities and shall be responsible for removing such material from the project locations as well as its offsite disposal.

E MEASUREMENT AND PAYMENT

Payment for work under this item 491.1 and 491.2 shall be made at the unit contract price per square yard of chip seal material applied. The quantity of chip seal material actually applied during work activities shall be measured, verified, and recorded daily by the Director or their Designee and Contractor. Payment for work under this item shall be full compensation for furnishing all necessary personnel, labor, equipment, and materials required to satisfactorily complete the work including vacuum sweeping to prepare work areas, blending and reacting the asphalt rubber mixture, applying the asphalt rubber mixture and aggregate to the roadway surfaces to be treated, compaction and rolling activities, final sweeping, and transportation and disposal of material generated during all vacuum sweeping operations.

ITEM 491.1000 RUBBERIZED CHIP SEAL – 3/8”

ITEM 491.2000 RUBBERIZED CHIP SEAL – ½”

ITEM 492.0000 BONDED WEARING COURSE

A DEFINITIONS

The term Director [Superintendent, etc.] shall mean the Director of Public Works of the awarding authority.

The term Designee shall mean an employee of the awarding authority, designated by the Director.

The term Contractor shall mean a professional company contracted by the awarding authority to perform work under this agreement.

B DESCRIPTION

The Bonded Wearing Course consists of a warm polymer modified asphalt emulsion bond coat followed immediately with an ultra-thin hot mix asphalt wearing course. The tack coat is spray applied immediately prior to the application of the wearing course to produce a durable wearing surface that can be opened to traffic. The finished surface treatment has a minimum thickness of 1/2”. All pavement repairs, crack filling and joint filling, and

pavement preparation will be paid for under the appropriate items.

C MATERIALS

1. Mixture Requirements:

The contractor shall formulate and submit to the awarding authority, a job mix Formula (JMF) that satisfies the design general limits listed in the Mixture Requirements table below. The production tolerances customarily used by the awarding authority for HMA shall apply, but shall not fall outside the following gradation requirements.

Sieve Size	*% Passing*
3/4" (19 mm)	*-*
1/2" (12.5 mm)	*100*
3/8" (9.5 mm)	*95 – 100*
#4 (4.75 mm)	*40 – 60*
#8 (2.36 mm)	*21 – 34*
#16 (1.18 mm)	*15 – 26*
#30 (0.60 mm)	*10 – 20*
#50 (0.30 mm)	*7 – 16*
#100 (0.15 mm)	*5 – 10*
#200 (0.075 mm)	*4 – 7*
% PGB	*4.9 – 5.4*

*Note: All aggregate percentages are based on the total weight of the aggregate.

2. Asphalt Binder:

Use the appropriate performance graded binder, (PGAB), for the project's geographical location and design traffic level.

3. Coarse Aggregate:

The coarse aggregates selected should be those typically used for high performance surfaces. Coarse aggregates, such as crushed gravel, limestone, dolomite, sandstone, granite, chert, traprock, ore tailings, slag or other similar materials, or blends of two or more of the above may be acceptable. When coarse aggregates for these mixes are from more than one source or of more than one type of material, they shall be proportioned and blended to provide a uniform mixture.

	Test Method	*Value*
LA Abrasion Value, % loss	*AASHTO T96*	*30 max*
Soundness, % loss Magnesium Sulfate *or* *Sodium Sulfate*	*AASHTO T104*	*18 max* *12 max*
Flat and Elongated Ratio, % @ 5:1	*ASTM D-4791*	*10 max*
% Crushed, single face	*ASTM D-5821*	*95 min*
% Crushed, two or more crushed faces	*ASTM D-5821*	*85 min*
Cleanliness (% passing 0.60 mm, (#30))	*ASTM D-142*	*2 max*
*Resistance to stripping**	*ASTM D-3625*	*80 min *****

*Anti-Stripping agents may be required to provide resistance to stripping.
** If the awarding authority currently uses a higher value then that value shall apply.

4. Fine Aggregate:

The fine aggregate shall be 100% crushed and have a minimum sand equivalent of 50, (AASHTO T 176-86).

5. Mineral Filler:

Hydrated lime, fly ash, baghouse fines and cement are acceptable as mineral filler.

6. Bond Coat:

Use grade CRS-1P polymer modified asphalt emulsion meeting the requirements of AASHTO T208 except as modified in the below table. If latex is used, it is required that it be co-milled at the bulk emulsion facility, to ensure complete and balanced blending.

Property	*Test Method*	*Minimum*	*Maximum*
Elastic Recovery, 25°C	***AASHTO T301***	***65***	
Residue by Distillation, %	***AASHTO T59***	***63***	
Penetration of Residue, 25°C, 100g, 5 sec	***AASHTO T49***	***60***	***150***

E EQUIPMENT

The equipment used by the Contractor shall include, but not be limited to, one or more of the following:

1. Paving:

The self-priming paver must be capable of spraying the bond coat, applying the hot asphalt overlay and smoothing the surface of the mat in one pass, without equipment driving on or disrupting the bond coat, at a rate of 30-100 feet per minute. The self-priming paver must incorporate a receiving hopper, feed conveyor, insulated storage tank for emulsion, metered tack coat spray bar and a variable width, heated, ironing type screed. The screed must have the ability to be crowned at the center both positively and negatively and have vertically adjustable extensions to accommodate the desired pavement profile.

2. Roller:

Use steel wheeled double drum rollers, weighing at least 8 tons, that are equipped with functioning water systems and scrappers to prevent the fresh mix from adhering to the roller drums.

F CONSTRUCTION PROCEDURES

1. Streets to be Treated:

The Contractor and the Director shall mutually determine the streets which shall receive bonded wearing course treatment and necessary surface preparations. Measurements of streets to be treated shall be made by the Contractor and the Director or his/her Designee, and the Contractor shall prepare a cost estimate for each street prior to beginning work.

2. Staging and Disposal Locations:

The awarding authority shall provide a staging area for equipment and materials to be used on the project. The Contractor and Director shall mutually review and agree that the location is of adequate size and condition to allow for safe and secure usage for the required operation(s).

The awarding authority shall provide a location for disposal of asphalt/aggregate debris created in the adjustment of utility castings/structures, milling of keyways, and any pre- or post- project sweeping.

3. Surface Preparation:

All surface preparations shall be completed by the awarding authority prior to applying the surface treatment unless otherwise noted or bid as separate items.

The awarding authority shall be responsible for removal of all thermoplastic or other traffic markings as needed.

The Contractor shall clean and flush filling all cracks and joints greater than 1/4” wide.

The Contractor shall place a leveling course on planed, milled or existing surface.

The Contractor shall adjust all City-owned roadway castings/utility structures. If required, the City will coordinate the re-setting/adjustment of all non-City-owned utility structures with the various utility companies.

The Contractor shall cover all manhole covers, water boxes, gas boxes, catch basins and other such utility structures with plastic or building felt. Reference each for location and uncovering after application.

The Contractor shall cut keyways at limits of work and additional locations as directed by the Director to a sufficient depth to create smooth transitions and good ride quality.

The Contractor shall thoroughly clean the surface by sweeping immediately prior to application of the bonded wearing course. Prior to sweeping, the awarding authority shall have removed all vegetation and soil that is bound to the roadway surface.

The Contractor shall remove all standing water. A damp surface is acceptable if favorable weather conditions are expected during paving operations.

4. Weather Limitations:

The minimum pavement surface temperature for application of the bond coat and placement of the wearing course is 50°F.

5. Application:

Apply the bond coat at a temperature of 120°F - 170°F. Provide a uniform application across the entire width to be overlaid, at a rate of 0.15 - 0.25 gallons per square yard. Continuously monitor the rate of spray.

No equipment shall come in contact with the bond coat before the hot mix asphalt concrete wearing course is applied.

Immediately after applying the bond coat, apply the hot mix asphalt overlay across the full width of the bond coat at a temperature of 280°F - 335°F.

6. Compaction:

Begin compaction immediately after the application of wearing course. Use a minimum of two (2) passes. The roller(s) will not be allowed to stop on the freshly placed wearing course. Use an adequate number of rollers to complete compaction before the pavement temperature falls below 185°F. Protect the wearing course from traffic until the rolling operation is complete and the material has cooled sufficiently to resist damage.

7. Traffic Control:

All Traffic Control to be provided by the Awarding Authority.

G PERFORMANCE

The Awarding Authority will not award this contract unless the Contractor furnished satisfactory evidence of his/her ability and experience to perform this work, and that he/she has sufficient capital and equipment to enable him/her to prosecute the work successfully and to complete it within the time named in the contract. The Contractor shall not sublet any portion of this contract, and will own all equipment used to complete such contract. As part of the bid, the Contractor must submit a list of two (2) similar and successfully completed municipal bonded wearing course jobs from each of the last five (5) years, whose relevance to the proposed job shall be deemed by the awarding authority. The name, address, and telephone number of a contact person involved with each of these projects must be included so they can be investigated prior to the award of the contract. It will be the responsibility of each bidder to visit the job site with the Director. The awarding authority can reject any bid of a contractor who has not visited the work site.

H METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Payment for work under this agreement shall be made at the contract unit price per square yards times the number of square yards, measured by the Contractor and the Director or his/her designee, of road surface treated. Price per square yard shall be for complete in place quantities. Upon completion of work, and acceptance by the Director, the Contractor shall submit a payment request to the Director. Payment shall be net thirty (30) days.

I GUARANTEE

Any material or workmanship found to be defective for up to one (1) year from the date of acceptance by the Director shall be replaced by the Contractor at no cost to the awarding authority. Upon notification of defective

material or workmanship, the Contractor shall immediately replace such defective areas.

Yellow highlights: Review/edit text. Remove awarding authoritys responsibilities?

ITEM 493.0000 FOG SEAL – EMULSIFIED ASPHALT TREATMENT

A GENERAL

The work to be done under this item shall confirm to all relevant provisions of MassDOT Standard specifications.

The Contractor shall furnish all materials, equipment, labor, and preparation necessary for traffic control and the application of a light coating of asphalt emulsion containing a rejuvenating agent to asphalt pavement for the primary purpose of slowing the oxidation, raveling, and other damage caused to unprotected asphalt pavements either as specified on the plans and/or as directed by the Engineer.

The City of Worcester nor City of Worcester DPW provides Contractor with locations for stockpiles or laydown area. Contractor shall be fully responsible for finding an approved and safe location for equipment, materials, if necessary. Straw waddles and silt sacks of an approved type, and in a sufficient number, shall be satisfactorily placed around and in all catch basins which lie 'downstream' from the stockpile site primarily to prevent any rain generated sludge from entering into the drainage system. Further, any stockpile sites shall be thoroughly cleaned and fully restored to their original condition, at the Contractors own expense, once the stockpile site is no longer needed to service the operational zone for which they were created.

The City of Worcester DPW or Water Department shall not provide water to Contractor from hydrants. Contractor is responsible for bringing their own water, if necessary. If contractor wishes to use City of Worcester Water, no water is to be drawn from any City hydrant until such time as the Contractor has posted a $1000 deposit with the DPW Water Department and has obtained in return a water meter assembly equipped with a backflow preventer. Any water drawn for any operation under this contract is to be metered through this unit. At the end of the Fog sealing application, and providing that the water meter/backflow preventer unit has been returned to the Water Department complete and in good working order, then the deposit shall be refunded to the Contractor by the DPW Water Department. Any unauthorized use of city hydrants will result in immediate project shutdown and notifications to DPW management, Permits, and Water Department will be made.

B EQUIPMENT

Provide applicable equipment in accordance with City of Worcester and MassDOT Standards:

Equipment, tools, and machines used in the performance of this work shall be maintained in satisfactory working condition at all times to ensure a high quality product. The Engineers decision in these matters shall be final.

The emulsion shall be applied with a computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spreader bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour or seven hundred (700') feet per minute. Before use the equipment must be tested under pressure for leaks to ensure it is in good working order.

The distributor truck shall be equipped with a 12 'foot minimum, spreader bar with individual nozzle control. The distributor truck shall be capable of specific application rates in the range of 0.05 to 0.25 gallons per square yard. These rates shall be computer-controlled rather than mechanical. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy.

Distributor trucks shall be equipped to effectively heat and mix the material to the required temperature prior to application. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Care shall be taken not to overheat or over-mix the material.

The distributor shall be equipped to hand-spray the emulsion in areas identified either on the plans or by the Engineer, or not accessible to the distributor truck itself.

The asphalt distributor truck shall be equipped with an aggregate spreader mounted to the distributor truck that can apply sand to the emulsion in a single pass operation without driving through the wet emulsion. The aggregate spreader shall be equipped with a variable control system capable of uniformly distributing the sand at the specified rate at varying application widths and speeds. The sander shall have a minimum hopper capacity of at least 3,000 pounds of sand. Push-type hand sanders will be allowed for use around lights, signs and other obstructions.

Any haul trucks, tri-axels, dump trucks, or other vehicles used for transportation of materials shall be clean and free of dirt, debris, and other materials.

The Contractor shall provide proof of calibration of the asphalt distributor and the aggregate spreader if aggregate is applied to the fog seal. Calibration shall be conducted no earlier than 5 days prior to operations. The Contractor shall submit results of calibration procedure to Engineer. Flow from each nozzle in the asphalt distributor must be uniform average flow.

City reserves the right to request a distributor test report less than one year old and to witness any calibration testing.

C PERFORMANCE OF WORK

The Contractor shall be ultimately responsible for ensuring that the roadway surface is thoroughly clean, dry, and free of all vegetation and granular material(s) prior to the application of the Fog sealing material. It is the Contractor's responsibility to ensure the roadway surface is totally cleaned and properly prepared and all surfaces shall be cleaned to the satisfaction of the Engineer. The Contractor shall clean any muddy or dirty areas by flushing with water. Allow surface to dry completely prior to applying asphalt emulsion.

All businesses, homes and/or City agencies that will be, and/or may potentially be affected by any aspect of the Fog sealing operations within job limits, shall be notified. The Contractor is to obtain pre-approval and subsequently apprise the Engineer of all such postings, notices, and/or notifications in advance of the actual notification process. Contractor shall request official construction flyer from Engineer and distribute flyers to all businesses, homes, agencies, in the limits of work two weeks before expected start date, one week before expected start date, and two days before expected start date. Distribution of flyers are to be done by Contractor. All materials for flyer notification are to be paid for by the Contractor. Notices that are posted at businesses and/or homes along the route shall be left in a secure but highly visible location that is nearest to the regular mail delivery as possible at each address. In addition, any general notices that are posted along the street, and which are placed on existing posts and poles, are not to be fastened with any metal device. Further, no signs are to be fastened to trees in such a way that the bark of the tree is penetrated and/or damaged by the fastening means, thus only string and/or plastic 'quick-ties' are to be used, and no posting upon trees is to take place without the prior consent of the Engineer. All temporary signs are to be removed immediately upon the completion of the Fog sealing operation which is particular to that portion of the project zone.

Any roadway areas that show signs of distress or damage that are in need of repair in order for Fog seal to properly work must be repaired by Contractor. This can include but not limited to structure adjustments, shimming, drainage improvements (possible structure and pipe installations), curb work, and roadway and driveway grading and/or paving.

Traffic control elements (cones, barrels, signs, etc.) shall be of the highest quality with the visibility target value still substantially intact, and such traffic control elements shall comply with the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD), the directives as shown on the plans and/or as may be otherwise directed by the Engineer. Traffic control elements shall be provided in such number and shall be subsequently deployed by the Contractor to the satisfaction of the Engineer, to ensure that vehicular and pedestrian traffic is properly and safely warned and/or channelized at all times in and around the project site and operations area(s). These same suitable methods shall be used by the Contractor to protect the Fog sealing from traffic until the new surface can support traffic without damage.

The material shall be spread only on an initially dry and clean roadway surface and the atmospheric temperature is at least 48 degrees Fahrenheit and rising, and there is no threat of rain and/or temperatures below 32 degrees Fahrenheit or above 140 degrees Fahrenheit predicted within 24 hours of the application of the Fog sealing material. Said weather conditions shall be based upon predictions as professionally forecast.

The Contractor shall follow the construction methods as described. Target application rates for the emulsion shall be in the range of 0.06 to 0.15 gallons per square yard as established by the Engineer after spraying a test strip or strips with varying application rates in order to determine the optimum rate to achieve coating without runoff or delayed curing times. Target application rate for the aggregate shall be 0.5 pounds per square yard, also as established by the Engineer after spraying the test strip(s). Apply the asphalt emulsion at the target rate(s) established during the test strip. Maintain the asphalt emulsion temperature from 120 to 160 degrees Fahrenheit during construction, including the start of each day. Reheat the asphalt emulsion at a rate of no more than 25 degrees Fahrenheit per hour whenever the asphalt emulsion is allowed to cool below 110 degrees Fahrenheit. If the target application rates are not the optimum application rates to achieve proper coating of the existing or newly constructed pavement surface, or if the break time is too long or too short, immediately notify the Engineer. Adjust

and document the new application rate by stationing. Do not allow the asphalt emulsion to streak on the road surface. If the Engineer determines that streaking is occurring, cease operations until the Engineer is satisfied that streaking has been eliminated. Apply the asphalt emulsion to all exposed areas of asphalt surface as directed by the Engineer.

During the application of the fog seal, ensure there are no deficiencies in the fog seal, resulting from poor workmanship, flushing, tracking from equipment, surface patterns, and sweeping. Inspect workmanship for untreated areas, minimum overlap on longitudinal joints, and minimum overlap on construction joints.

Verify the following for daily acceptance:

· Fog seal edges are neat and uniform along the roadway lane, shoulder and curb lines.

· Fog seal has no surface patterns such as lean or heavy lines.

· Fog seal has no bleeding/flushing areas.

· Fog seal uniformly covers all portions of the asphalt surface

· Blotter sand is broadcast uniformly and at the proper rate.

Utility castings shall be protected from damage during construction processes. Any casting damaged by the Contractor shall be replaced at no cost to the City. All drainage structures shall be protected from spoils and cleaned after construction has been completed, to the satisfaction of the Engineer. Work included for protecting and cleaning structures is considered incidental to its respective items and no additional payments will be made. If work is to be performed in the vicinity of bodies of water, proper erosion controls will be required.

Contractor is responsible for all temporary and permanent striping and line painting that is removed or covered during Fog sealing. Contractor shall make note of existing crosswalks, legends, stop bars, lane lines and replace in kind. Temporary line painting will be required via the use of a waterborne paint. All striping and line painting work is to be done at the Contractor's expense.

Contractor shall be responsible for entire clean up of all Fog seal locations. This includes removal of all equipment, materials, and signage. Contractor shall ensure any and all loose material or spills are entirely removed from locations following completion. Contractor shall repair any damage caused by Contractor or subcontractors during work.

D MATERIALS

Rejuvenating asphalt emulsion, CMS-1PF, shall contain a polymer and conform to the following specifications. The emulsion shall be certified as meeting this specification from the manufacturer and shall not be diluted prior to application.

Property	Test Procedure (AASHTO)	Specification (min)	(max)
Emulsion Properties			
Viscosity, Saybolt-Furol, @ 77°F, SFS	T59	10	100
Storage, 24 hours, %	T59		1
Oil Distillate, %	T59		0.5
Sieve Test, %	T59		0.1
Residue by Distillation(1) @350°F, % Residue by Distillation, % by weight	T59	30	
Residue Properties From Distillation	T59		
Penetration @ 4C, 200g weight, 60 sec Residue by Distillation, % by weight	T49	30	
Residue Properties From Low Temp Evaporation	PP72-11, Procedure B		
Dynamic Shear, G*/sin @ 64oC, kPa	T315	Report Only	
Polymer Properties			
Swelling in rejuvenating agent, % max weight increase: 48 hrs.	ASTM D471 (2)		40%
Tensile Strength (psi)	ASTM D412a (3)	800	
Glass Transition Temperature (Tg) – Midpoint by DSC (°C)	ASTM D7426 (4)	0	
Latex Density at 23°C (g/cm3)	ASTM D6937 (5)	1.00	1.05
Latex pH	ASTM E70 (6)	6.0	8.0
Test on Rejuvenating Agent			
Flash Point, COC, °F	T48	380	
Viscosity, 140°F, CST	201	50	175
Saturate, % by wt	ASTM D2007		30
Asphaltenes	ASTM D2007		1.0
Test on Residue			
Weight Change, %			6.5
Viscosity Ratio			3

Exception to AASHTO T59: Bring the temperature on the lower thermometer slowly to 350°F plus or minus 10°F. Maintain this temperature for 20 minutes. Complete the total distillation in 60 plus or minus 5 minutes. Polymer Testing, Resistance to Swelling: Using a syringe, place 0.8 gm of latex into a 18 mm diameter DSR mold. Allow the sample to dry at ambient lab conditions (air conditioned) on the bench for 72 hours. Sample should be easily removable from the mold. Take the "button" out of the mold and place the sample into a forced air oven at 40°C (104°F) for 48 hours (on release paper). If at the end of the ambient dry, the sample sticks to the mold, place it into the oven and check it after 1-2 hours. After 48 hours, cool and weigh the sample to the nearest 0.0001 gram and record the weight. Put ½ inch of Rejuvenating Agent into a 3 oz. penetration tin. Place the "button" on the Rejuvenating Agent, and add another ½ inch Of Rejuvenating Agent, so that the "button" is covered.

Put the cap on the penetration tin and place it into the 40°C oven for 48 hours. Remove the "button" from the Rejuvenating Agent, blot surface of the "button" to remove excess Rejuvenating Agent, cool the "button" to room temperature and weigh it. Calculate weight gain of the "button", express as a %

To prepare the polymer film, dilute the waterborne polymer to 40% Total Solids Content and pour 57 g into a Teflon or silicone release mold of dimensions 7" X 7" X ¼". Allow to dry at 23°C (73 °F) and 50% RH (controlled conditions) for 7 – 10 days total time, during which time the film should be flipped around once, preferable after 3 or 4 days. The film should be transparent in the end. To drive out any residual water, place the film in an oven at 50°C for 30 min. Dried film thickness should be 25 mil +/- 5 mils. Discard films <20mil. Cut out dumbbell-shaped test specimens of dimension 75 mm total length, 25 mm mid-section (L) and 4 mm width of mid-section. Grip in Instron machine with gap size 1 inch, use 8 inch/min cross-head speed.

-Use between 3 – 30 mg dry polymer. Instrument used is TA Q2000Differential Scanning Calorimeter (DSC). Heating

rate is 20°C/min.

-Replace “Emulsified Asphalt” with “Latex” in text of test method. The testing temperature used should be 25 +/- 3°C. The calculation should be as follows:

D = (Wf –Wt) *0.1

S.G. = D/8.337

Where: Wf = Weight of filled cup (g), Wt = Weight of empty cup (g)

A pH meter with automatic temperature measurement should be used in the evaluation with a calomel cell assembly or combination electrode. Calibration should be made using the procedure with the pH meter, according to ASTM method, prior to testing the pH of the latex. In Section 9, the procedure for measuring pH of the latex should be as follows:

- Place the electrode and probe into the dispersion that is to be measured and swirl the sample cup or beaker gently. (You may also use the probe in a stirring motion.)

- Wait for the reading to stabilize (usually less than a minute) and read/record this value. Note the temperature if not utilizing an ATC probe.

- Take the Electrode and ATC probes from the sample and rinse thoroughly with deionized water. Pat dry and place back into appropriate solution recommended by electrode manufacturer for storage.

The aggregate material shall be a dry, clean, dust and dirt-free, sound, durable, angular shaped manufactured specialty sand, such as that used as an abrasive (i.e., trade name “Black Beauty”), with a Mohs hardness of 6 to 8. The Contractor shall submit manufacturer’s technical data and a manufacturer’s certification indicating that the specialty sand meets the requirements of the specification to the Engineer prior to start of construction. The sand must be approved for use by the Engineer and shall meet the following gradation limits.

Sieve Size	% Retained
No. 8 (2.38 mm)	0
No. 16 (1.19 mm)	0-10
No. 20 (0.84 mm)	0-25
No. 30 (0.60 mm)	15-50
No. 40 (0.42 mm)	20-45
No. 50 (0.30 mm)	5-35
No. 70 (0.21 mm)	0-5
No. 200 (0.07 mm)	0-2

The emulsion manufacturer, through the Contractor, shall submit to the Owner certified test results that the emulsion meets the specification. The polymer manufacturer and the rejuvenating agent manufacturer, through emulsion supplier and the Contractor, shall submit to the Owner certified test results on the polymer and the recycling agent that meets the required specifications. The Owner will not accept test results dated more than 90 days from the date of bid opening.

Certifications and test results on the emulsion must be submitted to the Owner and approved by the Owner 5 days prior to supplying material.

Laboratories shall be independently operated and shall not be under the control of the Contractor. Further,

laboratories shall be pre-approved by the Engineer in advance of all testing and/or mix design procedures, and upon request said laboratories are to submit to the Engineer evidence which satisfactorily ensures their qualifications to meet both the testing and/or the mix design needs of the project.

At least fourteen days prior to the commencement of operations the Contractor is to submit to the Engineer, in hard-copy form, a signed list which includes the vendors name and address, the component material(s) which will be supplied by the vendor, and a certificate of compliance which clearly states that the mixture component they are supplying to this project will and shall meet or exceed the design mix criteria for the duration of this project. Once the laboratory, the design, the materials, and/or the vendors have been approved there shall be no substitution unless otherwise allowed and/or otherwise directed to do so by the Engineer. In any event the Contractor shall repair, at his own expense, any surface failure(s) which occur for any reason within one (1) year's time from the date of application, and the Engineers decision as to what constitutes a failure of the Fog sealing shall be final and all subsequent repairs shall be made to Engineer's satisfaction at Contractor's expense.

E MEASUREMENT AND PAYMENT

This Item will be paid at the contract unit price bid per square yard for application of Fog Seal material, complete in place, which unit price shall include full compensation for labor, materials, tools, and equipment including cleaning of roadways, providing and establishing all traffic control elements, establishing/re-establishing detouring, notifications, and all other incidentals that are necessary to complete the work under this item in accordance with the plans, as directed by the Engineer, and as specified herein.

SECTION 500 - TRAFFIC

Items 501 through 504 shall conform to specifications on file for Retroflected White and Yellow and Black Lead Free Hot-Applied Thermoplastic Marking Materials at the Department of Transportation & Mobility and the Contractor shall provide all labor, material and equipment for the complete application of the item as shown on the drawings and described in these specifications at the unit price as bid and as shown in the proposal.

ITEM 501.0000 6" REFLECTORIZED WHITE LINE (THERMOPLASTIC)

ITEM 502.0000 4" REFLECTORIZED YELLOW LINE (THERMOPLASTIC)

ITEM 503.0000 12" REFLECTORIZED WHITE LINE (THERMOPLASTIC)

A. *MATERIALS*

The materials used for this section shall conform to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and Pavement Markings.

B. *EXECUTION*

SURFACE PREPARATION

The pavement shall be dry and free of sand, grease, oil or other foreign substances. Bituminous concrete shall have been in place for at least 48 hours prior to paint application.

APPLICATION

In accordance with the manufacturer's specification and with good painting practices, markings shall be applied at locations and at specified dimensions as designated on the drawings.

All applicable requirements of Section 860 (MSSHB) shall be met for work in this section. PROTECTION

The Contractor shall protect pavement markings until sufficiently dry to bear traffic. Cones or like barriers shall be used to protect markings.

C. *MEASUREMENT AND PAYMENT*

Item 501, 502, and 503 are paid for by the linear foot. The price shall include all work necessary to successfully perform all tasks associated with these specifications and to the satisfaction of the Contracting Officer and the Department of Transportation & Mobility

ITEM 504.0000 PREFORM THERMOPLASTIC PAVEMENT LEGENDS & SYMBOLS (THERMOPLASTIC)

A. *MATERIALS*

The materials used for this section shall conform to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and Pavement Markings. The materials used for this section shall conform to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and

Pavement Markings. Pre-cut ENNIS-FLINT® by PPG PREMARK® or approved alternative shall be used for all symbols or legend pavement markings installed on the public way or City owned parking lots. Material shall include factory-applied surface and intermix beads to ensure uniform distribution.

B. *EXECUTION*

SURFACE PREPARATION

The pavement shall be dry and free of sand, grease, oil or other foreign substances. Bituminous concrete shall have been in place for at least 48 hours prior to paint application.

APPLICATION

In accordance with the manufacturer's specification and with good painting practices, markings shall be applied at locations and at specified dimensions as designated on the drawings. A manufacturer's recommended sealer is required when applying PreMark material on concrete surfaces and for large, multi-colored specialty markings and colorized lanes. accordance with the manufacturer's specification and with good painting practices, markings shall be applied at locations and at specified dimensions as designated on the drawings.

PROTECTION

The Contractor shall protect pavement markings until sufficiently dry to bear traffic. Cones or like barriers shall be used to protect markings.

C. *MEASUREMENT AND PAYMENT*

Item 504 are paid for each. The price shall include all work necessary to successfully perform all tasks associated with these specifications and to the satisfaction of the Contracting Officer and the Department of Transportation & Mobility

Items 505 through 508 shall conform to specifications on file for "Retroreflective White and Yellow and Black Lead Free Waterborne Pavement Marking Materials" at the Department of Transportation and Mobility and the contractor shall provide all labor, material and equipment for the complete application of the item as shown on the drawings and described in these specifications at the unit price and as shown in the proposal.

ITEM 505.0000 6" REFLECTORIZED WHITE LINE (WATERBORNE)

ITEM 506.0000 6" REFLECTORIZED YELLOW LINE (WATERBORNE)

ITEM 507.0000 12" REFLECTORIZED WHITE LINE (WATERBORNE)

ITEM 508.0000 PAVEMENT ARROW/LEGEND REFLECTORIZED WHITE (WATERBORNE)

A. *MATERIALS*

The materials used shall be chlorinated rubber zone marking paint that complies with TTP 115-E TYPE III / AASHTO M 248 TYPE N & PERFORMANCE OF A-A-2886 B. The materials used for this section shall additionally conform to the applicable portions of Section M7.01 Pavement Markings (MSSHB). Use of these materials are for temporary purposes only, pending installation of permanent thermoplastic markings, and at the discretion of the Department of Transportation & Mobility.

B. *EXECUTION*

SURFACE PREPARATION

The pavement shall be dry and free of sand, grease, oil or other foreign substances. Bituminous concrete shall have been in place for at least 48 hours prior to paint application.

APPLICATION

In accordance with the Manufacturer's Specification and with good painting practices, markings shall be applied at locations and at specified dimensions as designated on the drawings. All applicable requirements of Section 860 (MSSHB) shall be met for work in this section. Glass beads shall be added to the wet material at the time of installation.

PROTECTION

The Contractor shall protect pavement markings until sufficiently dry to bear traffic. Cones or like barriers shall be used to protect markings.

C. *MEASUREMENT AND PAYMENT*

Items 505, 506, and 507 are paid for by the linear foot. Item 508 shall be paid per each. The price shall include all work necessary to successfully perform all tasks associated with these specifications and to the satisfaction of the Contracting Officer and the Department of Transportation & Mobility. Texturized Synthetic Pavement shall be paid for at the Contract unit price per square yard in place, which price shall include all labor, materials, equipment and incidental costs required to complete the work as described above and to the satisfaction of the Engineer. Saw cutting and milling of the asphalt pavement will be considered incidental to this item. No separate payment will be made for the preparation of the "mockup", shop drawings or attendance of the manufacturer's representative during construction. All costs in connection with these shall be included in the unit price bid. Saw cutting and milling of the asphalt pavement will be considered incidental to this item.

ITEM 509.0000 BICYCLE LANE MARKINGS

ITEM 509.0100 BIKE LANE SYMBOLS

ITEM 509.0200 SHARED LANE SYMBOLS

A. *MATERIALS*

The materials used for this section shall conform to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and Pavement Markings. Pre-cut ENNIS-FLINT® by PPG PREMARK® or approved alternative shall be used for all symbols or legend pavement markings installed on the public way or City owned parking lots. Material shall include factory-applied surface and intermix beads to ensure uniform distribution.

B. *EXECUTION*

SURFACE PREPARATION

The pavement shall be dry and free of sand, grease, oil, or other foreign substances. Bituminous concrete shall have been in place for at least 48 hours prior to paint application.

APPLICATION

In accordance with the manufacturer's specification and with good painting practices, markings shall be applied at locations and at specified dimensions as designated on the drawings. A manufacturer's recommended sealer is required when applying PreMark material on concrete surfaces and for large, multi-colored specialty markings and colorized lanes.

PROTECTION

The Contractor shall protect pavement markings until sufficiently dry to bear traffic. Cones or like barriers shall be used to protect markings.

C. *MEASUREMENT AND PAYMENT*

Item 509.01 and 509.02 are paid for per each. The price shall include all work necessary to successfully perform all tasks associated with these specifications and to the satisfaction of the Contracting Officer and the Department of Transportation & Mobility.

ITEM 509.0300 HIGH FRICTION GREEN BIKE BOXE MARKINGS

ITEM 509.0400 HIGH FRICTION GREEN TWO-STAGE LEFT TURN QUEUE BOXE MARKINGS

ITEM 509.0500 HIGH FRICTION GREEN ELEPHANT FEET CROSSING MARKINGS

A. *MATERIALS*

The materials used for this section shall conform to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and Pavement Markings. Pre-cut ENNIS-FLINT® by PPG PREMARK® Bike Lane Green with ViziGrip® high skid surface enhancement, or approved alternative, shall be used for all bike boxes, two-stage left turn queue boxes, and elephant feet crossings installed on the Public Way. Material shall include factory-applied surface and intermix beads to ensure

uniform distribution

ITEM 509.0600 HIGH FRICTION GREEN BIKE LANE MARKINGS

A. MATERIALS

The materials used for this section shall conform to the applicable portions of MassDOT 2023 Standard Specifications for Highways and Bridges Division III Section M7 Paints, Protective Coatings, and Pavement Markings. High friction MMA green surface for bike lanes shall be MMAX colored green with corundum by Ennis-Flint or approved alternative, installed on the Public Way. Material shall include factory-applied surface and intermix beads to ensure uniform distribution.

B. EXECUTION

SURFACE PREPARATION

The pavement shall be dry and free of sand, grease, oil, or other foreign substances. Bituminous concrete shall have been in place for at least 48 hours prior to paint application.

APPLICATION

In accordance with the manufacturer's specification and with good painting practices, markings should be applied at locations and at specified dimensions as designated on the drawings. A manufacturer's recommended sealer is required when applying PreMark material on concrete surfaces and for large, multi-colored specialty markings and colorized lanes.

PROTECTION

The Contractor shall protect pavement markings until sufficiently dry to bear traffic. Cones or barriers shall be used to protect markings.

C. MEASUREMENT AND PAYMENT

Item 509.06 green materials are paid for per linear foot. The price shall include all work necessary to successfully perform all tasks associated with these specifications and to the satisfaction of the Contracting Officer and the Department of Transportation & Mobility.

ITEM 512.0000 PULL BOX 8"X23" (SD2.030)

ITEM 513.0000 PULL BOX 12"X24" (SD2.031)

A. GENERAL

Work to be done under these items shall conform to the relevant provisions of Section 800 (MSSHB) and the following:

The 8"x23" pull boxes shall have the word "W.D.P.W." stamped on the covers; the 12"x24 " pull boxes shall have "TRAFFIC" stamped on the covers and be used only for the interconnection cable.

B. MEASUREMENT AND PAYMENT

The pay item for this work shall be Pull Boxes (complete in place) including all excavation, trimming or cutting of existing concrete or bituminous concrete, backfill, and placing of concrete or bituminous SUPERPAVE bituminous concrete collar. All labor; equipment, tools, and incidental expenses required to locate, maintain in proper working order, and set to finish grade.

ITEM 519.0000 MOBILE LIGHTED VARIABLE MESSAGE BOARD

A. GENERAL

All message boards shall conform to NEMA TS 4-2005 Section 2 and MUTCD specifications. All boards shall have at a minimum three lines of available text and be able display a minimum of three different screens.

Deployment of the message board(s) will be in the direction of the contracting officer. All boards must have the ability to be programmed in the field. All messages to be displayed will be approved by the contracting officer prior to deployment.

Additional time required for the boards to remain on site, due to the contractor's schedule, will result in

nonpayment for those days. The boards will remain in place, operational and maintained, until the top course of asphalt is complete.

B. *MEASUREMENT AND PAYMENT*

Payment for the item shall be paid per day for each board while in use.

ITEM 520.0000 WARNING AND REGULATORY SIGNS

A. *GENERAL*

All traffic signs must conform to the 2023 Manual of Uniform Traffic Control Devices (for Conventional Roads) and the MassDOT Standard Specifications for Highways and Bridges for type and size. All regulatory and warning signs shall conform to the MUTCD specifications for size and type.

Regulatory and warning signs shall be 0.08” aluminum with high intensity prismatic reflective sheeting. Parking signs shall be engineer-grade retro-reflective sheeting on 0.08” aluminum.

WRTA bus stop signs, when applicable, will be provided to the Contractor. Signs that have been removed for replacement shall be delivered to the Street Operations Traffic Division at 26 Albany Street.

Special "Private Street Dangerous" and "Not a Thru Street" blades are 6" aluminum extruded with 3" all uppercase letters, with the same materials used for street name blades.

B. *METHOD OF CONSTRUCTION*

All hardware for Warning and Regulatory signs shall be aluminum cantilever side mounts or aluminum post caps for top mounts. The Contractor is responsible to provide stainless steel banding, brackets, buckles and bolts for the installation of such materials. All banding materials shall be 1/2".

C. *MEASUREMENT AND PAYMENT*

Payment for this item shall be paid per each.

ITEM 521.0000 TYPE "A" STREET NAME SIGNS

A. *GENERAL*

Type "A" street name sign blades (used exclusively on traffic signal mast arms) shall be 12" aluminum rounded corner sign blades with 8" uppercase and 5.5” lowercase lettering (Colors: scotch lite white for letters and 0.5” border, green background). The font shall be Times New Roman with a width factor of between 0.5 and 0.7. In no event shall the length of the sign exceed 72”. In special cases of long street names, alternate abbreviations or exceptions to the font width factor may be granted by the Director of Engineering. Type

"A" signs shall contain a 7.5" solid red heart with 0.25” silver border positioned before the street name verbiage with block number located in the upper right corner of the street name sign. The name suffix shall be 4” high, located in the lower right corner of the sign, and abbreviated (St, Rd, Ave, Blvd, Ct, Pkwy, Cir, etc.). All signs shall be single sided and all materials covering the sign blade and all letters shall be high intensity grade material.

B. *METHOD OF CONSTRUCTION*

Type “A” signs shall be mounted to mast arms or signal masts with stainless steel banding, buckles, brackets, and bolts.

C. *MEASUREMENT AND PAYMENT*

Payment for this item shall be paid per each.

ITEM 522.0000 TYPE "B" STREET NAME SIGNS

A. *GENERAL*

Type "B" street name sign blades shall be 9" aluminum extruded sign blades with 6" uppercase and 4.5” lowercase letters (Colors: scotch lite white for letters, green background). The font shall be Times New Roman with a width factor of between 0.5 and 0.7. In no event shall the length of the sign exceed 48”. In special cases of long street names, alternate abbreviations or exceptions to the font width factor may be granted by the Director of Engineering. A red 5” heart with a 0.25” silver border shall be placed before the street name. The name suffix shall be 3” high and abbreviated (St, Rd, Ave, Blvd, Ct, Pkwy, Cir, etc.). All signs shall be doubled sided and all materials covering the sign blade and all letters shall be high intensity grade material.

B. METHOD OF CONSTRUCTION

All hardware for Type "B" signs shall be aluminum cantilever side mounts or aluminum post caps for top mounts. The Contractor is responsible to provide stainless steel banding, brackets, buckles and bolts for the installation of such materials. All banding materials shall be 1/2".

C. MEASUREMENT AND PAYMENT

Payment for this item shall be paid per each.

ITEM 523.0000 TRAFFIC SIGN POLES

A. GENERAL

All traffic sign poles shall be 2 inch black (Paint/Powder coat finish) quick punch square galvanized poles. All poles shall be secured to 2 1/4-inch galvanized anchors extending no more than 6 inches above finished grade of sidewalk or tree lawn (Hardware shall consist of 5/16 " zinc plated corner bolt fastened with an acorn nut.) Pole and anchor system shall comply with breakaway requirements in the MUTCD.

Portions of anchors extruding above the ground surface shall be sprayed black in the field.

All street name signs will be mounted on top of pole with a top mount bracket and or by means of a cantilever bracket. Signs shall be parallel to corresponding street. Signs in excess of 36" long, mounted with a cantilever bracket, shall be mounted with a bracket extension.

All pole assemblies without top mounted signs will be fitted with 2" Rain Caps. Bottom of lowest sign on pole shall be installed 7’ above sidewalk or ground surface.

B. METHOD OF CONSTRUCTION

All traffic sign poles shall be installed in a 12" x 12" cement concrete foundation, with a minimum depth of 2 feet. This installation process shall be used for all types of bituminous concrete sidewalks or loam borders. In cement concrete sidewalks the Contractor shall install pre-molded bitumastic filler.

The traffic sign pole shall be centered in the foundation with a minimum of 7'-0" distance from the finished surface to the bottom of the sign and not less than 18" from the edge of the curbing. Poles that have been removed for replacement shall be disposed by the Contractor.

If warning and regulatory and/or type “B” signs are to be reused on a new pole, under this item, those signs will be reinstalled on the new traffic pole at no cost to the City of Worcester.

C. MEASUREMENT AND PAYMENT

Payment for this item shall be paid per each.

ITEM 526.0000 PARKING METERS

A GENERAL

All parking meters shall be the STRADA PAY STATION by FlowBird.

B EXECUTION

Installation of the parking meter shall be in the location indicated in the plan or at the direction of the Contracting officer. Installation shall comply with the manufacturer's requirements including placement on the specified concrete pad

C MEASUREMENT AND PAYMENT

The work under Item 526 Parking Meters will be paid per each installation complete in place.

ITEM 530.0000 POLE PAINTING

A. LABOR SPECIFICATIONS

1. The Contractor is to supply all labor and materials including paint, brushes, rollers, scrapers or other materials needed to adequately paint the city poles (Spray cans will not be allowed).
2. Brush and any other debris will be removed from around the pole to an approximate 2-foot radius around the pole if required. Any brush, rollers and debris to be debris to be disposed of will be placed

in the back of the truck and disposed of by the Contractor at his expense in an approved manner.

3. A “skirt” or other type of covering shall be laid on the ground around the base of the pole to prevent paint from splattering on the ground or sidewalk.
4. Any loose paint will be scrapped from the pole using a wire brush. Paint chips will be cleaned or removed from around the pole.
5. The paint to be used will be a glossy black rust inhibitive enamel.
6. Painting will only be done under temperature and/or weather conditions as per the recommendations of the paint manufacturer.
7. All left over paint, paint cans or painting supplies, such as brushes, rollers and rags, shall be disposed of by the Contractor at his expenses in a pre-approved manner that complies with all regulations pertaining to hazardous materials.

B. *MEASUREMENT AND PAYMENT*

The work under this item will include all materials and labor necessary to complete the work as specified herein.

The pay item will be paid per each.

SECTION 600 - TRAFFIC SIGNAL EQUIPMENT

A SCOPE OF WORK

The work under these items consists of furnishing and installing traffic control equipment, the controller and cabinet, signal heads, signal posts or mast arms, anchor bolts and foundations, service connection, wire and cable, pavement markings and all incidental materials necessary for operating and controlling the traffic control signals as shown on the plans. All work shall conform to the provisions of the City of Worcester’s Specifications and the latest revisions of the Massachusetts Standard Specifications for Highways and Bridges Section 800 of the MSSHB and the latest edition of the Manual on Uniform Traffic Control Devices. The contractor is responsible for researching all existing utilities through Dig Safe.

All work done under these specifications shall be in conformance with Section 800 of the MSSHB STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES dated 1988, the SUPPLEMENTAL SPECIFICATIONS, dated November 30, 1994, the 1977 CONSTRUCTION STANDARDS, the 1990 STANDARD DRAWINGS FOR SIGNS AND SUPPORTS, the 1968 STANDARD DRAWINGS FOR TRAFFIC SIGNALS AND HIGHWAY LIGHTING and the AMERICAN STANDARDS FOR NURSERY STOCK (ANSI-Z60.1-1990), as

amended, the PLANS, and these SPECIAL PROVISIONS

The payment clauses contained in Section 800 of the MSSHB Standard Specifications do not apply to these special provisions.

The General Conditions, Supplementary Conditions and Special Provisions shall take precedence over the General Requirements of Division I of the Section 800 of the MSSHB Standard Specifications.

B PLANS

(Supplementing Section 800 of the MSSHB Subsection 5.02)

The Contractor shall furnish “AS BUILT” plans of the completed project to the City of Worcester’s Commissioner of Transportation & Mobility. These “AS BUILT” plans shall be furnished prior to the date of final acceptance. The Contractor shall furnish all AutoCAD drawing files to the City of Worcester Commissioner of Transportation & Mobility or his authorized representative, related to the project. All AutoCAD files shall be set to the State Plane Coordinate System, or the City will provide a copy of the City Map for the contractor to insert the “AS Built” information on a separate layer.

C BUY AMERICA PROVISIONS (23 CFR 635.410)

(Supplementing Section 800 of the MSSHB Subsection 6.01 Source of Supply and Quality)

All steel and iron must be produced in the United States. The determination of foreign or domestic character will be based on the place of manufacturer and the origin of more than fifty percent of its components. Foreign steel

can be used if the cost of materials does not exceed 0.1% of the total contract costs or $2,500 whichever is greater. The action of applying coating to covered material (i.e., steel and iron) is deemed a manufacturing process subject to Buy America. Coating includes epoxy coating, galvanizing, painting and any other coating that protects or enhances the value of a material subject to requirements of Buy America.

D PROVISIONS FOR TRAFFIC AND PROSECUTION OF WORK

(Supplementing Section 800 of the MSSHB Subsection 8.02)

Before starting work under this contract, the Contractor shall prepare and submit to the Commissioner of Transportation & Mobility for approval, a plan (based on the Contractor Traffic Management Plan) that indicates the traffic routing proposed by the Contractor during the various stages and time periods of the work and the temporary barricades, signs, drums and other traffic control devices to be employed during each stage and time period of the work to maintain traffic and access to abutting properties.

With the approval of the Commissioner of Transportation & Mobility, the Contractor may reduce the width of the roadway to one lane during working hours only if and when suitable detours or pavement width is available; however, two-way traffic shall be maintained on all sections at all times. Reasonable facilities shall be provided by the Contractor for the safe and convenient passage of vehicles and pedestrians through the project locations. Particular care shall be taken to establish and maintain such methods and procedures so as not to create hazardous conditions. “Stop and Go” operation of the existing traffic signal system shall be maintained at all times. Exceptions for short downtimes for splicing cable or modifying the controller are acceptable with approval from the City’s Commissioner of Transportation & Mobility. The Contractor shall provide police control at the intersection when the “Stop and Go” operation must be discontinued for periods of more than one half hour (30 minutes). It shall be a requirement by the City of Worcester that any installation of wiring done by the Contractor in the construction of this roadway will not be permitted unless installed by licensed electricians. The contractor shall employ, at the job site, only personnel with a minimum of two years of experience in technical traffic signal work or in the construction of traffic signals.

The contractor shall, without additional compensation, be responsible for ensuring safe travel conditions throughout the construction zone and access to adjacent properties during the prosecution of the work. Any construction or regulatory signs within the construction signing limits shall always be appropriate for the roadway conditions. Any signs, the meaning of which is not consistent with the construction activity or travel lane configuration, shall be covered or removed. Temporary pavement markings shall be installed to designate all travel lanes at any time when barrels or cones do not otherwise designate the travel lanes. Traffic cones should be removed at the end of each workday. At the end of each workday, the contractor shall review the construction zone to verify (and adjust if necessary) that the travel ways are

E PAINTING OF SIGNAL EQUIPMENT

All new traffic signal equipment shall be powdered coated Black and as noted below

F MAINTENANCE OF TRAFFIC SIGNALS

The Contractor shall provide all labor, equipment and materials required for total maintenance and emergency repairs of all existing and proposed temporary and permanent traffic signal control equipment, within the project limits, including damage by automobile accidents, unless otherwise specified under Subsection 7.17 “Traffic Accommodation” of the Section 7 of the MSSHB Standard Specifications, as amended, in which case Subsection 7.17 will govern. These provisions will apply to all signalized locations included as part of the Contract on the day that the Contractor will commence work on the project, until the date of acceptance of the completed project from the City of Worcester. This written notice must be given before the Contractor may proceed with any work on a specified traffic signal system. For these paragraphs, the phrase “Traffic Signal Control Equipment” is intended to include, but not limited to, controllers, detectors, signal housing, support structures, cabinets, wires, conduit and all other auxiliary electrical equipment used for traffic control. In the event of damage caused by automobile accidents, the Contractor shall replace all damaged material with new material. The Contractor, installing the traffic signal equipment, will be required to service and maintain the traffic signal controllers and associated equipment, on a 24-hour basis, including Sundays and Holidays.

No separate payment will be made for maintenance of existing installation, and the removal and stacking of existing traffic signal equipment, including relocating the existing signal equipment to new foundations as a temporary setup. All costs in connection therewith shall be included in the lump sum price bid for Item 600.

No other Contractor will be allowed to service the traffic signal equipment other than the Contractor, who installed

the traffic signal equipment, until the final acceptance by the City of Worcester. If the Contractor fails to provide maintenance to the traffic signal equipment during the duration of the project, the City has the right to dispatch their traffic signal contractor and bill the contracting contractor for payment of parts and labor. A reasonable time frame for repairs shall not exceed 24 hours.

The cost of maintenance of signals shall be deemed to be included in the various traffic signal Contract items, and no additional payments will be made, except as provided under Subsection 7.17.

G UNIT PRICES

The method of measurement and basis for payment for all work necessary to complete the items identified in the bid proposal shall be made in accordance with the itemized bid form contained in the bid proposal. The contractor shall be responsible for the prosecution of all necessary work in order to meet the time schedule requirements with no additional compensation therefore, other than as provided under the contract unit prices or lump sum payments for the various items scheduled in the proposal. The contractor shall have no claim for damages of any kind on account of any interruption, delay or suspension of the work affected by the above time schedule requirements.

H ORDERING OF MATERIALS AND DRAWINGS

The Contractor shall provide the Commissioner of Transportation & Mobility, within 10 days of receipt of the contract, written evidence that:

They have ordered the shop drawings for the materials for which shop drawings are required to complete the work on the contract subject.

They have ordered the Traffic Control Devices for which shop drawings are not required and all necessary components to complete the work on the contract subject.

The Contractor shall submit shop drawings for all signal supports, a list of equipment, and manufacturer's equipment specifications to the Commissioner of Transportation & Mobility in accordance with the relevant provisions of Section 600. The Contractor will submit shop drawings and long hand calculations stamped by a Massachusetts Registered Structural Engineer for all mast arm assemblies. All traffic signal equipment must be on the most current Section 800 of the MSSHB Traffic Signal Approved Equipment List. All traffic signal equipment must be in full compliance with the National Transportation Communications for Intelligent Transportation System (ITS) Protocol (NTCIP) 1201 and 1202 standards and capable of communicating with the City of Worcester Central Monitoring software.

The Contractor shall further provide the Commissioner of Transportation & Mobility written evidence within 30 days of receipt of the Contract that these orders have been confirmed in writing by the manufacturer with delivery dates appropriate for timely completion of the project. These confirmations of orders will become part of the project records.

Failure to comply with any of the ordering requirements shall nullify a request for extension of the project completion date as a consequence of late delivery of traffic signal control devices or castings.

I PROCEDURES FOR SHOP DRAWINGS

The following procedure shall be followed when making shop drawings for this project:

1. The Prime Contractor shall submit three (3) sets of drawings directly to the Commissioner of Transportation & Mobility for preliminary review.
2. The Commissioner of Transportation & Mobility will send a written reply, returning two (2) sets to the Prime Contractor within five (5) working days of receipt of the drawings.
3. If the Commissioner of Transportation & Mobility's reply indicates rejection or advises corrections or additions to the drawings, steps 1 and 2 are repeated until the Commissioner of Transportation & Mobility indicates that approval will be given.
4. The Contractor shall then submit three (3) sets of drawings to the Commissioner of Transportation & Mobility for approval and distribution.

Three (3) sets of wiring diagrams with both internal and external wiring for the control cabinet and all accessories as actually used in the field shall be furnished, including one (1) reproducible AutoCAD CD Disk for the controller cabinet wiring when installed. Before acceptance of the job, all operation and maintenance manuals and complete and accurate parts lists shall be supplied.

The Commissioner of Transportation & Mobility will have final approval for all traffic signal equipment.

The Contractor shall not receive payment for, nor will he be allowed to install any item or materials, which require shop drawing approval unless, he has received written approval for the shop drawing for that item from the City's Traffic Engineer.

The Contractor shall submit a list of the manufacturer's designations (catalog number, model number or revision number) for all equipment to be used in the installation of the traffic control signal system for which shop drawings are not required.

Shop drawings are required for signal heads and back plates, mounting hardware, loop detector cable and sealant, mast arms (including long hand calculations with deflection listed), traffic signal bases and poles, pedestrian signals and buttons, interconnecting cable, traffic signal cable, electrical conduit, central office monitoring equipment, controllers and all equipment housed within the controller cabinets, including load switches, amplifiers, conflict monitors, special logic boards, relays, etc.

J SERVICE CONNECTIONS

The Contractor shall be responsible for the payment of all fees for services and permits rendered in conjunction with service connections by companies under this project. The cost thereof shall be included in the lump sum price of the Traffic Signal Controls listed in the proposal.

K RESPONSIBILITY AND DISPOSAL OF SURPLUS MATERIALS

Removal of existing traffic signal equipment and their accessories shall be done in a manner that will not damage reusable material. Any traffic signal equipment damaged though carelessness or lack of protection by the Contractor shall be replaced at the Contractor's expense. All traffic signal equipment to be removed and stacked shall be delivered to the City of Worcester Traffic Department, at the City Yard, located at 26 Albany Street, as directed by the Commissioner of Transportation & Mobility. All surplus materials resulting from the excavation and not needed for use on the project as determined by the Engineer shall be disposed of by the Contractor and away from the limits of the project. All foundations for traffic signals or controller cabinets are to be removed completely and not covered over, with the exception of strain pole foundations. Strain pole foundations will be broken down to a depth of not less than eighteen (18") inches below the finished grade level.

Removal and resetting requires the removal of signal equipment, including replacing old poles with new poles, installing new flute jackets, either painting the existing base or installing a new base as directed by the Commissioner of Transportation & Mobility. All existing equipment to be utilized in the construction of the new installation should be thoroughly cleaned, powdered coated for the type required for the installation.

L FINE TUNING, ADJUSTMENT, AND TESTING PERIOD

After the Contractor has finished installing the controller and all other associated signal equipment and after the Contractor has set up the signal equipment to operate as specified in the contract documents, the fine tuning, adjusting and testing period shall begin. The Contractor shall advise the Engineer, in writing, of the date of the beginning of the fine-tuning and testing period. This testing period shall not start until the work at the intersections is complete. During this period, the Contractor, under the direction of the Engineer, shall make necessary adjustments and tests to insure the safe and efficient operation of the equipment. This period shall not last for more than 30 days and the Contract completion date has taken this testing period into consideration. No request for final acceptance will be considered until successful completion of the testing period.

The Contractor shall notify the Commissioner of Transportation & Mobility in writing of the start date of fine- tuning period prior to the starting date. The cost of electrical energy consumed by the operation of traffic signals during the construction, fine tuning and testing of the traffic signals will be borne by the Contractor.

M GUARANTEE AFTER FINAL ACCEPTANCE

The Contractor shall diagnose (troubleshoot) the system and, at his own expense, replace any part of the traffic signal control equipment found to be defective in workmanship, material or manner of functioning within one year from the date of final acceptance of all the installations under this contract. This requirement does not affect the one-year

warranty period on equipment specified in subsection 815.20 of Section 800 of the MSSHB Standard Specifications.

Upon the date of final acceptance of the project, the Contractor shall turn over all guarantees and warranties to the City.

Final acceptance will not be given unless all permits, finished sketches or wiring diagrams are turned over to the City's Traffic Engineer. No retainage or bonds will be released until final acceptance is approved.

N QUALIFIED ELECTRICIANS

The Contractor shall submit a list of the Journeyman Electricians (Massachusetts License) along with copies of their licenses, who will perform the electrical work within this project. Journeymen performing electrical work on traffic signals must be certified by I.M.S.A. with a LEVEL II or higher certification in Traffic Signal Technicians. A copy of the certification shall be submitted to the Commissioner of Transportation & Mobility. The Contractor shall submit all requirements within ten (10) days after awarding of the bid.

O FLASHING OPERATION

Changes from flashing to stop-and-go to flashing operation shall occur as set forth in the latest edition of the MUTCD.

ITEM 601.0000 CONTROLLER-TS 2 TYPE 2 (EACH)

A. GENERAL

The controller unit shall be a Yunex m62-series or approved equivalent. It should be user-friendly, fully actuated, keyboard entry menu driven, with internal time base coordination capability, internal time clock and emergency preemption without the need for external equipment. The controller shall conform to Section 800 of the MSSHB Standard Specifications. The controller shall be compatible with a master controller, the City of Worcester's current traffic responsive signal system (TACTICS) and the City of Worcester Centralized Traffic Management System Software (CTSS), while conforming to all applicable requirements of NEMA Standard TS 2 Type II.

The controller shall provide an integrated communications module with Ethernet ports, USB ports, and "D" Connectors. These connectors shall enable communication among malfunction management units, conflict monitors, detectors, video-detection systems, and all other cabinet-based TS 1 or TS 2 devices. They should also provide connectivity for signal coordination and remote management. The controller must be capable of operating in either single or dual ring mode with either sequential or concurrent phase control. Adapters shall be supplied to connect the controller in either a TS 1 or TS 2 configuration. Overlap phases shall be programmable through the keyboard and be capable of operating as a volume density controller. The controller shall contain all the necessary hardware to operate as a Closed Loop System. An operation manual and graphics shall be supplied for each controller. The controller shall contain all the necessary hardware, including cables and internal system modem and security controlled external modem connected to either telephone or fiber optic communications system. When assigning the phasing and sequence, phase 9 shall always be programmed for an exclusive pedestrian phase. The controller shall have a 16-line LCD display that displays 2 separate operations of the controller and 5 programmable function keys. The controller shall contain a communications module that has 4 Ethernet ports, 4 USB ports, and a GPS port. Wiring Harness to be provided with each controller.

All traffic signal controllers shall be compatible with the existing interconnected system, and the City of Worcester Centralized Traffic Management System Software (CTSS). The controller unit shall retain all intersection data and controller programming in a plug-in memory module utilizing non-volatile EEPROM memory. The Real Time Clock shall be maintained by a battery backup during power outages. The controller should be programmable for Daylight Savings Time.

The controller unit shall be capable of two (2) through sixteen- (16) phase operation and sixteen (16) keyboard programmable overlaps. The controller shall have internal pre-emption with capability of six (6) unique pre-empt sequences. Each pre-empt sequence shall be fully user programmable for timing and signal display in response to an individual pre-empt command input. The controller shall provide access for all preemption and coordination functions. The controller unit and all equipment shall have approved surge protection. The

controller shall have a standard RS232 port for one (1) data transfer cable and one (l) printer cable provided with each unit. The controller shall be provided with a standard cable for connection from the controller to the pre-emption unit.

Timing circuits of the traffic signal controllers shall be fully digital and shall be as accurate as the 60 Hz power source with an input range from 105 VAC to 130 VAC, over a temperature range encountered in Massachusetts.

B. *MEASUREMENT AND PAYMENT*

Payment for this item shall be at the bid price per item complete in place.

ITEM 601.1000 CONTROLLER CABINET HARNESS (EACH)

ITEM 602.0000 CONTROLLER CABINET ASSEMBLY, SIZE "P"-PER SPECIFICATIONS LUMP SUM

A GENERAL

The controller cabinet shall be size "P", Type TS-2 and installed as required in Section 800 of the Massachusetts Department of Transportation Standard Specifications for Highways and Bridges.

B SPECIFICATIONS

Each cabinet shall be equipped with two (2) video detection dual channel video processors, an Integrated BIU and Video Detection Communications Module, and a Single Point Interface Ethernet Device with MPEG4/H.264 Video Streaming, all meeting the City of Worcester Specifications for Video Detection as described herein. The cabinet shall contain a 9" LCD color monitor. A watertight sealant shall be placed between the controller cabinet and the foundation. The top of the concrete base for the controller cabinet shall be approximately 12 inches above finish grade (minimum). The foundation shall provide a spare sweep as directed by the Engineer.

The cabinet is fabricated sheet metal, base mounted type. Cabinet shall be fabricated from a minimum thickness of 0.125-inch aluminum.

A National Grid approved 100-amp meter socket with bypass shall be mounted on the side of the cabinet. National Grid shall furnish and install the meter. The cabinet shall include four (4) video suppressors to allow conversion to video detection with ease. A separately fused, ground fault duplex fifteen (15) amps outlet on the door, a double duplex 15-amp outlet on the side panel and a light receptacle shall be installed for the power supply of additional equipment. Adequate 120V AC power terminals shall be provided. Lightning arresters of the rare gas type with auxiliary air gap shall be installed. All signal outputs shall be separately fused by cartage type fuse.

It is intended that all equipment be mounted and all necessary provisions for mounting and wiring of all equipment shall be made at the factory of the controller equipment manufacturer prior to shipping the cabinet and control components. All necessary terminal strips, brackets, etc. shall be installed at the factory. The controller cabinet rack assembly shall be equipped for an Opticom phase selector, including harness. Terminals for auxiliary equipment to be installed shall be clearly and permanently labeled as to functions. It is understood that all cabinets for the National Electrical Manufactures Association (NEMA) controllers of the same phase capacity in the City of Worcester are interchangeable. Thus, the amount of field wiring shall be kept to a minimum.

No equipment components shall be stacked. Brackets, shelves, hangers, and other supports designed to assure convenient accessibility for inspection and maintenance shall be installed at the factory. Adjustable aluminum shelving is required. No plywood shelving side panels or rear panels shall be used in any cabinet. A pull-out document drawer shall be provided to store plans and provide a shelf for a laptop computer. A suitable weatherproof container for plans and diagrams shall be mounted on the cabinet door with eyehooks fastened from the panel" cover.

Each main door should be designed to open easily and close securely while retaining weatherproof quality. Handle and latch mechanisms shall be designed for trouble free operations. An adjustable latching mechanism shall be supplied to hold the main door in the open position for use when servicing equipment. Each main door should have a momentary push-button switch installed to provide an alarm to the system of any entries to the cabinet and provide automatic lighting within the cabinet.

A second hinged door, mounted on the main door, shall give access to designated switches on a "police panel". This door shall be provided with a different lock and key. Mounted within the "police panel" door shall be switches to control flashing operation and shutdown. Each controller cabinet shall be equipped with an external multi-port signature modem to allow communications to a Closed Loop system and communications with a Video Detection system. The controller cabinet shall contain a video compressor mounted on the side of the cabinet to allow conversion from loop detection to video detection.

Two thermostatically controlled exhaust fans, rated at 100 cubic feet per minute, shall be mounted in a screened opening at the top of each cabinet. Screened intake vent louvers near the bottom and/or sides shall have an effective area at least twice that of the opening provided for the exhaust fan. Standard size, replaceable, fiberglass

air filters shall be provided.

Controller cabinet wiring diagrams shall be submitted on printed reproducible sheets no larger than 24 inches by 36 inches with electronic versions in AutoCAD-2018 and Adobe-PDF formats. All actual and potential terminal strip connections shall be shown. Accessory equipment includes, but is not limited to, flashers, switches, relays, logic modules, preempt phase selector, detectors, etc. All identification on the diagram shall be installed, and all field labeling shall be consistent with the diagrams. The format symbols, identifications, operating sequence, etc., common to all intersection wiring diagrams shall be standardized and consistent with appropriate City of Worcester Standards. The control cabinet wiring diagrams shall include a sketch of the intersection controlled and the approximate location and identification of each signal face and detector as shown on the plans. The control cabinet wiring diagrams shall also include all information shown on the phasing and timing charts as shown on the plans, including all special reference notes and all field labeling. This may be a reduced copy of the original phasing and timing charts. All actual and potential terminal strip connections shall be shown on the wiring diagrams. All holes and interior surfaces likely to carry a cable shall be deburred and made free of all sharp edges. All holes shall be sealed with a plastic or rubberized washer to prevent damage to cable. All wiring shall be concealed internally. All unused bays shall be covered to prevent dust from entering.

All Load Switches shall be a modular solid-state assembly with I/O and have L.E.D. indicators to show which I/O function is called for by the controller (i.e., Red, Yellow or Green), meet or exceed NEMA TS L- 1989 requirements and be listed on the MassDOT Qualified Traffic Control Equipment list (QTCE). The controller shall have a full complement of load switches.

All Relay Switches shall be a 30A modular solid-state assembly and meet or exceed NEMA TSI-1989 requirements and be listed on the MassDOT QTCE.

The Malfunction Management Unit (MMU2 700 series) shall comply with Section 4 of the NEMA TS-2 standards. The MMU2 shall be connected to the controller unit by the Synchronous Data Link Control (SDLC) and the active status of the MMU2 will be read through the controller unit and also through a Closed Loop Communications System. The MMU2 should have an Ethernet port, PCD display and shall work with all modes of FYA.

The Bus Interface Unit (BIU) shall meet or exceed all the requirements of the NEMA BIU2 TS2-2003 clause 8.3 standards for BIU configuration. All outputs are rate at 150mA continuous sink current and provide 500mA current limit. The BIU shall supply 4 optically insolated inputs.

A separate power supply should be supplied and installed in the TS 2 cabinet. The unit shall be AC line powered and provide regulated DC power, unregulated AC power, and a line frequency reference for the rack mounted loop amplifiers, bus interface units, load switches and other auxiliary cabinet equipment as required including video detection. At a minimum, the power supply shall meet all requirements of Section

5.3.5 of the NEMA TS 2 Standard. The power supply shall be shelf mounted. The unit shall have at least the following four outputs with LED indicators on the front panel to indicate their status: +12 VDC rated at

5.0 amps, +24 VDC rated at 3.0 amps, 12 VACS rated at 250 milliamps, and 60 Hz line frequency reference. Test point terminals shall also be located on the unit's front panel for +12 VDC, +24 VDC, and logic ground testing.

A Synchronous Data Link Control (SDLC) Serial Bus shall conform to section TS2 Section 3.31 a SDLC to allow communications between the controller unit, MMU, and BIUs. Two (2) additional spare BIUs shall be equipped with each controller cabinet.

The Opticom detector rack shall be wired and one— four channel (4) Opticom Phase Selectors (700 series) capable of using IR and GPS activation technology. A pre-emption indicator light shall be provided and mounted at all locations as shown on the plans. It shall be in a position where it may be visible from all pre-emption approaches to each intersection. The light shall be weather tight and consist of a single white flash strobe, which shall be illuminated whenever the controller is in the fire-pre-emption phase. The indicator light shall meet all ITE, NEMA, IMSA and Section 800 of the MSSHB standards. The light shall have a minimum diameter of five and one half (5-1/2") and be capable of flashing at a rate of 80 to 95 flashes per minute.

C CABLE INSTALLATION

Cables from each local controller to each traffic signal shall have a minimum of Twenty (20) conductors #12 AWG, singles, stranded, IMSA Specification 19-1 1968 traffic control cable shall be used for signal cable.

Special purpose grounding and bonding wire shall be # 8 AWG or larger conforming to the requirements of ASTM B3.

ITEM 602.0500 CONTROLLER CABINET SHELL ONLY, SIZE "P"

ITEM 602.1000 CONTROLLER CABINET ASSEMBLY, SIZE "M"-PER SPECIFICATIONS

A GENERAL

The controller cabinet shall be size "M", Type TS-2 and installed as required in Section 800 of the Massachusetts Department of Transportation Standard Specifications for Highways and Bridges.

B SPECIFICATIONS

See 602.00 – CONTROLLER CABINET ASSEMBLY-TYPE P for specifications other than cabinet type.

C REQUIREMENTS

Payment for this item shall be at the bid price per item complete in place.

ITEM 602.1500 CONTROLLER CABINET SHELL ONLY, SIZE "M"

ITEM 602.2000 SSS-87 STANDARD LOAD SWITCH W/I & O FUNCTIONS (200 TYP)

ITEM 602.3000 SSF-87 FLASHER LOAD SWITCH (204 TYP)

ITEM 602.4000 30A RELAY SWITCHES

ITEM 602.5000 MMU-16 SERIES MANAGEMENT MALFUNCTION UNIT

ITEM 602.5100 CHANNEL CONFLICT MONITOR FOR CLOSED LOOP SYSTEM

ITEM 602.5200 6 CHANNEL CONFLICT MONITOR FOR CLOSED LOOP SYSTEM

ITEM 602.6000 BIU 700

ITEM 602.7000 24V -5A SHELF MOUNT POWER SUPPLY FOR TS-2 CABINET

ITEM 602.8100 OPTICOM DUAL (2) CHANNEL PHASE SELECTORS (700 SERIES)

ITEM 602.8200 OPTICOM FOUR (4) CHANNEL PHASE SELECTORS (700 SERIES)

ITEM 602.8300 WHITE CONFORMATION STROBE INDICATOR FOR PRE-EMPTION

ITEM 602.8400 OPTICOM DETECTOR (700 SERIES) – ONE-WAY DIRECTION

ITEM 602.8500 OPTICOM DETECTOR (700 SERIES) – TWO-WAY DIRECTION

ITEM 602.9000 COOLING FANS FOR CONTROLLER CABINET

ITEM 602.9100 THERMOSTATS FOR COOLING FANS IN CONTROLLER CABINET

A GENERAL

Each cabinet shall be equipped with two (2) video detection amplifiers (1 single channel video detector and 1 dual channel video detector), an Integrated BIU and Video Detection Communications Module, and a Single Point Interface Ethernet Device with MPEG4/H.264 Video Streaming, all meeting the City of Worcester Specifications for Video Detection as described herein. The cabinet shall contain a 9" LCD color monitor. A watertight sealant shall be placed between the controller cabinet and the foundation. The top of the concrete base for the controller cabinet shall be approximately 12 inches above finish grade (minimum). The foundation shall provide a spare sweep as directed by the Engineer.

The cabinet is fabricated sheet metal, base mounted type. Cabinet shall be fabricated from a minimum thickness of 0.125-inch aluminum.

A National Grid approved meter socket shall be mounted on the side of the cabinet. The Contractor shall furnish and install the meter socket and National Grid Company shall furnish and install the meter. The cabinet shall include four (4) video suppressors to allow conversion to video detection with ease. A separately fused, ground fault duplex fifteen (15) amps outlet on the door, a double duplex 15-amp outlet on the side panel and a light receptacle shall be installed for the power supply of additional equipment. Adequate 120V AC power terminals shall be provided. Lightning arresters of the rare gas type with auxiliary air gap shall be installed. **All signal outputs shall be separately fused.**

It is intended that all equipment be mounted and all necessary provisions for mounting and wiring of all equipment shall be made at the factory of the controller equipment manufacturer prior to shipping the cabinet and control components. All necessary terminal strips, brackets, etc. shall be installed at the factory. The controller cabinet rack assembly shall be equipped for an Opticom phase selector, including harness. Terminals for auxiliary equipment to be installed shall be clearly and permanently labeled as to functions. It is understood that all cabinets for the National Electrical Manufactures Association (NEMA) controllers of the same phase capacity in the City of Worcester are interchangeable. Thus, the amount of field wiring shall be kept to a minimum.

No equipment components shall be stacked. Brackets, shelves, hangers, and other supports designed to assure convenient accessibility for inspection and maintenance shall be installed at the factory. Adjustable aluminum shelving is required. No plywood shelving side panels or rear panels shall be used in any cabinet. A pull-out document drawer shall be provided to store plans and provide a shelf for a laptop computer. A suitable weatherproof container for plans and diagrams shall be mounted on the cabinet door with eyehooks fastened from the “police panel” cover.

Each main door should be designed to open easily and close securely while retaining weatherproof quality. Handle and latch mechanisms shall be designed for trouble free operations. An adjustable latching mechanism shall be supplied to hold the main door in the open position for use when servicing equipment. Each main door should have a momentary push-button switch installed to provide an alarm to the system of any entries to the cabinet and provide automatic lighting within the cabinet.

A second hinged door, mounted on the main door, shall give access to designated switches on a “police panel”. This door shall be provided with a different lock and key. Mounted within the “police panel” door shall be switches to control flashing operation and shutdown. Each controller cabinet shall be equipped with an external multi-port signature modem to allow communications to a Closed Loop system and communications with a Video Detection system. The controller cabinet shall contain a video compressor mounted on the side of the cabinet to allow conversion from loop detection to video detection.

Controller cabinet wiring diagrams shall be submitted on reproducible sheets no larger than 24 inches by 36 inches and in AUTOCADD format. All actual and potential terminal strip connections shall be shown. Accessory equipment includes, but is not limited to, flashers, switches, relays, logic modules, preempt phase selector, detectors, etc. All identification on the diagram shall be installed, and all field labeling shall be consistent with the diagrams. The format symbols, identifications, operating sequence, etc., common to all intersection wiring diagrams shall be standardized and consistent with appropriate City of Worcester Standards. The control cabinet wiring diagrams shall include a sketch of the intersection controlled and the approximate location and identification of each signal face and detector as shown on the plans. The control cabinet wiring diagrams shall also include all information shown on the phasing and timing charts as shown on the plans, including all special reference notes and all field labeling. This may be a reduced copy of the original phasing and timing charts. All actual and potential terminal strip connections shall be shown on the wiring diagrams. All holes and interior surfaces likely to carry a cable shall be deburred and made free of all sharp edges. All holes shall be sealed with a plastic or rubberized washer to prevent damage to cable. All wiring shall be concealed internally. All unused bays shall be covered to prevent dust from entering.

All Load Switches shall be a modular solid-state assembly with I/O and have L.E.D. indicators to show which I/O function is called for by the controller (i.e. Red, Yellow or Green), meet or exceed NEMA TS 1- 1989 requirements and be listed on the MassDOT Signal Equipment Approval list. The controller cabinet shall have a full complement of load switches.

All Relay Switches shall be a 30A modular solid-state assembly and meet or exceed NEMA TS1-1989 requirements and be listed on the MassDOT Traffic Signal Equipment Approval list.

The Malfunction Management Unit (MMU) shall comply with section 4 of the NEMA TS-2 standards. The MMU shall be connected to the controller unit by the Synchronous Data Link Control (SDLC) and the active status of the MMU will be read through the controller unit and also through a Closed Loop Communications System. The MMU shall have an Ethernet port, LCD display and shall work with all modes of FYA.

The Bus Interface Unit (BIU) shall meet or exceed all the requirements of the NEMA TS2-2003 standards for BIU

configuration.

A separate power supply should be supplied and installed in the TS 2 cabinet. The unit shall be AC line powered and provide regulated DC power, unregulated AC power, and a line frequency reference for the rack mounted loop amplifiers, bus interface units, load switches and other auxiliary cabinet equipment as required including video detection. At a minimum, the power supply shall meet all requirements of Section

5.3.5 of the NEMA TS 2 Standard. The power supply shall be shelf mounted. The unit shall contain four LED indicators on the front panel to indicate the four outputs: + 12 VDC +/- 1 VDC @ 5.0 amps, + 24 VDC

+/- 2 VDC @ 2.0 amps, 12 VAC @ 250 milliamps, and 60 Hz line frequency reference. A test point terminal shall also be located on the unit's front panel for +24VDC and logic ground testing.

A SDLC Serial Bus shall conform to section TS2 Section 3.31 a SDLC (Synchronous Data Link Control) to allow communications between the controller unit, MMU, and BIU's. Two (2) additional spare BIU's shall be equipped with each controller cabinet.

Cable installation

Cable from each local controller to each traffic signal shall have a minimum of Twenty (20) conductors #12 AWG, singles, stranded, I.M.S.A. Specification 19-1 1968 traffic control cable shall be used for signal cable. Special purpose grounding and bonding wire shall be No. 8 AWG or larger conforming to the requirements of ASTMB-3.

B MEASUREMENT AND PAYMENT

Payment for these items shall be as designated at the applicable unit price as bid in the proposal.

ITEM 603.0000 CONCRETE FOUNDATIONS (FOR CONTROLLER CABINET)

ITEM 603.7000 24V 5A SHELF MOUNT POWER SUPPLY FOR TS-2 CABINET

ITEM 603.7500 16-CHANNEL 10-POS DETECTOR RACK W/OPTICOM COMPATIBILITY

A GENERAL

All controller cabinets shall be constructed using 4,000 psi, ¾ inch, 610 Cement Concrete Masonry conforming to the relevant provisions of Section M4 of the Standard Specifications. All controller foundations shall have a 12" reveal. No forms for foundations shall be set, nor shall concrete be placed until the excavation has been inspected and approved by the City.

All sweeps to be installed in cabinet foundation shall be 3-inch (PVC) sweeps with sufficient 3-inch PVC riser to project above the finish grade of the base. A cement concrete pad shall be built in accordance with the City's sidewalk specifications. This pad shall project at least 1 ft. to each side of the cabinet and at least 3 ft. in front. This pad shall contain a 12" x 24" electrical pull box 2 ft. in front of the cabinet. This pull box will provide 3 - 3" PVC conduit directly into the cabinet foundation, separate from the electrical and telecommunications conduit connections.

B MEASUREMENT AND PAYMENT

Payment for this item shall be at the bid price per item complete in place.

ITEM 604.0000 VIDEO DETECTION-COMPLETE SYSTEM

A GENERAL

This specification sets forth the minimum requirements for a system that detects vehicle, bicycle, and pedestrian traffic on a roadway using only video images of traffic. The video detection system (VDS) shall be the Vantage NEXT platform manufactured by ITERIS (or approved equivalent) and shall be capable of integrating into a TS1 or TS2 cabinet with complete operation and management functionality in either environment.

B SYSTEM HARDWARE

The video detection system shall consist of at least four video cameras, a camera surge-protection panel, a video detection processor (VDP)/central control unit (CCU) which mounts on or to a standard NEMA cabinet shelf, a 10-inch monitor, and a pointing device. The system should also include at least two detector-rack- mounted dual video processors and four detector-rack-mounted expansion modules.

C SYSTEM SOFTWARE

The system should include software that detects vehicles and bicycles in multiple lanes using only the video image. Detection zones shall be definable using only an on-board video menu and a pointing device to place the zones on a video image. Up to 32 detection zones per camera shall be available. A separate computer should not be required to program the detection zones.

D FUNCTIONAL CAPABILITIES

The VDP shall process video from up to four camera sources, as specified. The video shall be input to the VDP from the camera sensors via Ethernet cables plugged into the CCU. The interface connectors shall be RJ-45 type.

The VDP shall detect the presence of vehicles in up to 32 detection zones per camera. A detection zone shall be approximately the width and length of one car.

Detection zones shall be programmed via an on-board menu displayed on a video monitor and a pointing device connected to the VDP. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters. A separate computer shall not be required for programming detection zones or to view system operation.

The VDP shall store up to five different detection zone patterns. The VDP can switch to any one of the three different detection patterns within one second of user request via menu selection with the pointing device.

The VDP shall detect vehicles in real time as they travel across each detector zone.

The VDP shall accept new detector patterns from an external computer through the Ethernet port when the external computer uses the correct communications protocol for downloading detector patterns. Windows-based software designed for local or remote connections and providing video capture, real-time detection indication and detection zone modification capability shall be provided with the system.

The VDP shall send its detection patterns to an external computer through the Ethernet port when requested. The VDP will accept new detector patterns from an external computer using the appropriate communications protocol for uploading.

The camera system shall be able to transmit a video signal, with minimal signal degradation, up to 1,000 feet under ideal conditions.

The associated VDP shall default to a safe condition, such as a constant call on each active detection channel, in the event of loss of video signal.

The system shall be capable of automatically detecting low-visibility conditions such as fog and respond by placing all defined detection zones in a constant call mode. A user-selected output shall be active during the low-visibility condition that can be used to modify the controller operation if connected to the appropriate controller input modifier(s). The system shall automatically revert to normal detection mode when the low- visibility condition no longer exists.

E VEHICLE DETECTION

A minimum of 32 detection zones shall be supported, and each detection zone shall be definable in size and shape to suit the site and the desired vehicle detection region.

A single detection zone shall be able to replace multiple inductive loops, and the detection zones shall be OR ‘ed as the default or may be AND ‘ed together to indicate vehicle presence on a single phase of traffic movement.

Placement of detection zones should be done by using only a pointing device, and a graphical interface built into the VDP and displayed on a video monitor, to draw the detection zones on the video image from the video camera. No separate computer should be required to program the detection zones.

A minimum of five detection zone patterns shall be saved within the VDP memory. The VDP's memory shall be non-volatile to prevent data loss during power outages. The VDP shall continue to operate (e.g. detect vehicles) using the existing zone configurations even when the operator is defining/modifying a zone pattern. The new zone configuration shall not go into effect until the configuration is saved by the operator.

The selection of the detection zone pattern for current use shall be done through a menu or remote computer via Ethernet port. It shall be possible to activate a detection zone pattern for a camera from DVP memory and have that detection zone pattern displayed within 1 second of activation.

When a vehicle is detected crossing a detection zone, the corners of the detection zone will flash on the video overlay display screen to confirm the detection of the vehicle.

Detection shall be at least 98% accurate in good weather conditions and at least 96% accurate under adverse weather conditions (rain, snow, or fog). Detection accuracy is dependent upon site geometry; camera placement, camera quality and detection zone location, and these accuracy levels do not include allowances for occlusion or poor video due to camera location or quality.

Detector placement shall not be more distant from the camera than a distance of ten times the mounting height of the camera.

The VDP shall provide up to 64 channels of vehicle presence detection through a standard SDLC connector.

The VDP shall provide dynamic zone reconfiguration (DZR) to enable normal detector operation of existing channels except the one where a zone is being added or modified during the setup process. The VDP shall output a constant call on any detection channel corresponding to a zone being modified.

Detection zone setup shall not require site specific information such as latitude, longitude, date and time to be entered into the system.

The VDP shall output a constant call for each enabled detector output channel if a loss of video signal occurs.

The VDP shall output a constant call during the background learning period.

Detection zone outputs shall be configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse, extend, and delay outputs shall be user definable between 0.1 to 25.0 seconds.

Up to six detection zones shall be capable of counting the number of vehicles detected. The value of the count shall be internally stored for later retrieval through the Ethernet port. The data collection interval shall be user definable in periods of 5, 15, 30 or 60 minutes.

F VDP HARDWARE

The VDP should be specifically designed to mount in standard TS-1, TS-2, and 170 type cabinets.

The VDP shall operate in a temperature range from -34°C to +74°C and a humidity range from 0%RH to 95%RH, non-condensing.

The VDP should be powered by 12 or 24 VDC. These modules shall automatically compensate for the different input voltages.

The VDP shall utilize flash memory technology to enable the loading of modified or enhanced software through the Ethernet port without modifying the VDP hardware.

The front of the VDP shall include detection indications, such as LEDs, for each channel of detection that display detector outputs in real time when the system is operational.

The VDP shall have full-function BIU and integrated video detection communication. The VDP shall provide outputs to the controller of vehicle calls from video processors that reside within the shelf mounted unit and in the detector rack.

The VDS shall have the capability of monitoring phase information and passing that information and other system data such as “time” from the controller to video detection processor modules. The VDP shall also accept data from video processor modules and relay the information to the controller. The unit shall provide a maximum of 64

detector outputs to the controller via the SDLC interface.

G VIDEO DETECTION CAMERA

The video cameras used for traffic detection shall be furnished by the VDP supplier and shall be qualified by the supplier to ensure proper system operation.

The VDS camera sensor should utilize a single shielded CAT5E cable for power and video. Cable termination at the camera should not require crimping or special tools. The cable termination only require a standard wire stripper and a screwdriver. No connectors (e.g., BNC) shall be allowed.

The camera sensor shall allow the user to set the focus and field of view via the VDS software. Camera sensor control from the controller cabinet shall communicate over a single CAT5E or CAT6 cable. No additional wires shall be required.

The camera should produce a usable video image of the features of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a usable video image shall be the minimum range from nighttime to daytime, but not less than the range 0.003 lux to 10,000 lux.

The camera electronics shall include automatic gain control (AGC) to produce a satisfactory image at night for the VDS algorithms.

The imager luminance signal to noise ratio (S/N) shall be more than 50 dB with the automatic gain control (AGC) disabled.

The imager should employ three-dimensional dynamic noise reduction (3D-DNR) to remove unwanted image noise.

The camera imager should employ wide dynamic range (WDR) technology to compensate for wide dynamic outdoor lighting conditions. The dynamic range shall be greater than 100 db.

The camera should be digital signal processor (DSP) based and shall use a CCD sensing element and shall output color video with resolution of not less than 540 TV lines. The CCD imager shall have a minimum effective area of 811(h) x 508(v) pixels.

The camera should include an electronic shutter control based upon average scene luminance and should be equipped with an auto-iris lens that operates in tandem with the electronic shutter. The electronic shutter shall operate between the range of 1/60th to 1/90,000th second.

The camera should utilize automatic white balance.

The camera shall include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry by means of a portable interface device designed for that purpose and manufactured by the detection system supplier.

The horizontal field of view shall be adjustable from 4.5 to 48 degrees. This camera configuration may be used

for the majority of detection approaches in order to minimize the setup time and spares required by the user. The lens shall be a 12x zoom lens with a focal length of 3.5mm to 35mm.

The lens shall also have an auto-focus feature with a manual override to facilitate ease of setup.

The camera shall incorporate the use of preset positioning that store zoom and focus positioning information.

The camera shall have the capability to recall the previously stored preset upon application of power.

The camera shall be housed in a weather-tight sealed enclosure. The housing shall allow the camera to be rotated to allow proper alignment between the camera and the traveled road surface.

The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view. The camera enclosure with sunshield shall be less than 3.5" (89mm) in diameter, less than 5.25" (133mm) long, and shall weigh less than 2.5 pounds (1.14kg) when the camera and lens are mounted inside the enclosure.

The enclosure shall be designed so that the pan, tilt and rotation of the camera assembly can be accomplished independently without affecting the other settings.

H CAMERA LENS

The camera enclosure shall include a proportionally controlled Indium Tin Oxide (ITO) lens coating for the heating element of the front glass that maximizes heat transfer to the lens. The output power of the heater shall vary with

temperature, to ensure proper operation of the lens functions at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure. The transparent coating shall not impact visual acuity and shall be optically clear.

The glass face on the front of the enclosure shall have an anti-reflective coating to minimize light and image reflections and will include a Titanium Dioxide self-cleaning coating.

When mounted outdoors in the enclosure, the camera shall operate satisfactorily in a temperature range from

-30° F to +140° F (-34 °C to +60 °C) and a humidity range from 0% RH to 100% RH. Measurement of satisfactory video shall be based upon VDP system operation.

The camera should be powered by 48VDC. Power consumption shall be 5 watts typical and 16 watts or less under worst conditions.

Recommended camera placement height shall be 33 feet (or 10 meters) above the roadway, and over the traveled way on which vehicles are to be detected. For optimum detection the camera should be centered above the roadway traveled. The camera shall view approaching vehicles at a distance not to exceed 350 feet (107 meters) for reliable detection (height to distance ratio of 10:100). Camera placement and field of view (FOV) shall be unobstructed and as noted in the installation documentation provided by the supplier.

The video signal should be fully isolated from the camera enclosure. Cable terminations at the camera for video and power should not require crimping tools.

A weather-proof protective cover shall be provided to protect all terminations at the camera.

No special tooling shall be required to remove or install the protective cap.

The camera assembly shall include a temperature sensor. The sensor will be polled by the VDS every minute and will supply the current air temperature. The VDS software will display this information on the On-Screen Display for each camera.

I INSTALLATION

The cable to be used between the camera and the CCU in the traffic cabinet shall be CAT5E, shielded, direct burial cable. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. Shielded RJ-45 connectors shall be used where applicable. The CAT5E cable, RJ-45 connector, stripping and crimping tool shall be approved by the supplier of the video detection system, and the manufacturer's instructions must be followed to ensure proper connection. The video detection system shall be installed by supplier factory certified installers and as recommended by the supplier and documented in installation materials provided by the supplier. Proof of factory certification shall be provided.

J MAINTENANCE AND SUPPORT

The supplier shall maintain an ongoing program of technical support for the video detection system and a limited two-year warranty on the video detection system.

The supplier shall supply management software with free software and device firmware upgrades (as needed) for the lifetime of the system. Upgrades shall be performed by the supplier in coordination with the end user.

ITEM 604.0200 16 CHANNEL TS 2 CABINET DETECTOR RACK WITH BIU

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.0300 TS1 CABINET DETECTOR RACK WITH POWER SUPPLY

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.0500 WDR VIDEO DETECTION CAMERA WITH MOUNTING HARDWARE EACH

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.0700 VIDEO DETECTION CAMERA WITH RADAR AND MOUNTING HARDWARE

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.0800 VIDEO DETECTION CAMERA SURGE PROTECTION PANEL

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.1000 RACK-MOUNT VIDEO DETECTION PROCESSOR (4-CHANNEL)

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.1500 RACK-MOUNT VIDEO DETECTION PROCESSOR EXTENSION MODULE

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 604.2000 VIDEO DETECTION RACK PLUG-IN AMPLIFIERS – DUAL CHANNEL

ITEM 604.3000 VIDEO DETECTION RACK PLUG-IN AMPLIFIERS – THREE CHANNELS

ITEM 604.4000 VIDEO DETECTION RACK PLUG-IN AMPLIFIERS – FOUR CHANNELS

ITEM 604.5000 VIDEO CAMERA WIRING HARNESS WHIPS

ITEM 604.6000 GALAXY CAMERA BRACKET W/74" GUSSETED TUBE, VINYL INSERT, AND DETECTOR MOUNTING HARDWARE

ITEM 604.6100 ASTRO-BRAC – VIDEO MOUNTING HARDWARE W/WIRING BOX

A GENERAL

This specification sets forth the minimum requirements for a system that detects vehicles on a roadway using only video images of vehicle and bicycle traffic including cameras that are to be used by video detection systems. The video detection camera should be specifically designed and manufactured for video vehicle detection applications and shall be approved by the video detection processor manufacturer. The video detection camera shall be made in the U.S.A. in compliance with the FTA “Buy America” regulations. The video detection system shall be capable of operating and communicating with the City’s current Closed Loop system over fiber optic lines within the City’s Ethernet system.

B VIDEO DETECTION CAMERA

The video cameras used for traffic detection shall be furnished by the Video Detection Processor (VDP) supplier and shall be qualified by the supplier to ensure proper video detection system operation. The camera shall produce a usable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day.

The minimum range of scene luminance over which the camera produces a usable video image shall be the minimum range from nighttime to daytime, but not less than the range 0.1 lux to 10,000 lux. The camera should use a Charge Couple Device (CCD) sensing element and shall output monochrome or color video with resolution of not less than 380 lines horizontal. The camera should include auto-iris control based upon average scene luminance and should be equipped with an auto-iris lens. The camera should include a

variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry. The camera electronics should include AGC to produce a satisfactory image at night.

The camera should be housed in an environmentally sealed enclosure pressurized with dry gas to minimize the

formation of condensate and extend the life of the camera and lens. The housing shall be field rotatable to allow proper alignment between the camera and the traveled road surface. The camera enclosure shall be equipped with a sun shield. The sunshield shall include a provision for water diversion to prevent water from flowing in the cameras field of view. The camera enclosure with sunshield shall be less than 6" diameter, less than 26" long, and shall weigh less than 12 pounds when the camera and lens are mounted inside the enclosure. The camera enclosure shall include a thermostatically controlled heater to assure proper operation of the lens iris at low temperatures and prevent moisture condensation on the optical

faceplate of the enclosure. When mounted outdoors in the enclosure, the camera shall operate satisfactorily in a temperature range from -34 degrees C to +60 degrees C and a humidity range from 0% RH to 100% RH.

The camera shall be powered by 120 VAC 60 Hz. Power consumption shall be less than 40 watts under all conditions. Recommended camera placement should be 33 feet (or 10 meters) above the roadway, and over the traveled way on which vehicles are to be detected. The camera shall view approaching vehicles at a distance not to exceed 350 feet for reliable detection. The camera enclosure shall be equipped with separate, weather-tight connections for power and video cables at the rear of the enclosure to allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole. Video and power shall not be connected with the same connector. The video signal output by the camera shall be in RS170 format and be viewed in real time continuous video imaging. The video signal should be fully isolated from the camera enclosure and power cabling.

The camera shall produce a usable video image of the bodies of vehicles under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a useable video image shall be the minimum range from nighttime to daytime, but not less than the range 0.1 lux to 10,000 lux. The camera should use a Charge Couple Device (CCD) sensing element and should output monochrome video with resolution of not less than 380 lines horizontal.

The camera should include an electronic shutter control based upon average scene luminance and should be equipped with a factory adjusted manual iris. Auto-iris lenses are not allowed. The camera shall include a variable focal length lens with variable focus that can be adjusted, without opening up the camera housing, to suit the site geometry by means of a portable interface device designed for that purpose and manufactured by the detection system supplier. The horizontal field of view shall be adjustable from 8.1 to

45.9 degrees.

The camera electronics should include Automatic Gain Control (AGC) to produce a satisfactory image at night.

The camera shall be housed in a weather-tight sealed enclosure. All connections should be made in a tight seal at the video camera and in the controller cabinet only. No other splices will be permitted. The housing shall be field rotatable to allow proper alignment between the camera and the traveled road surface. The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view. The camera enclosure with sunshield shall be less than 6" diameter, less than 15" long, and shall weigh less than 6 pounds when the camera and lens are mounted inside the enclosure. The camera enclosure shall include a thermostatically controlled heater to ensure proper operation of the lens shutter at low temperatures and prevent moisture condensation on the optical faceplate of the enclosure.

When mounted outdoors in the enclosure, the camera shall operate satisfactorily in a temperature range from

-34 degrees C to +60 degrees C and a humidity range from 0%RH to 100% RH. The camera should be powered by 120-240 VAC 50/60 Hz... Power consumption shall be 15 watts or less under all conditions.

Recommended camera placement height shall be 33 feet (or 10 meters) above the roadway, and over the traveled way on which vehicles are to be detected, when possible, for this reason, the video detection mounting hardware shall consist of a 6-foot ASTRO-Brac bracket. The camera shall view approaching vehicles at a distance not to exceed 350 feet for reliable detection (height to distance ratio of 1:10). Camera placement and Field of View (FOV) shall be unobstructed and as noted in the installation documentation provided by the supplier. The supplier shall be responsible for the complete set-up of the detection zone system.

The camera enclosure shall be equipped with separate, weather-tight connections for power and video cables at the rear of the enclosure. No splices shall be allowed between the video camera and between the controller cabinet. All connections should be at the camera and in the controller cabinet only. These connections may also allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a Lens Adjustment Module (LAM) supplied by the VDP supplier. Video and power should not be connected within the same connector.

The video signal output by the camera shall be Color RS170 or CCIR format.

The video signal shall be fully isolated from the camera enclosure and power cabling. Each video processor shall contain a permanent labeled for the street name, phase, and detector number and detector termination terminals. The label shall be made of durable material such as laminated plastic, attached by wire or plastic ties. Adhesive attachment of the label shall not be acceptable.

The detector output shall be relay type with Fail Safe call capacity.

C MEASUREMENT AND PAYMENT

Payment for this item shall be at the bid price per each item complete in place.

ITEM 605.0000 VIDEO COMPRESSION SYSTEM (COMPLETE IN PLACE)

A GENERAL

Integrated Bus Interface Module (BIU) and Video Detection Communication Module.

This specification sets forth the minimum requirements for a full-function BIU and integrated video detection communication module. The module shall provide outputs to the controller of vehicle calls from video processors and other modules (e.g. loop amplifiers) that reside within the detector rack.

B FUNCTIONAL CAPABILITIES

The module shall have the capability of monitoring phase information and passing that information and other system data such as "time" from the controller to video detection processor modules. The module shall also accept data from video processor modules and relay the information to the controller. The unit shall provide a maximum of 64 detector outputs to the controller via the SDLC interface. The module shall reside in a NEMA TS-2 BIU slot of a detector rack to maximize the use of detector slots for video detection processor modules. The module shall interface with up to 4 video processor modules.

C REQUIREMENTS

The module shall be in compliance with the following industry specifications:

Transportation Electrical Equipment Specifications (TEES), August 16, 2002 (or latest edition), California Department of Transportation

NEMA Standard Publication TS 1-1989 (or latest edition)*, Traffic Control Systems,* National Electrical Manufacturers Association

NEMA Standard Publication TS 2-2003, Traffic Controller Assemblies With NTCIP Requirements, Version

02.06 (or latest edition), National Electrical Manufacturers Association

D DATA INTERFACES

The module shall have three data interfaces:

The interface to the controller shall be accomplished by the use of the TS-2 SDLC port and protocol in accordance with the TS-2 specifications. The module shall be able to be configured to respond to BIU addresses 8, 9, 10 and 11 or a combination thereof.

The interface with the detector rack shall use discrete logic inputs and outputs as defined in the TS-2 specifications for BIU's.

The interface to communicate with card rack video detection processors shall be manufacturer specific.

E USER INTERFACE

The module shall be self-initiating upon application of power or upon power-on reset via the reset button. The operational user interface shall be limited to those items on the front panel and shall not require a video monitor, mouse (pointing device) or computer attached directly to the module. A manual single pole single throw (SPST) reset push button shall be provided to the user to conduct a power-on reset of the module. The depression of the reset button shall not cause the MMU to go into "intersection flash" mode. The reset button shall be accessible from the front panel. High intensity LED indicators shall be used. The LED devices shall be clear when not lit and high intensity when lit. The indicators shall be "ON" for the active state and "OFF" for the inactive state. One LED indicator shall be provided for the TS-2 SDLC interface. The indicator shall be used to inform the user of any communication activity on the TS-2 port. LED indicators on the module representing the current status of the 64 output channels shall be provided. An illuminated LED indicator shall represent a "call" status; and a non-illuminated LED indicator shall represent a "no-call" status. Power requirements of the module shall meet the requirements

defined in the TS-2 specifications for BIU modules. The module shall require a normal supply voltage of 24 VDC ± 2 VDC. A voltage of 16 VDC or less shall be considered loss of power and a voltage of 18 VDC or more shall be considered adequate for operation.

The plug-in card shall be design for "hot swapping"; in other words designed so that the unit is not damaged by insertion to or removal from a powered rack. The unit shall operate within the environmental limits identified

in the NEMA TS-2 specifications. The module shall be designed and tested to meet the environmental requirements specified in the TS-2 specifications.

F MECHANICAL

The physical form factor of the module shall be in accordance with NEMA TS-2 BIU form factor requirements as specified in the TS-2 specifications. All interface cables and display indicators shall be on the front of the unit for easy access. The module front panel shall be aluminum and shall be designed for ease of manufacturability. All ferrous metal parts shall be protected against corrosion. All materials shall be moisture and fungus resistant. Printed circuit boards shall meet the requirements of the TS-2 specifications. Input and output connectors shall be provided with locking mechanisms that eliminate accidental extraction of interface cables.

Limited Warranty

The supplier shall provide a limited three-year warranty on the module. See supplier's standard warranty included in the Terms and Conditions of Sale documentation. During the warranty period, technical support shall be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory-certified personnel or factory-certified installers.

Maintenance and Support

The supplier shall maintain an adequate inventory of parts to support maintenance and repair of the video detection system. These parts shall be available for delivery within 30 days of placement of an acceptable order at the supplier's then current pricing and terms of sale for said parts. The supplier shall maintain an ongoing program of technical support for the video detection system. This technical support shall be available via telephone, or via personnel sent to the installation site upon placement of an acceptable order at the supplier's then current pricing and terms of sale for on site technical support services. Installation or training support shall be provided by a factory-authorized representative. All product documentation shall be written in the English language.

G MEASUREMENT AND PAYMENT

Payment for this item shall be paid for each item complete in place.

ITEM 605.1000 CENTRAL CONTROL UNIT (1-U RACK MOUNT)

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 605.2000 CENTRAL CONTROL UNIT (SHELF-MOUNTED; TS 1) WITH POWER SUPPLY

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 605.3000 CENTRAL CONTROL UNIT (SHELF-MOUNTED; TS2-FOUR SENSOR) WITH POWER SUPPLY

Shall meet or exceed specification of component in Section 604.00 - Video Detection-Complete System.

ITEM 606.0000 WIRE LOOP INSTALLED IN ROADWAY SD4.041

A GENERAL

This item shall include all insulated wire embedded in the bituminous concrete pavement and other surfaces and the wire inserted in the 1-1/2-inch PVC conduit leading from the roadway to the manhole. Also included are all labor, tools, materials, and other equipment necessary to install the loop completely in place and operative. The electronic equipment to which the loop must connect to from an operating vehicle presence detection device is not included in this item. All loops shall have two turns of wire. All loop detector beldin wire from the controller to

the pull box shall be replaced. Each loop shall have a separate lead wire to the pull box, with each having a separate sweep. Additional pull boxes and conduit may be necessary to complete the wire loop installation. No core drilling thru the curb will be allowed.

B MATERIALS

Loop detector wire shall be No. 14 AWG stranded with 600-volt THHN cross-linked polyethylene insulation. Loop wire shall be protected by a flexible, vinyl plastic tubing of 3/16 inch ID, a minimum of 1/32 inch wall, and 1/4-inch O.D.

C BITUMINOUS CONCRETE PAVEMENT

The actual configuration of the loops shall be as dimensioned on the Traffic Control Location Plans and Traffic Signal Detail Plans. The Contractor shall mark the loop location on site, and request the Contracting Officer's inspection and approval before the Contractor proceeds with the installation work.

D CUTTING SLOTS

Slots in the bituminous concrete binder course shall be cut with a concrete sawing machine to a uniform depth as shown in the Traffic Detail Plans and as required to accommodate all necessary loop turns or leads. Diagonal saw cuts of at least 12 inches in length shall be made at each corner to prevent sharp bends in the wire. The diagonal cuts shall overlap the main cuts so that each wire-bearing slot has full depth. Drilled corners are optional.

E SEALING OF SLOTS

The pavement slots for bituminous concrete pavements shall be filled with approved embedding sealer strictly in accordance with the directions of the manufacturer. The sealer shall be specifically recommended by the manufacturer for use in new and existing bituminous concrete pavements.

F PAVEMENT JOINTS OR CRACKS

Loop wires crossing pavement joints or noticeable cracks shall be protected with an approved insulating sleeve continuously for at least six inches each side of the joint or crack. The objective is to prevent bonding of the wire to the pavement. The ends of the sleeving material shall be taped to prevent entry of slot sealing compound into the sleeving. Said sleeving shall be furnished and installed at no extra cost and shall be incidental to the induction loop item. The end of the 1-1/2 inch PVC conduit shall be plugged with an approved material, and loop ends shall be sleeved as for cracks.

G TESTING OF LOOPS

No splice shall be used in the installation of any induction loop or its lead-in wire to the appropriate hand-hole. The following test procedures shall be performed by the Contractor in the presence of the Contracting Officer after installation as, detailed below. The cost of equipment, labor and materials to perform such testing and similar retesting following repairs, replacement, or adjustment of any detector shall be at no additional cost above the total sum bid for each individual traffic signal control item.

After installation of wire loop vehicle detectors in the roadways and installation of loop connected leads to the controller cabinet each loop and lead-in combination shall be tested for proper installation. If any loop and lead-in combination fails to pass any one of the five following tests it shall be repaired and then retested.

1. The DC resistance from lead to lead of the same loop shall not exceed 3 ohms as measured by a high-quality battery powered voltage ohm meter.

2. A megohm (megger) test at 500 V DC or greater, shall be made between lead-in shield and the earth ground rod. The resistance shall not be less than 100 megohms.
3. The two leads of a loop shall be temporarily spliced together, and a similar megger test made between the leads and the earth ground rod. This resistance shall not be less than 100 megohms.
4. The two leads of a loop shall be temporarily spliced together, and a similar megger test made between the leads and the lead-in shield. This resistance shall not be less than 100 megohms.
5. The inductance shall be 50 - 700 microhenries.

H MEASUREMENT AND PAYMENT

For bituminous concrete payment all main saw cuts shall be measured for payment. Limits of measurement shall be the intersection of main saw cuts to the centerline of the end of 1-1/2 inch conduit used for lead-in wires. Diagonal cuts shall not be measured. The contract unit price per linear foot of induction loop as measured shall include full payment for all sawing,

loop joint, wire, sealing, etc. The actual length of wire shall not be considered in any measurement. The cost of the continuous wire extending into the hand-hole shall be included in the unit price. Payment for loop lead-in cable shall be incidental to the cost of the wire loop and included under this item.

ITEM 607.0000 COAXIAL CABLE AND CONNECTIONS

A GENERAL

The coaxial cable to be used between the camera and the VDP in the traffic cabinet shall be Belden 8281 or a 75 ohm, precision video cable with 20 gauge solid bare copper conductor (9.9 ohms/M), solid polyethylene insulating dielectric, 98% (min) tinned copper double –braided shield and black polyethylene outer covering. The signal attenuation shall not exceed 0.78 dB per 100 feet at 10 MHz Nominal outside diameter is 0.304 inches. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. Three (3) 75-ohm BNC 6 plug connectors shall be used and supplied at both the camera and cabinet ends. The coaxial cable, BNC connector, and crimping tool shall be provided to the City of Worcester by the supplier of the video detection system, and the manufacturer's instructions must be followed to ensure proper connection.

The power cabling shall be 16 AWG four conductors including one conductor for ground shall be combined with the coaxial cable, so only one cable is required for connecting the camera and power supply. The cabling shall comply with the National Electric Code, as well as local electrical codes. Cameras may acquire power from the luminaries if necessary.

The video detection system shall be installed by supplier factory certified installers and as recommended by the supplier and documented in installation materials provided by the supplier. Proof of factory certification shall be provided.

B MEASUREMENT AND PAYMENT

Payment for this item shall be paid per linear foot.

ITEM 607.1000 CAT6 DIRECT BURIAL SHIELDED CABLE (1000 FT) EACH

ITEM 607.1500 CAT6 SHIELDED PASS THROUGH RJ45 CONNECTORS (100-PACK) EACH

ITEM 608.0500 12"-3 SECTION LED TRAFFIC SIGNAL HEADS W/VISORS COMPLETE

ITEM 608.1000 12" BI-MODEL FIBER-OPTIC LEFT TURN ARROW W/HOUSINGS

ITEM 608.2000 12" TUNNEL VISORS FOR TRAFFIC SIGNALS

ITEM 608.3000 12" GEOMETRICALLY PROGRAMMED LOUVER SLOTTED UNIVERSAL FULLCIRCLE & VISORS

A GENERAL

Traffic Signal Heads shall be standard aluminum traffic signals and shall be weather tight assemblies, complete with LED indicators, "Black" in color with black fronts and be on the MassDOT approval list of approved traffic signal equipment. All RED, AMBER, and GREEN indications shall be LED with tunnel visors, with upper and lower mounting hardware with accessibility to wiring without disassembling the hardware and meet or exceed the requirements

on LED Specifications listed within these Specifications.

B MEASUREMENT AND PAYMENT

Payment for this item shall be paid for each item complete in place.

ITEM 609.0000 16" COUNTDOWN LED PEDESTRIAN SIGNAL HEADS W/VISORS

ITEM 609.1000 16" COUNTDOWN LED PEDESTRIAN MODULES

ITEM 609.2000 16" PEDESTRIAN HOUSING WITH VISORS ONLY

ITEM 609.3000 16" OPEN PEDESTRIAN VISORS

A GENERAL

The countdown pedestrian signal heads shall be 16" LED countdown pedestrian signal module housed in an aluminum casing with visors. The signal shall consist of international symbols of an LED upright solid hand symbolizing "Don't Walk" and a solid walking person symbolizing "Walk". The internal countdown module shall be comprised of two 7 segment digits, 8 inches high and made of 88 Portland Orange LED's. The countdown module shall display the number of seconds remaining throughout the pedestrian clearance interval only and blank out when not activated. This programming function shall be available on the back of the pedestrian module. The intersection controller bases the clearance time upon the Don't Walk signal indications which automatically set the pedestrian countdown module. The countdown module shall continuously monitor the intersection controller for any changes to the pedestrian phase timing and reprogram itself automatically. All pedestrian signals shall be a one-piece unit containing both the LED "HAND" and LED "FIGURE" fixture in the same unit with an open visor, with upper and lower mounting hardware. The LED countdown signal shall retain all timing information from the controller and not be

adjusted in the pedestrian signal head. The countdown pedestrian signal heads shall comply with all standards and specifications of the latest edition of the MUTCD.

B MEASUREMENT AND PAYMENT

Payment for this item shall be paid for each item complete in place.

ITEM 610.0000 RECTANGULAR RAPID FLASHING BEACON ASSEMBLY

A GENERAL

The Work under these Items shall conform to the relevant provisions of Section 800, of the Standard Specifications, the 2023 Manual on Uniform Traffic Control Devices (MUTCD), the MUTCD interim approval for optional use of rectangular rapid flashing beacons, and the National Electric Code.

The work shall include the furnishing of Rectangular Rapid Flashing Beacon system (TAPCO brand or approved equivalent) with 110-watt solar panel systems to be installed by others.

The manufacturer shall offer a three-year unconditional warranty against all defects in material and workmanship.

The open ends of conduits entering or leaving strain poles, posts and pull boxes shall also be sealed with the approved elastic sealing compound.

B MEASUREMENT AND PAYMENT

The work under Item 610.00 will be paid for at the respective contract lump sum price, which shall include all compensation for the work, all labor, materials, and equipment necessary or incidental to the Rectangular Rapid Flash Beacon Assembly including but not limited to major items listed on the plans.

C DESCRIPTION OF COMPONENTS

The product shall be the TAPCO system or approved alternative. This assembly includes a complete functional RRFB system with RRFB Light Bars, iNX Push Buttons, Crosswalk Illuminators, 110-Watt Solar Panels, and Control Cabinets with Flash Controllers, Wireless Transceivers, 105Ah Batteries, Mounting Hardware, Static Signage, Poles, and Bases for both sides of a street. These components shall meet or exceed specifications in the following sections:

ITEM 610.1000 RRFB Control Cabinet

ITEM 610.2000 RRFB Controller

ITEM 610.3000 RRFB Solar Charge Controller

ITEM 610.3500 RRFB 85-Watt Solar Panel

ITEM 610.4000 RRFB 105 Ah Battery

ITEM 610.4500 RRFB Wireless Transceiver

ITEM 610.5000 RRFB Crosswalk Illuminator

ITEM 610.5500 RRFB Light Bar

ITEM 610.6000 RRFB Audible Push Button

ITEM 610.7000 RRFB Static Signs

ITEM 610.8000 RRFB Pole and Base

A. GENERAL REQUIREMENTS

The RRFB Light Bar Manufacturer shall have a minimum of ten years of relevant intelligent traffic product manufacturing experience, as well as a minimum of three years of RRFB Light Bar manufacturing experience.

Upon activation by pedestrian push button, the RRFB controllers shall activate all RRFB Light Bars in the crosswalk system simultaneously. RRFB Light Bars shall flash synchronously and then cease operation after a programmable timeout.

All proposed traffic signal equipment including but not limited to bases, doors, signal posts, pushbutton housings, controller cabinets (exterior), service meter socket box, hardware, and rigid mounting brackets for signals and signs shall be colored gloss Black, subject to the approval of the City.

RRFB Control Cabinet shall be NEMA 3R Type.

Shall be 21.1” tall x 17.5” wide x 11.6” deep and constructed of minimum 0.125" thick aluminum.

To promote airflow for internal components, the cabinet shall be vented with screening included on all vents and drains to prevent insects and other foreign matter from entering.

For security, the cabinet must include at least three tamper-resistant stainless-steel hinges and a replaceable #2 traffic lock with keys.

To facilitate maintenance or repairs, the cabinet shall include a removable control panel to which all control circuit components either mount or connect.

For easy installation on a wide range of pole sizes and types, the cabinet shall utilize six 5/16"-18 stainless steel mounting studs that mate to a range of bracket options. To ensure a secure mount to the supporting post, three banding style brackets that fit poles with a 2-3/8” or larger diameter shall be included as standard equipment.

Mounting brackets also available for square pole, wooden post, and wall mount applications.

To prevent corrosion, all materials used in the construction or mounting of the control cabinet shall be either aluminum or stainless steel. Anti-vandal mounting hardware shall be available as an option.

A UV resistant label shall be applied to the exterior of the cabinet and include system specific information including model number, serial number, date of manufacture, as well as any applicable regulatory compliance information.

ITEM 610.2000 RRFB CONTROLLER

The RRFB Programmable Flash Controller is housed within the NEMA 3R type Control Cabinet, and shall:

1. Include integrated constant-current LED drivers with a minimum of two-channel output for driving one or two RRFB units.
2. Automatically adjust the LED drive current control to optimize brightness for the ambient lighting conditions determined by the phototransistor input.
3. Have the LED drive outputs reach the full output current as programmed within the duration of the 100ms on-time.
4. Include an integrated Real Time Clock (RTC) with on-board battery backup.
5. Have the capability of RS232 communication for programming with Windows-based software.
6. Include a minimum of two General Purpose Inputs and Outputs (GPIO).

Shall synchronize the system components to activate the indications within 120msec of one other and remain synchronized throughout the duration of the flash (timeout) cycle.

Shall operate on the license-free ISM band. Shall comply with part 15 of FCC rules.

Shall operate from 3.3VDC to 15VDC.

Shall be, in the unlikely event of failure, replaceable independently of other components.

ITEM 610.3000 RRFB SOLAR CHARGE CONTROLLER

RRFB Solar Charge Controller shall utilize an intelligent 4-stage algorithm and Pulse Width Modulation (PWM) for battery charging.

Shall automatically provide Low Voltage Disconnect (LVD) to protect batteries when needed.

Shall automatically provide Load-Reconnection once battery levels have been restored to an acceptable value.

Shall protect against and automatically recover from: short circuit, overload, reverse polarity, high temperature, lightning and transient surge, as well as voltage spikes.

Shall be independently replaceable of other control panel components.

Shall operate from -40° to +140°F (-40° to +60°C).

ITEM 610.3500 RRFB 110-WATT SOLAR PANEL

RRFB 110-Watt Solar Panel shall be constructed of an anodized aluminum frame, high-transmission 1/8" tempered glass, with silicon cells encapsulated in double-layer EVA, and with a white polymer backing.

The Solar Panel shall be affixed to a pole top bracket that allows an adjustable angle to provide maximum insolation exposure.

To ensure maximum solar insolation regardless of installation location, the post top mounting system shall provide 360° of rotational direction adjustment and upon installation, must be oriented with the collector facing South.

The solar panel must be IEC61215, TUV, and UL 1703 certified. The solar panel shall operate at 12VDC nominal with a maximum output rating of 110 watts.

All solar panel connectors shall conform to Ingress Protection, IP-67 rating, dust proof, and protected from temporary immersion in water up to 1 meter deep for 30 minutes. Connectors shall be Deutsch DTM series.

All solar panel fasteners shall be anti-vandal pin-type set screws. Wrench shall be provided.

ITEM 610.4000 RRFB 105 AH BATTERY

RRFB 105 Ah Battery shall be housed inside the RRFB Control Cabinet. Shall be internally housed in its own IP67 type enclosure.

Shall be independently replaceable of other control panel components. Shall be able to monitor internal temperature.

Shall operate between the temperatures of -40° to +176°F (-40° to +80°C).

ITEM 610.4500 RRFB WIRELESS TRANSCEIVER

Shall operate wirelessly at 900 MHz, utilizing Frequency Hopping Spread Spectrum (FHSS) technology to minimize the effects of external RF interference.

Shall seamlessly integrate with the controller to ensure sequential activation of other radio-equipped devices in the system.

Shall include an integrated LCD and two user-interface buttons for setup and troubleshooting, including readouts of flash duration (timeout), battery conditions, and LED testing functionality.

Shall include two LED indicators for status and troubleshooting.

Shall be capable of operating as a Parent (Gateway) or Child (Node or Repeater).

Shall be capable of providing site-survey data for verification of signal strength between network devices.

Shall include network-wide modification of sign controller settings and output durations, using programmability from any networked transceiver without the use of additional equipment or software.

Shall have a nominal output voltage of 12 VDC and a capacity of 105Ah.

Shall be three quantity 12-volt 35Ah batteries connected in parallel and individually fused. Shall be rechargeable type Absorbent Glass Mat.

Shall be sealed and spill-proof.

Battery shall be replaceable independently of other components. Shall be fused for short-circuit protection.

ITEM 610.5000 RRFB CROSSWALK ILLUMINATOR

RRFB Crosswalk Illuminator shall operate in conjunction with the crosswalk controller and intelligent warning devices.

Shall activate when less than 10 lux of ambient light is present (when activated by a pedestrian). Shall provide at least 20 vertical lux at 5 feet for a standard 2 lane crosswalk.

Shall activate with a .5 second soft start.

Shall allow for multiple brightness options for each of illuminator. Shall be housed in its own IP66 type enclosure.

Shall be made of weather resistant materials (aluminum, stainless steel, plastic). Shall be able to be adjusted and aimed both horizontally and vertically.

Shall be independently replaceable among other control panel components. Shall operate between the temperatures of -40° to +176°F (-40° to +80°C).

ITEM 610.5500 RRFB LIGHT BAR

The RRFB-XL2™ Light Bar or approved equal shall be in conformance with all applicable FHWA MUTCD standards and guidelines, and shall meet or exceed the requirements specified in FHWA Memorandum IA-21, Interim Approval for Optional Use of Pedestrian-Actuated Rectangular Rapid Flashing Beacons at Uncontrolled Marked Crosswalks.

Shall house two rapidly and alternately flashing rectangular yellow LED array vehicle indications and one side-mounted yellow LED array pedestrian indication. The LED arrays shall be designed, located and operated in accordance with the detailed requirements as specified on the plans.

When activated, The Light Bar shall have 75 periods of flashing per minute and shall have alternating and simultaneous flash operations following the “WW+S” flash pattern.

Active vehicle indications shall be visible at distances over 1000 feet during the day and over one mile at night.

The light intensity of the vehicle indications shall meet the minimum specifications of Society of Automotive Engineers (SAE) standard J595 (Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles) dated January 2005. Manufacturer Certification of Compliance shall be provided upon request.

Shall have a housing that is constructed of durable, corrosion-resistant powder-coated aluminum with stainless steel vandal-resistant fasteners.

Shall have enclosed components that are modular in design whereby any component can be easily replaced without having to uninstall the RRFB assembly.

Shall include mounting hardware for either single or back-to-back pole mounting and shall be universal to the pole type.

Shall have two vehicle RRFB indications that are approximately 7” wide x 2.8” high, each with 8 yellow LEDs in its array and one Pedestrian indication that is approximately 0.5” wide x 1.7” high with 8 individual yellow LEDs in its array.

Shall have overall dimensions of approximately 23.6” wide x 3.8” high x 1.4” deep.

ITEM 610.6000 RRFB AUDIBLE PUSH BUTTON

Shall be ADA compliant.

Shall function as a normally open (n/o) circuit with the following features:

1. Voice narration message with ambient adjustable volume control and field-replaceable speaker
2. Voice narration to be English and English/Spanish selectable
3. Programmable number of audible message repeats
4. Configurable Locator Tone
5. Ability to configure features using mobile application

Shall have a directional push button that can be rotated into a fixed position for the application. Shall be provided with all necessary mounting hardware, wiring and associated ADA signage. Shall have ambient noise detection configurable for auto volume control.

Shall have Bluetooth Low Energy (BLE) radio to provide optional wireless communication and configuration features.

Shall have an operating voltage range of 10-24 VDC. Shall have an idle current of approximately 9 mA @ 12V. Shall operate from -30° to +165°F (-34° to +74°C).

ITEM 610.6500 RRFB PEDESTRIAN THERMAL SENSOR

The pedestrian thermal sensor shall have an aluminum housing with sunshield and use infrared heat profiles to

identify road users within detection zones and send actuation signals to pedestrian signal. Sensor shall integrate directly with RRFB assembly specified in Item 610.00.

Shall detect users located between zero and 82 feet from sensor. Shall function reliably in dark, shadow, and sun glare conditions.

Shall be IP-67 rated and have an operating temperature between -40 degrees Fahrenheit and 131 degrees Fahrenheit.

Sensor shall function with between 12 V and 24 V DC, be configurable with Ethernet or Wi-Fi connections.

Shall include all cabling, mounting hardware brackets, and banding straps to needed for install and to provide functional detection at any pedestrian-signal location.

ITEM 610.7000 RRFB STATIC SIGNS

Each static sign face shall be constructed on a 0.080" thick 5052-H32 aluminum and screened onto 3M Diamond Grade DG3 Reflective sheeting of specified color.

Shall have MUTCD-compliant sign legend, or as directed by the City. Shall have two holes for mounting to a post or pole.

Shall include pole-mounting hardware.

ITEM 610.8000 RRFB POLE AND BASE

Pole shall be a standard specified outer diameter aluminum pedestal pole.

Pole shall be supplied with one end threaded for easy installation into a pedestal base. Pole shall be Schedule 40 pipe raw aluminum as required.

Pedestal Base shall be TP-358 cast aluminum that mounts on a concrete foundation attached by four internal anchor bolts imbedded in the foundation.

Pedestal Base shall have a large 8.5" square hand hole cover allowing access to the interior.

ITEM 611.0000 ACCESSIBLE PEDESTRIAN SIGNAL

A. GENERAL

Accessible pedestrian signal (APS) shall be ADA compliant and shall function as a normally open (n/o) circuit with the following features:

Voice narration message with ambient adjustable volume control and field replaceable speaker Voice narration to be English and English/Spanish selectable

Programmable number of audible message repeats Configurable Locator Tone

Configurable features through app

Ambient noise detection configurable for auto volume control

Bluetooth Low Energy (BLE) radio providing wireless communication and configuration functionality Shall have an operating voltage range of 10-24 VDC.

APS shall have a directional push button that can be rotated into a fixed position for the application. APS shall be provided with all necessary mounting hardware, wiring, interconnect boards, SDLC cables, PC app dongle, and associated ADA signage.

APS shall have an idle current of approximately 9 mA @ 12V and operate from -30° to +165°F (-34° to +74°C).

ITEM 611.1000 APS INTELLIGENT CENTRAL CONTROL UNIT (ICCU)

APS Intelligent Central Control Unit (ICCU) shall be a Polara iCCU-S2 or approved equivalent.

ITEM 611.1200 APS PED HEAD CONTROL UNIT (IPHCU)

APS Ped Head Control Unit (IPHCU) shall be a Polara iPHCU3S or approved equivalent.

ITEM 611.1600 APS PUSH BUTTON (2-WIRE)

APS Push Button (2-Wire) shall be a Polara iNS2 or approved equivalent.

ITEM 611.1800 APS PUSH BUTTON (3-WIRE)

APS Push Button (3-Wire) shall be a Polara iNS3 or approved equivalent.

ITEM 612.0100 TRAFFIC SIGNAL POLES-9 FT. STANDARD

ITEM 612.1000 ALUMINUM POLE PLATES FOR SIDE OF POLE MOUNTING

ITEM 612.2000 UPPER & LOWER PIPE ASSEMBLY FOR SINGLE SECTION- COMPLETE

ITEM 612.2500 UPPER & LOWER PIPE ASSEMBLY FOR TWOWAY SECTION COMPLETE

ITEM 612.3000 UPPER & LOWER PIPE ASSEMBLY FOR MULTI - SECTION COMPLETE

ITEM 612.4000 THREADED 3-WAY CENTER SUPPORT W/SET SCREWS

ITEM 612.5000 IRON "T" W/SET SCREWS – THREADED ALL ENDS

ITEM 612.5100 IRON ELBOW W/SET SCREWS – THREADED BOTH ENDS

ITEM 612.5200 SUPPORT TUBE 1 ½" X 43" THREADED BOTH ENDS

ITEM 612.5400 IRON SLIP "T" ON CENTER SUPPORT – THREADED BOTH ENDS W/SET SCREWS

ITEM 612.5500 SUPPORT TUBE, 1-1/2" NPS-ALUMINUM-19"-POWDER COAT BLACK

ITEM 612.5600 SUPPORT TUBE, 1-1/2" NPS-ALUMINUM-43"-POWDER COAT BLACK

ITEM 612.5700 SUPPORT TUBE, 1-1/2" NPS-ALUMINUM-57"-POWDER COAT BLACK

ITEM 612.6000 STEEL WASHERS FOR TRAFFIC SIGNALS

ITEM 612.7000 SLIP FITTER ASSEMBLY FOR 3- & 4-WAY SIGNAL HEADS THREADED

ITEM 612.7100 CAST NIPPLE LOCKING NUT

ITEM 612.7200 NEOPRENE WASHERS FOR TRAFFIC SIGNALS

ITEM 612.7300 SERRATED LOCKING RINGS FOR TRAFFIC SIGNALS

ITEM 612.7400 THREADED OCTAGON SIGNAL CLOSURE CLOSING CAP - 2" LENGTH

A GENERAL

Traffic signal and pedestrian posts shall be 4-inch aluminum pipe. Bottoms shall have 4-inch pipe threads. All signal posts shall have a Black powdered coat finish. All threads shall be protected during transportation.

All brackets shall be 1- 1/2" steel pipe with cast iron fittings painted Black. All pedestrian signal heads and traffic signal heads shall be attached to the traffic post with upper and lower assemblies with accessibility to the wiring without dissembling the hardware, unless attached directly onto the post top. All the traffic signal hardware material (T, elbows fittings, etc...) shall be cast iron, threaded at all openings, with set screws and painted Black.

B MEASUREMENT AND PAYMENT

Payment for these items shall be paid for each item complete in place.

ITEM 613.0000 ALUMINUM OCTAGON TRAFFIC SIGNAL BASES W/STEEL COUPLING

A GENERAL

Bases shall be of the octagonal transformer type made of aluminum alloy 356 (ASTM B-26) permanent mold castings with threaded steel collar inserts and a standard removal access panel, as shown on the shop drawings. Bases shall have a "Black" powdered coat finish.

B MEASUREMENT AND PAYMENT

Payment for these items shall be paid for each item complete in place.

ITEM 614.1500 15 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.2000 20 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.2500 25 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.3000 3 0 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.3500 3 5 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.4000 4 0 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.4500 4 5 FT. MAST ARM ASSEMBLY-TYPE II, MAX (HEAVY) LOADINGS

ITEM 614.5000 M A S T ARM BASES – 20" BOLT PATTERN ON BOTTOM

ITEM 614.6000 MAST ARM ORNAMENTAL BASES-VALMONT TYPE

ITEM 614.7000 MAST ARM ORNAMENTAL BASES-UNION METAL TYPE

ITEM 614.8100 ASTRO-BRAC ASSEMBLY-ONE WAY – 3 SECTION

TEM 614.8200 ASTRO-BRAC ASSEMBLY-ONE WAY – 4 SECTION

ITEM 614.8300 ASTRO-BRAC ASSEMBLY-ONE WAY – 4 SECTION

ITEM 614.8400 OPTICOM BAND MOUNTING HARDWARE KITS FOR MAST ARMS

ITEM 614.9100 CAST IRON RIGID MAST ARM HANGER BODY ASSEMBLY

ITEM 614.9200 CAST IRON PLUMBIZER ASSEMBLY

ITEM 614.9300 CAST IRON FREE SWING MAST ARM HANGER ASSEMBLY- COMPLETE

ITEM 614.9400 RIGID MAST ARM HANGER-2-WAY-ALUMINUM 1-1/2" NPS UPPER AND TRI-STUD LOWER (SE-

3346 OR APPROVED EQUIVALENT)

A GENERAL

All traffic signals shall be designed in a **STANDARD BOX CONFIGURATION**. This will allow proper video detection alignment and proper street name sign alignment.

Mast arm bases shall be a permanent mold casting of 356-T4 aluminum alloys. The mast arm shaft shall have an ornamental base similar to the Washington base style manufactured by Valmont Industries or similar to the Main Street Streetscape project. The use of adapter rings or clips is prohibited. The base height shall not exceed 45 inches. The base shall have a door opening and a door with a cap screw fastening device. A tapped hole shall be provided for a grounding lug. All bolts for holding hand hole and access covers shall be greased at the time of installation.

The anchor bolts shall be high strength (50,000 psi minimum yield strength). The anchor bolts shall be determined by the size of the mast arm but not less than 1 – ½ inches. All anchor bolts threads shall be greased prior to installing the base. Traffic signal posts shall not be erected on foundations until the concrete has set for a minimum of twenty - eight (28) days. Posts shall be set so that they are plumb prior to all loads applied.

Mast arms shall be a steel pole and be designed to accommodate fixed signals at the end and intermediate points as shown on the plans and designed to accommodate **max loadings (Heavy Loads)** and be designed to the latest Mass Dot specifications.. The mast arm lengths shall be as shown on the plans. Each member shall be spun from seamless tubing, ASTM- A36 alloy. Every arm shall have a high steel clamp set with minimum 5/8-inch neck bolts, or suitable means of attachment to mast arm shaft. A brushed wiring entrance hole shall be provided adjacent to the intermediate hanger. Every wiring entrance shall have a rubber grommet.

All mid mounted mast arm signal housings are to be fixed mounted using ASTRO-BRAK or an approved equal mounting at the center of the housing. No Clevis pin brackets are to be used without approval from the City's Traffic Engineer. Signal heads shall be vertically fixed-mounted. All arms shall have a removable cap at the tip. Mounting hardware for side-of-shaft mounting shall be heavy-duty pole plates and couplings. The bottom of the signal heads shall have a minimum clearance of not less than 16 feet or greater than 19 feet above the pavement grade at the center of the roadway.

The signal head mounting system shall be detailed and submitted to the City's Traffic Engineer for approval. The final adjustment of the facing of the traffic signals shall be made as directed by the City's Traffic Engineer after all signals at the intersection are in operation. . Exposed surfaces of the traffic signal post and bases shall have a "Worcester Black" polyester powder finish.

All mast arm posts shall be produced from one piece of seamless tubing, ASTM-A595 GR A Alloy, with a steel monotube (7GA = .1793 inches) and be designed to the latest Section 800 of the MSSHB specifications. The shaft shall be tapered at .14 in/ft. The top 6 feet of the shaft shall be uniform. The pole shall have no visible longitudinal or circumferential welds except those joining the shaft at the base. The shaft shall have a J-hook wire support inside the pole near the top. Access from the top of the post must be available to run any wiring without disassembling the mast arm. The bottom of the pole shall have a 4"x 6 ½ "hand hole for access to wiring. Exposed surfaces of the traffic signal mast arm post and bases shall have a "Worcester Black" polyester powder finish and tire wrapped with heavy, water-repellent paper for protection during shipping and installation.

The Contractor shall be responsible for making all necessary arrangements to have the proper utility companies relocate overhead wires in order for the proper mast arm clearances to be obtained, should any conflicts occur. The Contractor shall take extra care and precautions in placing signal heads to ensure the existing structures and overhead utility wires do not interfere with the visibility of the signal heads suspended above the roadway. All measurements to determine the exact dimensions and clearances between mast arms and existing structures and overhead utility lines shall be made in the field by the Contractor in the presence of the City's Traffic Engineer and incorporated into the erection plans and shop drawings which are submitted for approval.

All structures shall be constructed in accordance with the applicable requirements of the Section 800 of the MSSHB standard drawings. The completed structure with all appurtenances attached thereto shall be designed and constructed in accordance with the most current requirements of AASHTO " Section 800 of the MSSHB Standard Specifications for Structural Supports for Highway signs, Luminaries and Traffic Signals" (Current edition) for a wind speed of 130 miles per hour and a 30% Gust Factor with maximum loading. Longhand design calculations shall be submitted for all mast arm and span wire assemblies. All shop drawings and calculations shall be stamped by a

professional structural engineer registered in the State of Massachusetts.

B MEASUREMENT AND PAYMENT

Payment for these items shall be paid for each item complete in place.

ITEM 615.0000 MAST ARM FOUNDATION – COMPLETE

A GENERAL

All sweeps to be installed in mast arm bases shall be 3 inch (PVC) sweeps with sufficient 3 inch PVC riser to project above the finish grade of the base. One spare sweep and riser, capped at both ends, shall be poured in place in each mast arm base. The Engineer shall determine the location of the spare sweep. No more than two sweeps shall be in any foundation. The foundation design shall be in conformance with Section

190.62 and 801.62 of the Section 800 of the MSSHB Standard Specifications. No pre-cast foundations shall be used for mast arms.

The foundation shall be constructed with a concrete mixture having a minimum of 5,000-psi compressive strength at 28 days. Unless otherwise directed by the Engineer, poles shall not be erected on a concrete foundation until the concrete has set for at least 28 days. All mast arm anchor bolts shall be determined by the size of the mast arm but not less than 1 -1/2 inches. Bolts shall be installed in the base to the precise spacing as shown on the plans.

After the mix is placed in the forms, it shall be vibrated by mechanical means long enough to ensure complete placement without honeycombing. Care shall be exercised not to over-vibrate and reduce air content below specifications. Curing shall be by wet method for a minimum of 72 hours. Thereafter, it shall be air cured until it reaches design strength of 5,000-psi compressive strength. All foundations shall be installed at the locations as shown on the plans except as approved deviations, which are required to meet field conditions.

B MEASUREMENT AND PAYMENT

Payment for these items shall be paid for each item complete in place.

ITEM 616.0000 12" RED LED BALL INDICATION

ITEM 616.1000 12" RED LED ARROW INDICATION

ITEM 616.2000 12" RED LED FOR 3M PROGRAMMABLE SIGNALS

ITEM 616.3000 12" GREEN LED BALL INDICATION

ITEM 616.4000 12" GREEN LED ARROW INDICATION

ITEM 616.5000 12" GREEN LED FOR 3M PROGRAMMABLE SIGNALS

ITEM 616.6000 12" AMBER LED BALL INDICATION

ITEM 616.7000 12" AMBER LED ARROW INDICATION

ITEM 616.8000 12" AMBER LED FOR 3M PROGRAMMABLE SIGNALS

A GENERAL

An independent laboratory shall certify that all LED signal modules comply with Section 6 Quality Assurance of the ITE's Publication ST-021 and approved as an Energy Star Partner.

LED traffic signal modules shall be designed as replacements for existing signal lamps. LED signal modules shall fit into existing traffic signal housings built to VTCSH Standard without any modification to the existing housing. Installation of the LED module into an existing signal housing shall only require removal of the existing lens and incandescent bulb, fitting of the LED module unit securely in the housing door and connecting to existing electrical wiring or terminal block by means of simple connectors. All LED modules shall be standard 12-inch lenses.

On the backside of the LED signal module there shall be a permanently marked "up" arrow to aid in proper orientation of the module for installation.

The manufacturer's name, trademark, serial number and other necessary identification shall be permanently marked on the backside of the LED signal module.

B PHYSICAL AND MECHANICAL REQUIREMENTS

The LED signal module shall be a single, self-contained device, not requiring on-site assembly for installing into an existing traffic signal housing. This device shall conform to ASTM specifications for materials used in the construction of the LED signal module.

The assembly and manufacturing process for the LED signal assembly shall be as such to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other sources. Enclosures containing the power electronic components of the signal module shall be made of flame retardant materials that will self-contain internal sparks and flames, as well as dripping materials.

Each LED signal module shell shall comprise of a smooth surface stabilized polycarbonate outer shell, multiple LED light sources, a regulated power supply and a polycarbonate back cover assembled in a silicon sealed unit. LED's are to be mounted on a polycarbonate positioning plate. Each LED signal module shall have a

beveled outer shell. A mechanical alignment and assembly mechanism must ensure that each LED should be maximized by an internal beam controlling optical faceted lens.

At time of installation, the legs of LED's (heat dissipaters) should be kept at full length to improve heat dissipation from LED's. The replacement of one or more LED's as well as the replacement of one or more LED circuits must be possible without desoldering or soldering.

C OPTICAL AND LIGHT OUTPUT REQUIREMENTS

The minimum luminous intensity values and light output distribution shall be shown in Section 11.04 and Table 1 of the VTCSH Standard.

The minimum luminous intensity values and light output shall be maintained within the input voltage range of 90 to 120 volts. LED signal modules shall not be allowed to fall short of the minimum intensity values at any of the 44 measuring points of the standard when lamp is turned on cold for measurements and after a 30 minute warm-up period at 100% duty cycle.

An LED traffic signal module shall not exhibit more than a nominal -1.5% change in luminous intensity per a

+1°C change in ambient temperature.

The chiromantical element of the LED signal modules shall conform to the chromatically requirements of Section

8.04 and Figure 1 of the VTCSH.

D ELECTRICAL

All wiring and terminal blocks shall meet the requirements of Section 13.02 of the VTCSH standards.

Two captive, 2-colored coded, 900 mm long, 600 volt, #18 AWG minimum, jacketed wires, conforming to the National Electric Code, rated for a service at 105°C, are to be provided for electrical connection.

Each module shall incorporate a regulated power supply engineered to electrically protect the LED's and maintain a safe reliable operation. The power supply shall provide capacitor filtered DC regulated current to the LED's as per the LED's manufacturer's specification. The module shall meet UL No. 1012 an/or CSA C22 No. 205 standards.

The LED signal module shall operate off a 60 Hz AC line voltage ranging from 90 volts rms to 135 volts rms. Nominal rated voltage for all measurements shall be 117 volts rms. The circuitry shall prevent flicker over this voltage range. The circuitry shall prevent flicker at all voltages below 90 volts rms for a minimum time period of 16 milliseconds.

The signal module on-board circuitry shall include voltage surge protection to withstand a single peak transient of 600 volts of each polarity for 100 MS duration. The LED signal and associated on-board circuitry must meet or exceed Federal Communications Commission (FCC) Part 15 regulations concerning the emission of electronic noise.

The individual LED light sources shall be wired so that a catastrophic failure of one LED light source will not result in the loss of illumination in more than 20 percent of the LED light sources.

The LED signal module shall be compatible with currently used controllers and conflict monitors. The LED signal circuitry shall prevent false controller conflict monitor action due to excessively high off-state input impedance.

Maximum wattage for 300 mm red ball shall be 20 watts and 8 watts for 300 mm red arrow.

E ENVIRONMENTAL REQUIREMENTS

The LED signal module shall be rated for use in the ambient operating temperature range of 35°C to 75°C. The LED signal module shall be dust and moisture tight to prevent all internal LED and electrical components.

The LED signal module shall be capable of withstanding exposure to an environment of 74°C - 95% relative humidity for 168 hours without internal condensing moisture. The lens of the LED signal module shall be capable of withstanding ultraviolet (direct sunlight) exposure for a minimum time period of five (5) years without exhibiting evidence of deterioration.

F WARRANTY

The LED signal module will be replaced or repaired by the manufacturer if it exhibits a failure due to workmanship or materials defects within the first 60 months of field operation.

The LED signal module will be replaced or repaired by the manufacturer if it exhibits either a greater than 50% light output degradation or fall below the minimum intensity levels within the first 36 months of field operation.

G MEASUREMENT AND PAYMENT

Payment for these items shall be paid for each item complete in place.

ITEM 617.0000 CLOSED LOOP MASTER COMPUTER SYSTEM COMPLETE IN PLACE

A GENERAL

Work under this item consists of furnishing and installing all materials, equipment, and software installation for the Master Control System including the Central Computer, portable laptop computer, printer, communication link, training and updating all graphics and operating system to the most current software supplied by the Contractor. If video detection is to be used, then a multi-camera processor and video viewer shall be supplied. **The master controller shall be in full compliance with the National Transportation communications for Intelligent Transportation System (ITS) Protocol (NTCIP) 1201 and 1202 standards and capable of communicating with the City of Worcester Central Monitoring software**

The system described in this specification is intended for use on arterial highways, crossing arterial or grid systems. The system shall consist of a Central Office Monitor, up to 256 on-street Masters and up to 32 interconnected intersection controllers per on-street master. The Central Office Monitor shall contain the latest software for a fully windows based open architecture closed loop traffic signal system. Each on-street master shall provide up to 2 independent sub-sections. It shall be possible to assign up to 32 intersections in any way distribution among the 2 sub-sections. The system shall be capable of operation as manual, traffic responsive or time of day (TOD). Each sub-section shall operate as an independent sub-section with its own Cycle/Split/Offset commands, traffic responsive algorithm, etc. The video detection shall provide monitoring of the intersection thru the cameras by either a single or multiple cameras mode. Either one or more video displays shall be monitored via a telephone modem or by hard wire connections.

The On-Street Master shall provide the computational power to provide traffic responsive operation, while the Central Office Monitor shall provide monitoring, report generation and data downloading and uploading capability. The local intersection controllers shall implement the selected traffic pattern and provide intersections timing and control. The On-Street Master shall be housed in a local intersection cabinet, as directed by Traffic Engineer. The local intersection cabinet may be required to be replaced to allow for additional space for the master controller unit. If intended as part of an existing closed loop system, the closed loop master controller shall be the same manufacturer as the existing controllers along the corridor to be interconnected. The following detailed electrical and mechanical specifications refer to the On-Street Master unit.

Construction

The unit shall consist of a mainframe suitable for shelf mounting, with appropriate interface harnesses.

Operator programmable data entry shall be accomplished through a menu driven keyboard and display located on the front panel.

Connectors shall be provided for interconnecting all inputs and outputs with their external control circuits.

Timing shall be accomplished by digital methods and with power applied shall use the power line frequency as the time base.

All components shall be operated in accordance with good commercial practice to optimize life and performance.

The design goal shall be such that, under 24 hour a day operating conditions in their circuit applications, all components shall have a life of not less than 5 years.

The circuit reference designation for each component on the printed circuit board shall be clearly marked immediately adjacent to the component.

Electrical

The master controller shall be designed for use on nominal 120 volt, 60 Hz single phase alternating current. It shall operate correctly in the voltage range of 95 to 135 volts AC.

All D-C inputs and outputs shall conform to NEMA TS1 -1983 standards for transition zone, response time, current capability, surge and noise immunity, as well as all other applied electrical specifications.

Environmental

The master controller shall maintain all its programmed functions from -30° F to + 165° F.

The unit shall perform to this specification when operated in relative humidity from 5% to 95%.

The unit shall conform to all applicable portions of the Environmental and Operating Standards as described in the NEMA Standard TS1-1983, Part 2.

Functional

The master control equipment shall be capable of maintaining coordination between all interconnected locations. All controllers shall have internal coordination operation.

The master control equipment shall also be capable of providing a yearly time program for selecting four cycle lengths, four splits, and three offsets plus flashing operation for control of two sub-systems of local controllers. The schedule shall be as included and/or as shown on the plans.

B SYSTEM CAPABILITIES

1. **System Operation**

Cycles, Splits, Offsets, Flash, Free

The system shall be capable of implementing any of four (4) cycles, four (4) splits and three (3) offsets. The system shall have the capability of implementing system flash and system free operations. The commands to implement these modes of operation shall be transmitted to the local controllers via a TDM- FSK Communications link.

Intersections:

The system shall have the capability of controlling up to 32 intersections via the TDM-FSK Communications Module. Each intersection shall be equipped with a TDM-FSK Communications Module capable of receiving commands and data from the On-Street Master and transmitting system detector data and local controller's status to the On-Street Master.

System Detectors

The system shall have the capability of accepting and processing data from up to a total of 64 system detectors. The system detector data shall be collected at selected local controllers, from 1 to 8 detectors per intersection, not exceeding a total of 64 per section.

Master Communications

The On-Street Master shall have the capability of two-way communications with the Central Office Monitor. The communications connection on the On-Street Master shall be an RS-232 port. It shall be possible to configure the On-Street Master for a dial up modem or direct RS-232 using a null modem cable.

When using the dial-up method, the On-Street Master shall be capable of dialing four (4) different telephone numbers and restricting calls to each phone user at selectable times of the day.

Downloading

The system shall have the capability of downloading all system information from the Central Office Monitor to the On-Street Master and all intersections timing data from the Central Office Monitor via the On-Street Master to each local intersection. The data shall be loaded into the Central Office Monitor via a keyboard/CRT with menu and prompt features.

System Monitoring of Local Intersections

The Central Office Monitor shall be capable of monitoring the operation of each local intersection. The information needed to perform this function is transmitted from each local intersection to the On-Street Master and then to the Central Office Monitor.

System Monitoring of System Performance

The Central Office Monitor shall have the capability of monitoring the system performance. System parameters shall be stored in the On-Street Master on a real-time basis. This data shall be transmitted to the Central Office Monitor for analysis, logging, display and report generation.

The system shall have the capability of uploading to the Central Office Monitor via the On-Street Master, the system and intersection timing data stored in each local intersection controller.

2. Traffic Responsive Mode

Traffic responsive operation shall be controlled by the On-Street Master using traffic volume and occupancy data from up to 64 system sampling detectors.

Pattern Matching Algorithm

The traffic responsive mode shall operate from a "pattern matching" algorithm. A minimum of 48 patterns per On-Street Master shall be selectable. Each "pattern" shall consist of a specified Cycle/Split/Offset to be determined when that pattern is selected. Pattern selection shall be determined by matching actual collected detector information to the various data previously programmed in the Master. The pattern with the "signature" that best fits the actual measured data is selected.

Signature Data

Signature data shall consist of a volume and occupancy assigned to each of 64 detectors per pattern.

System Sampling Detectors

Each of the 64 system sampling detectors shall be capable of being configured as a volume and an occupancy detector. The local intersection controller responsible for each sampling detector shall pre- process the detector data. The system shall collect the sampled data periodically for implementation into the traffic responsive algorithm.

Detector Weighting

Each system sampling detector shall provide a user definable weighting factor from 0 - 100%. This factor will determine the effect that detector has on the traffic responsive algorithm, 0% = no effect, 100% = maximum effect.

Detector Failure

A detector failure routine shall be incorporated into each local controller to determine if any of the 64 sampling detectors are operating outside of their programmed limits; erratic counts, no activity, or constant call. In the event a detector operates outside its limits for one sampling period, the controller will report back to the master that the detector has failed. In the event that more detectors fail than allowed by a programmable value, the On-Street Master shall place the system in time clock command operation. To prevent unwarranted detector failure logging, a means shall be provided at the local controller level to inhibit the lower thresholds limit (e.g. late night) by means of a clock command. A log shall be kept that contains the time any detector has failed.

Traffic Responsive Sampling Period

The sampling period over which each new set of traffic responsive commands is based shall be user definable from 0 - 99 minutes in 1 minute increments. Two additional sampling periods of independent duration's shall be selectable on a time of day basis.

Free to System Thresholds

For each section, programming entries shall be provided to establish minimum threshold for the transition from free to system (coordinated) operation. These entries shall consist of a minimum volume and a minimum average occupancy. When the traffic responsive mode is activated, one or the other of these minimums must be exceeded or the unit will determine that the traffic level is not sufficient to warrant system operation and will remain free.

3. System Management

Add/Drop Intersections: From a single menu structure, intersections 1 - 32 can be assigned (added and brought on

line) to a section, switched to a new section, or dropped from the Master control altogether. When dropped, the intersection will revert to local time base control.

Manual/Auto: From a single menu structure, means shall be provided to manually override each section with a user defined Cycle/Split/Offset. Manual selection will override the traffic responsive or time clock time of day modes.

4. **Sync Modes**

When in any of the master control modes, either manual, time clock or traffic responsive, the master shall issue Cycle/Split/Offset/System/Flash commands. Local controllers shall provide the following two sync reference modes, either one selectable by the user.

Independent daily reference. Each cycle references (resets) daily to a selectable time of day (typically midnight) and has its own reference to that daily point.

Absolute. Each cycle has its own, one time, user initiated reset point and references continuously from that single point in time. There shall be no daily reference in this mode, only from the single reset point.

5. **Time Clock**

The internal time clock shall be yearly programmable, consisting of programmed events which are assigned to day programs (24 hours), such day programs being assigned to week programs (7 days), and such week programs assigned to a year program. The real time clock shall operate on a 99 year calendar. The time clock shall be resident in the On-Street Master and shall have the following capabilities:

250 events

daylight savings time enable 99 day programs

99 exception days (holidays adjustments) 10 week programs

1 year program

Time Clock Coordination Control

When enabled to do so, the time clock shall control the coordination command set, thereby selecting the Cycle/Split/Offset and System/Free status in effect based on day program event selections.

Time Clock Internal Function Control

When enabled, it shall be possible to control functions by internal time clock without wiring. These functions shall be programmable as on, off, or automatically controlled by time of day events. Time clock functions shall be separated into groups, “sectional” functions and “global” functions. “Sectional” functions shall be specified on a per section basis and shall only affect local controllers assigned to that section. “Global” functions shall be unit wide, affecting all intersections assigned to the On-Street Master, regardless of section.

Time of Day Controlled Sectional Functions

Time of day controlled sectional functions shall consist of a minimum of the following:

Time clock CSO/system - For the specified section, any combination of cycle 1 - 4, split 1-4 and offset 1- 3 shall be selectable by time clock. It shall be possible to program clock selection of CSO during all periods, even during periods that one of the traffic responsive modes may override clock selection. Thus, clock selected CSO shall always be in a “default” mode when traffic responsive is not enabled

Traffic responsive CSO enabled - For the specified section, cycle, split, offset, and system (coordinated operation) are enabled to be selected by the traffic responsive algorithm.

Traffic responsive CSO enabled if traffic responsive cycle is greater than the clock cycle - For the specified section, if the traffic responsive computed cycle length is greater than the clock selected cycle, then cycle, split, offset, (and system) are enabled to be selected by the traffic responsive algorithm. If the traffic responsive cycle is not greater than the clock selected cycle length, the unit will remain in time clock mode for CSO.

Traffic responsive cycle enable - For the specified section, the cycle (and system) only is enabled to be selected by the traffic responsive algorithm.

Traffic responsive sampling period enable - For the specified section, an alternate traffic responsive sampling period is invoked.

Enable sectional system detector volume logging - For the specified section, system detector volume logging - system detector volume is enabled.

Daylight Saving Adjustment

The unit shall provide an enable/disable option for daylight savings adjustments. When enabled, the unit will automatically adjust daylight savings: forward at 2 AM on the second Sunday in March and back at 2 AM on the first Sunday in November. When disabled, the unit will make no daylight savings adjustments.

Exception Days

Exception day programming shall assign a selected day program to a particular day of the year, which will override the normal programming for that day. To provide the ability to program exception days that are suitable for any year, two types of exception days shall be provided:

Day of week, week of month, month of year specified exception days. This type of exception day shall accommodate holidays such as U.S. Memorial day, which is the last Monday in May, or U.S. Labor Day which is the first Monday in September, etc. These shall be programmed by DOW, WOM, MOY, since they do not fall on the same date every year.

Date specific exception days. This type shall accommodate holidays such as Christmas, January 1st, the

U.S. 4th of July, etc. These shall be programmed by date, and fall on the same date each year.

External Time Clock sync

Means shall be provided for external re-synching the internal time clock to a selected value via momentary activation of an input. The re-synching time shall be keyboard programmable, settable to any hour, minute, second of the day.

Clock Set

It shall be possible to manually set the time clock for the current time to the current hour, minute, second, year and date. The On-Street Master shall have the capability of re-synching all local intersections clocks from the clock in the On-Street Master. This re-synch operation shall automatically occur at midnight during the day at regular intervals.

Special Function Commands

The master shall be capable of issuing a minimum of 6 special function bits to each of the 32 local controllers once per second. Special function bits 1-6 shall be individually activated in any combination, either by special function clock ckt's 1-6 or by DC special functions inputs 1-6. Special functions inputs shall be connected through the master harness.

Local controllers interconnected to the On-Street Master shall respond to special functions bits in a user definable manner. For each bit at the local controller, two parameters shall be programmable:

Local controller bit mapping, i.e. the local controller function enable by the bit.

A programmable delay period responding to the bit, 0-255 seconds. The delay shall begin with the first assertion of the bit, but the controller function will not respond until the timer runs out. The function shall then activate and remain activated until reset of the bit by the Master.

NEMA local controller functions enabled by the special function bit mapping. For NEMA controllers interfaced into the system, the following list of functions shall be selectable for response to master special function bits.

Activate auxiliary ck't 1-4 (General purpose time clock ck't) UCF Flash

Max II select Inhibit Max per ring CNA I/II

Min Recall all phases

Place vehicles and pedestrian calls per phase 1-8 Set vehicle and pedestrian omits per phase 1-8 Call Red Rest mode per ring

Omit all Red Clearance per ring Enable Pedestrian Recycle per ring

Inhibit detector low threshold monitor Inhibit detector constant call monitor Enable dual entry

Conditional service enable Simultaneous gap out inhibit

Disable AC interconnect (enable time base coord) Lag phases 1,3,5,7

Select Max Plan 1-8

Call pre-empt Sequences 1-6 Enable local volume logging Activate dimming operation

Force to time clock control (override traffic responsive mode)

The system shall fulfill the requirements specified herein when provided with communications facilities specified in the following paragraphs. There shall be two types of facilities provided, one for communications between the On-Street Master and the local intersections, and the other for communications between the On-Street Master and the Central Office Monitor. Error checking shall be included.

C MEASUREMENT AND PAYMENT

Payment for these items shall be paid for each item complete in place.

ITEM 618 FIBER OPTIC INTERCONNECTION/ COMMUNICATION CABLE

A GENERAL

Work under this item consists of furnishing and installing all materials, equipment, appurtenances and making electrical connections for interconnecting traffic signal controllers to the On-Street Master. The installation shall be in conformance with the applicable provisions of Section 800 of MSSHB.

The interconnect fiber optic cable shall be 12 single mode, outside plant loose tube. The cable shall utilize a single layer polypropylene tube and shall use super absorbent polyester tape in place of gel for water blocking. The pair shall meet or exceed the following requirements:

Each controller cabinet shall contain a distribution panel Fiber Tron FTW024 or equal. All fibers shall be terminated at distribution panel in each cabinet, using ST connectors.

The total length shall not exceed six (6) miles. Impedance of 600 ohms resistive and balanced.

Envelope delay distortion shall be less than 1750 microseconds in the band from 800 to 2600 Hz.

Frequency response referred to 1000 Hz from 300 to 3000 Hz shall be flat-3, +12 dB Response reference to 1000 Hz from 500 to 250 Hz shall be flat-2, +8 dB

Insulation between any conductor and ground shall be at least 20 megohms DC and 50 Khom's AC from 300 to 3000 Hz.

Capable of transmitting a signal of not less than +10 dBm (average). Noise level shall be no more than -62 dBm.

Non-linear (harmonic distortion, fundamental to first harmonic of 25 dB minimum, fundamental to third harmonic of 30 dB minimum.

Breakdown between any conductor and ground shall be greater than 1500V rms at 60Hz.

Minimum receiving level at most distant point shall be no less than -16 dBm at 0 dBm input power.

The contractor shall install the proposed interconnect cable through the dedicated conduit solely for the purpose of interconnecting cable. He shall make all necessary electrical connections in the controller cabinets and the connections to the controller shall be made with a standard RS232 connector or Fiber optic connector.

When fully connected, the master controller shall generate and transmit information through the interconnecting system to all interconnected local controllers.

Splices shall not be permitted. Installation of the cable shall be that straight through pulls in hand holes and pull boxes designated for interconnecting cable. At least five (5) feet of cable shall be coiled in each pull box or hand hole to facilitate future maintenance. All interconnect cable shall be appropriately terminated in each control cabinet including lightning and surge protection for each conductor in each cabinet.

B MEASUREMENT AND PAYMENT

Payment for this item shall be paid by linear foot complete in place.

ITEM 619.0000 PORTABLE CHANGEABLE MESSAGE SIGN

A GENERAL

A minimum of 2 portable changeable message signs should be made available for a single contract. Work under this item shall consist of furnishing, positioning, repositioning, and removing Portable Changeable Message Signs as

specified or as directed by the Engineer.

B MEASUREMENT AND PAYMENT

Payment for this item shall be paid per day.

ITEM 619.0000 PULL BOX 8"X23" (SD2.030)

ITEM 620.0000 PULL BOX 12"X24" (SD2.031)

A GENERAL

Work to be done under these items shall conform to the relevant provisions of Section 800 (MSSHB) and the following:

1. The 8"x23" pull boxes shall have the word "W.D.T.M." stamped on the covers.

2. The 12"x24" pull boxes shall have "TRAFFIC" stamped on the covers and be used only for the interconnection cable.

B MEASUREMENT AND PAYMENT

The pay item for this work shall be Pull Boxes (complete in place) including all excavation, trimming, or cutting of existing concrete or bituminous concrete, backfill, and placing of concrete or bituminous SUPERPAVE bituminous concrete collar. All labor, equipment, tools, and incidental expenses required to locate, maintain in proper working order, and set to finish grade.

*SECTION 700 - ****
SECTION 800 - STREET LIGHTING

ITEM 804.2000 2 INCH ELECTRICAL CONDUIT TYPE NM – PLASTIC – (NEMA) FOR STREET LIGHTING

ITEM 804.2100 ADDITIONAL 2 INCH ELECTRICAL CONDUIT TYPE NM – PLASTIC – (NEMA) FOR STREET LIGHTING WITHIN THE SAME TRENCH

A. GENERAL

The work under this item shall conform to the relevant portions of Section 801 (MSSHB) and the following:

The work shall include the furnishing and the installation of 2 inch non-metallic conduit for the street lighting system in accordance with the plans and as directed by the Engineer.

The conduit material shall be Schedule 80 polyvinyl chloride (PVC plastic conduit).

The length of conduit estimated under this item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

B. MATERIALS

Rigid Plastic Conduit

Schedule 80 PVC conduit of the sizes shown on the plans shall be used throughout the project. Minimum size shall be 2” I.D. Raceways and fittings shall be produced by the same manufacturer. National Grid may have specific requirements as to what manufacturers they carry available spare parts for. Therefore, one manufacturer will be listed as preferred with their catalog numbers reflected, with the second listing being National Grid’s acceptable equal.

The rigid plastic conduit must conform to and meet all current requirements and testing procedures of the

American Society of Testing and Materials wherever such standards and test shall apply. The following ASTM standards shall apply as applicable.

ASTM Specification D1784 – Schedule 80 PVC Cell Classification

ASTM Specification D2564 – Specification for Solvent Cements for PVC Plastic Pipe and Fittings.

All belled-end pipes shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D2672.

PVC conduit manufacturers capable of meeting the specifications are Carlon, or approved equal.

C. *FITTINGS*

Provide all necessary couplings and elbows necessary for a complete system.

All conduits where the possibility of moisture or dirt is present shall be provided with Carlon PVC plugs, or approved equal, for 2" I.D. conduit.

All sweeps into lighting fixture bases shall be per the manufacturer's requirements.

Except where embedded in concrete, direct burial or indicated elsewhere in the contract documents, all conduits shall be supported to permit adequate lineal movement to allow for expansion and contraction of conduit due to temperature change.

D. *CONSTRUCTION METHODS*

The PVC conduit shall be installed in a trench as described in Section 801.60 (MSSHB). Refer to trench details for backfill requirements, warning tape and other requirements above the PVC conduits.

E. *INSTALLATION*

When crossing streets and driveways the conduit shall be encased with a minimum of 4 inches of concrete on all sides, extending a minimum of two (2) feet beyond the roadway or driveway access point of the conduit.

A polypropylene pull rope sized to properly support the installation of required electrical conductors shall be installed in all conduits.

Conduits entering pull boxes and/or handholes shall be terminated a minimum of two inches inside the wall of the pull box and/ or handhole.

All conduit installed in pull boxes and/or handholes shall be installed in knockouts or openings provided in the box. Any conduit installed in such a manner as to block complete access to any other conduit shall be removed and reset at the contractors own expense.

F. *MEASUREMENT AND PAYMENT*

Payment under this item will be as Linear Feet.

2 inch Schedule 80 Electrical Conduit Type NM Plastic (NEMA) will be paid for at the contract unit bid price per linear foot installed, which price shall include all labor, material, tools and equipment for furnishing and installing conduit, fittings, bends, sweeps, clamps, plugs, couplings, all trench excavation (except rock), backfilling, concrete encasement, pull ropes, and all incidental costs required to complete the work.

ITEM 804.3000 3-INCH ELECTRICAL CONDUIT TYPE NM PLASTIC (UL)

ITEM 804.3100 ADDITIONAL 3-INCH ELECTRICAL CONDUIT TYPE NM PLASTIC (UL) IN THE SAME TRENCH

ITEM 804.4000 4-INCH ELECTRICAL CONDUIT TYPE NM PLASTIC

ITEM 804.4100 ADDITIONAL 4-INCH ELECTRICAL CONDUIT TYPE NM PLASTIC (UL) IN THE SAME TRENCHGENERAL

The work under this Item shall conform to the relevant provisions of Section 801 (MSSHB) and the following:

The work shall include the furnishing and installation of 3-inch non-metallic conduit for traffic signal systems in accordance with the plans and as directed by the Engineer.

The conduit material shall be Schedule 80 polyvinyl chloride (PVC) plastic conduit.

The length of conduit estimated under this Item is not guaranteed by the Engineer; it may be increased or decreased

by the Engineer depending upon actual conditions encountered as provided for in Section 4.06 (MSSHB).

Where new conduits are installed in existing grass areas outside the limits of grading, the work shall include the placement of a minimum of 4 inches of topsoil and sod to restore the disturbed areas to their original condition. No separate payment will be made for this work, but all costs in connection therewith shall be included in the unit price bid.

Where conduit is installed in existing sidewalk or paved median areas to remain, the work shall include replacement of the gravel base material and the surface pavement to match preconstruction conditions. No separate payment will be made for this work, but all costs in connection therewith shall be included in the unit price bid.

When conduit is installed in cold plane and overlaid pavement, the trenches shall be sawcut through their full depth and the pavement removed. The conduit shall be placed on a sand bed and backfilled with excavatable controlled density fill conforming to Subsection M4.08.0 (MSSHB).

Where a telephone communications conduit is specified, a separate conduit shall be provided from the controller cabinet to the telephone manhole as shown on the plans. The Contractor shall provide a pull- string in the conduit for the telephone line. The Contractor shall be responsible for coordinating with the telephone company for installing the conduit into the telephone manhole.

B. *CONDUIT CROSSING ROADWAYS*

All conduits crossing the roadway shall be encased in Class C cement concrete with a minimum 9 inches of cover. Trenches in existing bituminous concrete pavements not subject to full depth reconstruction shall be saw cut to a 3-foot 6-inch width. The existing pavements shall be saw cut through their full depth and the pavement removed. Trench depth shall be a minimum of 3 feet. Backfill material shall consist of CDF Type IE excavatable flowable fill.

After conduit installation and backfill is complete, a 1 - foot (minimum) of high early strength cement concrete base course material cap shall be placed over the trench area. If the trench excavation or backfill operations have widened the top trench to the extent that a minimum of 12 inches of undisturbed soil is not available to support the concrete cap, the pavement shall be saw cut again and removed to provide the 12-inch width.

The finish grade of the concrete cap shall be 3.25 inches below existing pavement surface. One 1.75-inch lifts and one 1-1/2 inch lift of bituminous concrete pavement SUPERPAVE (binder and top course material) shall be placed over the concrete cap. If the existing pavement is to be resurfaced, then the concrete shall be finished flush with the existing surface.

No separate payment will be made for saw cutting, excavation and concrete, but all costs in connection therewith shall be included in the linear foot unit price bid for this item.

C. *MEASUREMENT AND PAYMENT*

Electrical Conduit will be paid for at the Contract unit price per foot, which price shall include saw cutting, excavation, ordinary borrow, gravel borrow, wood plank/ warning tape, sand bedding, all labor, materials, equipment and incidental costs required to complete the work.

Excavatable Controlled Density Fill will be paid for separately under Item 485.1.

ITEM 806.2000 2 INCH ELECTRICAL CONDUIT

ITEM 806.2100 ADDITIONAL 2 INCH ELECTRICAL CONDUIT IN THE SAME TRENCH

A. *GENERAL*

The work under this item shall conform to the relevant portions of Section 801 (MSSHB) and the following:

The work shall include the furnishing and the installation of 2 inch metallic conduit for the street lighting system in accordance with the plans and as directed by the Engineer.

The length of conduit estimated under this item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

B. *MATERIALS*

Rigid Metal Conduit

Rigid Metal conduit of the sizes shown on the plans shall be heavy wall zinc coated steel. Minimum size shall be 2" I.D. Raceways and fittings shall be produced by the same manufacturer. National Grid may have specific requirements as to what manufacturers they carry available spare parts for. Therefore, one manufacturer will be

listed as preferred with their catalog numbers reflected, with the second listing being National Grid's acceptable equal.

The rigid metal conduit must conform to the following standards applied as applicable. American National Standard Institute C80.1.

Federal Specification WW-C-581e UL Specification No. 6

National Electrical Code Article 346

C. *FITTINGS*

Provide all necessary couplings, elbows, and fittings necessary for a complete system.

Elbows, couplings, nipples, and other required fittings shall match the construction material of the rigid metal conduit. Couplings for rigid metal conduit shall be threaded type and rain proof.

All sweeps into lighting fixture bases shall be per the manufacturer's requirements.

D. *CONSTRUCTION METHODS*

The rigid metal conduit shall be installed in a trench as described in Section 801.60 (MSSHB). Refer to trench details for backfill requirements, warning tape and other requirements above the rigid metal conduits.

E. *INSTALLATION*

When crossing streets and driveways the conduit shall be encased with a minimum of 4 inches of concrete on all sides, extending a minimum of two (2) feet beyond the roadway or driveway access and egress points of the conduit.

A polypropylene pull rope sized to properly support the installation of required electrical conductors shall be installed in all conduits.

Conduits entering pull boxes and/or handholes shall be terminated a minimum of two inches inside the wall of the pull box and/ or handhole.

All conduit installed in pull boxes and/or handholes shall be installed in knockouts or openings provided in the box. Any conduit installed in such a manner as to block complete access to any other conduit shall be removed and reset at the contractors own expense.

F. *MEASUREMENT AND PAYMENT*

2 inch Electrical Conduit Type RM Steel (Galvanized) will be measured for payment by the linear foot of conduit installed.

2 inch Electrical Conduit Type RM Steel (Galvanized) will be paid for at the contract unit bid price per linear foot installed, which price shall include all labor, material, tools and equipment for furnishing and installing conduit, fittings, bends, sweeps, clamps, plugs, couplings, all trench excavation (except rock), backfilling, concrete encasement, pull ropes, and all incidental costs required to complete the work.

ITEM 810.2000 ELECTRIC HANDHOLE PRECAST CONCRETE

ITEM 810.3000 PULL BOX 12"X24" (SD 2.030) FOR SIGNAL CABLE

ITEM 810.4000 PULL BOX 12"X12" (SD 2.031) FOR INTERCONNECTION CABLE

A. *GENERAL*

The work under this item shall conform to the relevant portions of Section 801 (MSSHB) and the following:

The work shall include the furnishing and the installation of precast concrete electric handholes for street lighting system and traffic signal system shall be in accordance with the plans and as directed by the Engineer.

The quantity of handholes estimated under this item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

All pull boxes shall be a pre-cast concrete with cast iron covers. The 12"x 24" pull boxes shall have the word "W.D.P.W." stamped on the covers; the 12"x 12" pull boxes shall have "TRAFFIC" stamped on the covers and be used only for interconnection cable. The top of all pull boxes shall be flush with the finish grade.

B. *MATERIALS*

Refer to the plans for the details of the precast concrete electric handholes.

Precast concrete electric handholes shall meet the requirements of Section 801.61.C (MSSHB).

C. CONSTRUCTION METHODS

All electric handholes shall be constructed per Section 801.61.C (MSSHB), except as deviations may be required based on field conditions. All deviations must be approved by the engineer prior to making any changes.

Electric handhole frames and covers shall be set flush with finish grade.

D. INSTALLATION

Electric handholes shall be placed per the plans and shall be positioned using an approved grade so that the frame and cover are flush with the finish grade. Provisions shall be made so that adjustment can be made to the frame and cover to close any opening between the frame and precast handhole to prevent any contaminants or moisture from entering.

Furnish and install a gravel base, as per the plan, compact and level for placement of the precast concrete handhole.

Furnish and install a minimum of four (4) galvanized steel bolts of sufficient size and length to secure the frame to the precast concrete electric handhole. The bolts must be placed to allow for proper and sufficient adjustment of the frame and cover as necessary to make the frame and cover flush to finish grade.

Furnish and install a 5/8" X 8' long copper clad ground rod, a grounding clamp, and 3 feet of bare #4AWG wire in each electric handhole.

The electrical handhole shall be left free and clear of any foreign matter.

E. MEASUREMENT AND PAYMENT

Electric Handhole Precast Concrete (Municipal Standard) will be paid for at the contract unit bid price per each installed, which price shall include all labor, material, tools and equipment for furnishing and installing precast concrete electric handholes, cement mortar mix, galvanized threaded rod, galvanized bolts, galvanized nuts and washers, ground rod, clamp, wire, gravel base, compaction and leveling, leveling frame and cover, all excavation (except rock), backfilling, and all incidental costs required to complete the work.

ITEM 811.2000 ELECTRIC LOAD CENTER BASE CONCRETE

A. GENERAL

The work under this item shall conform to the relevant portions of Section 801 (MSSHB) and the following:

The work shall include the furnishing and the installation of concrete load center base for street lighting system in accordance with the plans and as directed by the Engineer.

The quantity of electric load center base estimated under this item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

B. MATERIALS

Refer to the plans for the details of the concrete electric load center base.

Concrete electric load center bases shall meet the requirements of Section 801.62 (MSSHB).

C. CONSTRUCTION METHODS

All concrete electric load center bases shall be constructed per Section 801.62 (MSSHB), except as deviations may be required based on field conditions. All deviations must be approved by the engineer prior to making any changes.

D. INSTALLATION

Concrete electric load center bases shall be placed per the plans and shall be positioned using an approved grade so that the top of the concrete is 6 inches above the finish grade.

Furnish and install a gravel base, as per the plan, compact and level for placement of the concrete electric load center base.

Furnish and install a minimum of four (4) ¾" galvanized steel anchor rods, as shown on the plans, of sufficient length to secure the electric load center cabinet to the concrete base.

Furnish and install a 5/8" X 10' long copper clad ground rod, a grounding clamp, and 4 feet of bare #6 AWG wire in each electric load center cabinet.

E. MEASUREMENT AND PAYMENT

Electric Load Center Base Concrete will be paid for at the contract unit bid price per each installed, which price shall

include all labor, material, tools and equipment for furnishing and installing concrete electric load center base, cement mortar mix, galvanized threaded rod, galvanized bolts, galvanized nuts and washers, ground rod, clamp, wire, gravel base, compaction and leveling, all excavation (except rock), backfilling, and all incidental costs required to complete the work.

ITEM 812.2000 LIGHT STANDARD FOUNDATION CONCRETE

A. GENERAL

The work under this item shall conform to the relevant portions of Section 801 (MSSHB) and the following:

The work shall include the furnishing and the installation of concrete light standard foundation for street lighting system in accordance with the plans and as directed by the Engineer.

The quantity of light standard foundations estimated under this item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

B. MATERIALS

Refer to the plans for the details of the light standard foundations.

Light standard foundation concrete shall meet the requirements of Section 801.62 (MSSHB).

C. CONSTRUCTION METHODS

All light standard foundations shall be constructed per Section 801.62 (MSSHB), except as deviations may be required based on field conditions. All deviations must be approved by the engineer prior to making any changes.

D. INSTALLATION

Light standard foundations shall be placed per the plans and shall be positioned using an approved grade so that the top of the concrete is as indicated on the plans in comparison to finish grade.

Furnish and install 20 inch sonotube, reinforcing rods and hoops, as shown on the plans, and per the Structural Engineers recommendations. Confirm exact light fixture pole base anchor requirements with the manufacturer prior to furnish and installation and install accordingly.

Furnish and install a 5/8" X 10' long copper clad ground rod, a grounding clamp, and #8 ribbon braid ground conductor.

Furnish and install 2" rigid steel conduit, stubbed out from base, as shown on the plans.

E. MEASUREMENT AND PAYMENT

Light Standard Foundation Concrete will be paid for at the contract unit bid price per each installed, which price shall include all labor, material, tools and equipment for furnishing and installing light standard foundation, cement mortar mix, galvanized reinforcing rod and hoops, galvanized threaded rod, galvanized bolts, galvanized nuts and washers, 2" rigid metal conduit, elbows, and sweeps, ground rod, clamp, wire, compaction and leveling, all excavation (except rock), backfilling, and all incidental costs required to complete the work.

ITEM 813.3100 CONDUCTOR #2 AWG

ITEM 813.3200 CONDUCTOR #6 AWG

ITEM 813.3300 CONDUCTOR #8 AWG

A. GENERAL

The work under this item shall conform to the relevant portions of Section 813 (MSSHB) and the following:

The work shall include the furnishing and the installation of conductors (wiring) for the street lighting system in accordance with the plans and as directed by the Engineer.

The length of the conductors estimated under this item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

B. MATERIALS

The conductors shall be new and shall have the size, grade and insulation, voltage and manufacturer's name permanently marked on the outer covering at regular intervals. The conductors are to be in complete reels or coils

with clear markings identifying type, size and insulation. All conductors shall be protected from weather and damage during storage and handling.

The conductors shall meet UL type RHH-RHW rated for the application per the National Electrical Code.

All wire, connectors, splices, etc. shall be rated for the application per the NEMA, or UL, whichever is applicable. All material and workmanship shall conform to the requirements of the NEC, Standards of ASTM for Testing and Materials, USA Standards, and any local ordinances which may apply.

Wire size shall be based on American Wire Gauge (AWG), as applied to copper conductors.

C. *CONSTRUCTION METHODS*

All conductors shall be installed per Section 813 (MSSHB), except as deviations may be required based on field conditions. All deviations must be approved by the engineer prior to making any changes.

D. *INSTALLATION*

Installation of conductors (wiring) shall not begin until such time as the conduit has been successfully tested and verified, meeting the requirements of Section 801.60 (MSSHB) Conduit, Paragraph H. Testing Installation.

All conductors shall be installed in conduit by hand, without damaging the cover, sheath, insulation or wires. No conductor installation shall commence until such time as all work which may cause damage to the conductors has been completed. When installing conductors into conduit, conductors shall be pulled into conduit freely without any bends, kinks, twisting or lapping. All conductors in a particular conduit shall be pulled at the same time, fed from unobstructed, free moving reels. Powdered soapstone, talcum or other approved lubricant may be used to assist in installation of the conductors in the conduit.

Splices in conduit shall not be allowed. All conductors are to be continuous between electric handholes. A splice shall be installed in each conductor at each and every handhole with a minimum of 2 feet of slack coiled with each handhole (2 feet of slack will be measured from the top of the cover, extending out of the handhole).

All splices, taps, and wire terminals shall be secured with materials and methods hereinafter specified and as per Section 813.60 of the Standard Specifications.

E. *SPLICING*

Splices shall be made per the requirements of Section 813.60 (MSSHB) Wire and Cable, C Splicing. Splices shall be made in handholes and control cabinets only.

The conductors shall be joined by the use of terminal lugs, listed by UL, and meeting all requirements of the NEC and Massachusetts Electrical Code.

Splices shall be insulated and waterproofed.

F. *CIRCUIT IDENTIFICATION*

All incoming and outgoing wires in street lighting control boxes, handholes, and light bases shall be banded and labeled per Section 813.60 (MSSHB) Wire and Cable, D. Highway Lighting Circuit Identification.

G. *TESTING*

Prior to energizing any circuit or conductor, complete testing as required within Section 813.62 (MSSHB) Ground Electrodes B. Resistance Tests.

H. *MEASUREMENT AND PAYMENT*

Conductors #2 AWG, #6 AWG, and #8 AWG will be paid for at their respective contract unit bid price per foot, which prices shall include all labor, material, tools and equipment, connectors, splices, sealing and waterproofing, for furnishing and installing conductors in conduit, handholes, manholes, light fixtures, and cabinets and all incidental costs required to complete the work.

ITEM 813.8000 ELECTRICAL SERVICE

A. *GENERAL*

The work under this item shall conform to the relevant portions of Section 813 (MSSHB) and the following:

The work shall include the electric service connections from the utility company point of service to the lighting control cabinet for the street lighting system in accordance with the plans and as directed by the Engineer.

B. *MATERIALS*

Refer to the specifications provided herein for conduit, conductor and handhole requirements.

C. CONSTRUCTION METHODS

Electric service shall be coordinated with the local utility company providing power to the area.

Electric service shall conform to all utility company policies and practices. All back charges from the utility company to the contractor shall be paid for by the contractor and shall be included within this pay item. Service connections shall be coordinated and installed in accordance with the local utility company requirements as provided by the utility company.

Each service shall include a three wire single phase solid neutral service conductors, conduits, conduit risers, core drilling and sealing of manholes, and splicing connections required to complete the installation. Meters will be furnished and installed by the local utility company.

D. MEASUREMENT AND PAYMENT

Electric Service payment will be measured for payment by linear foot of conduit between service location and the lighting control cabinet.

Electric Service will be paid for at the contract unit bid price per foot, which prices shall include all labor, material, tools and equipment, conduit, conductors, sweeps, bends, couplings, connectors, splices, sealing and waterproofing, for furnishing and installing conductors in conduit, handholes, manholes, core drilling and sealing and all incidental costs required to complete the work.

ITEM 814.0000 REMOVE AND RESET LIGHT POLE

A. GENERAL

This work consists of removing an existing street light pole (including mast arm, luminaire, wiring connections, and base hardware), storing it safely, and resetting the same pole at the same or new location as directed by the Engineer. Work includes disconnection, temporary storage, transportation, resetting of the pole, reconnecting wiring, alignment, grounding, and restoration.

B. MEASUREMENT AND PAYMENT

Payment under this item shall be at the contract unit bid price per each location (complete in place).

ITEM 815.0000 REMOVE AND STACK / DISPOSE OF STREET LIGHT FOUNDATION

A. GENERAL

This work includes the complete removal of existing street light foundations, including anchor bolts, embedded hardware, and any associated conduit. Work also includes stacking the removed foundation in a designated location 1065 Millbury Street **or** disposing of the foundation off-site, as directed by the City. Remove the foundation in a single piece when feasible.

If the foundation must be broken to remove, the contractor shall notify the City prior to demolition.

B. MEASUREMENT AND PAYMENT

Payment under this item shall be at the contract unit bid price per each location (complete in place).

ITEM 820.0000 DECORATIVE STREET LIGHTING

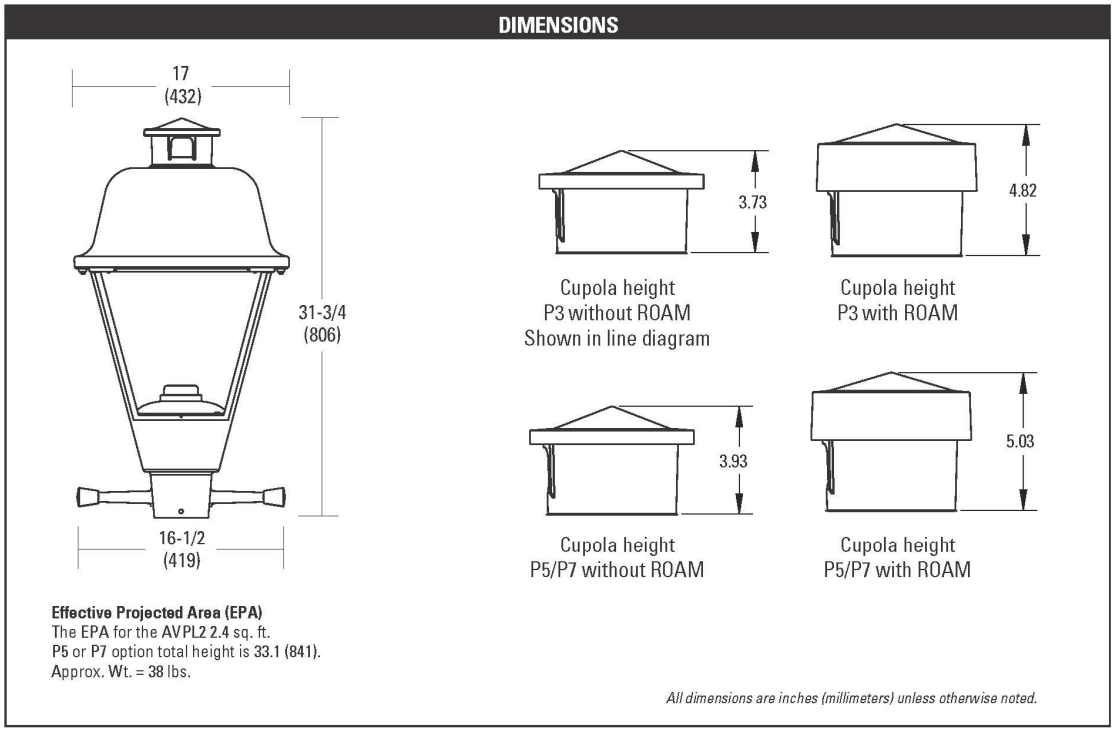
A GENERAL

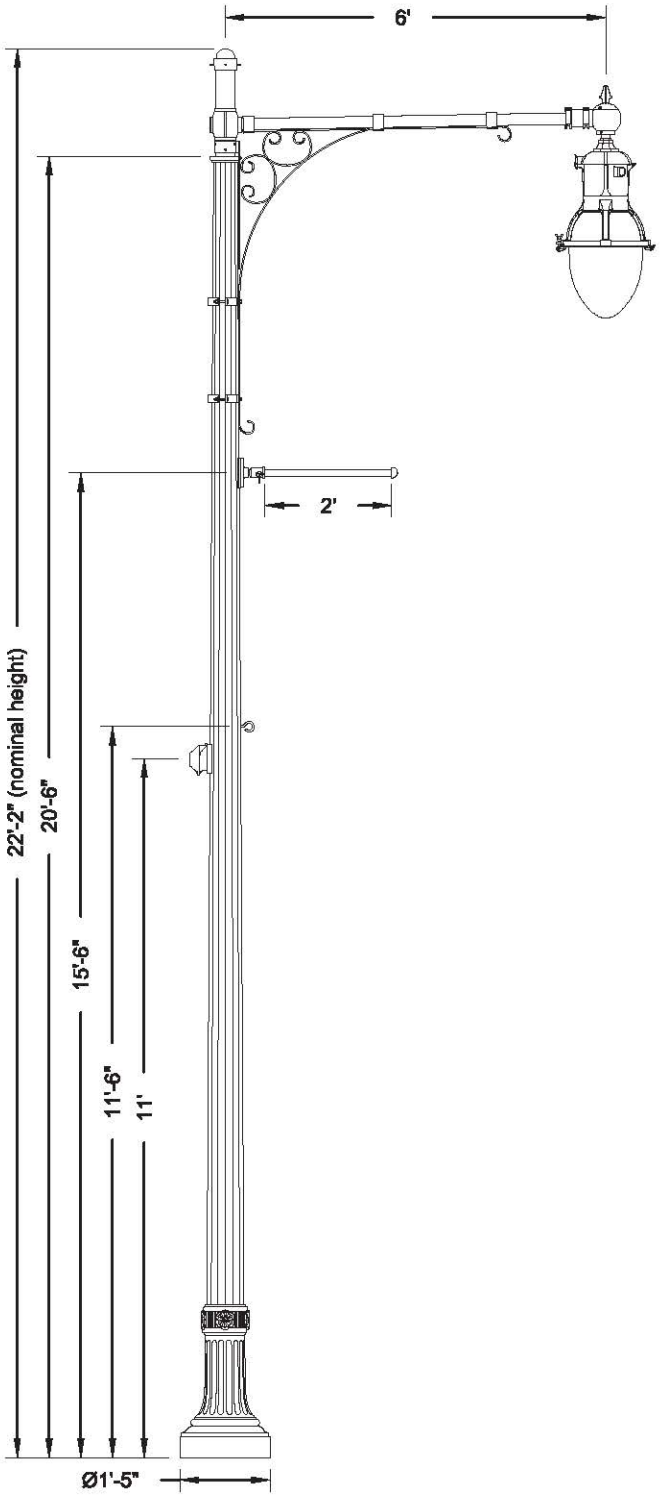
The post, base, arm, luminaire, accessories, and finish shall adhere to the following details or approved equal. For installation of all new utility standard poles and hardware, decorative poles and hardware, mechanical hatches, covers, windows or inspection plates, will be completed using a never seize agent which shall be placed on all hardware screws, bolts or fastening mechanical items which close, open or bolt together as part of its function, (poles, stanchions, handholes, inspection plates).

B MEASUREMENT AND PAYMENT

Payment under this item shall be at the contract unit bid price per each location.

Variant LED Series AVPL2 20LEDE70 MVOLT 4K R2 AY P7, NL-RW14 RFD210292





Specifications

POS T DESCRIPTION
The lighting post shall be cast iron and steel construction, massively tapered with a deep, 16-flute steel shaft and a classic 16-flute cast iron base. The post shall be provided with (1) OUC single arm, 45° from post center to luminaire center, (1) Boston Harbour QSM leveling fitter factory attached to the luminaire, (1) 24" breakaway banner arm, (1) bolt on eyebolt and (1) GFI weatherproof receptacle with large, in-use cover.

MATERIALS
The post material shall be ASTM A48, Class 30 cast iron, formed true to the pattern with complete detail. All exposed hardware shall be stainless steel. Anchor bolts to be completely hot dip galvanized. Partially galvanized bolts are not acceptable.

DIMENSIONS
The post shall be 20'-6" in height with a 17" diameter base. The post shall taper from a Ø7" at the top of the base to a Ø4.5" at the post top. An integral Ø3"x4" tenon shall be provided at the top for arm mounting.

INSTALLATION
The post shall be provided with four 3/4" DIA, hot dip galvanized L-type anchor bolts. A door shall be provided in the base for anchorage and wiring access. A grounding screw shall be provided inside the base opposite the door.

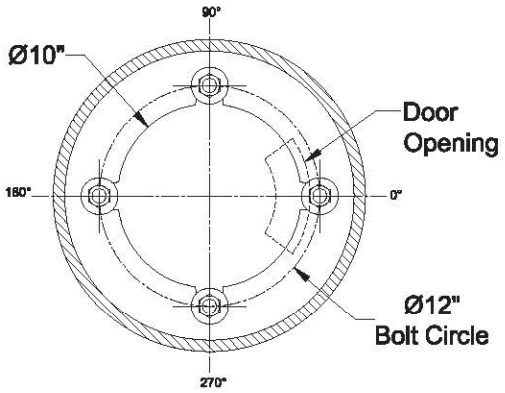
FINISH
The entire post assembly shall be standard Holophane black.

LUMINAIRE DESCRIPTION
- Memphis Teardrop LED 2 Series
- 12,000 Lumens w/Uplight, 4 COBs, 4000k CCT, Auto-Sensing Voltage (120-277)
- Black finish, Teardrop glass, Type 3 Asymmetric, Quick Lock Stem mount

Accessory Mounting Detail

	Orientation	Height
BANNER ARM	0°	15'-6"
EYEBOLT	0°	11'-6"
RECEPTACLE	180°	11'-0"

Anchorage Detail

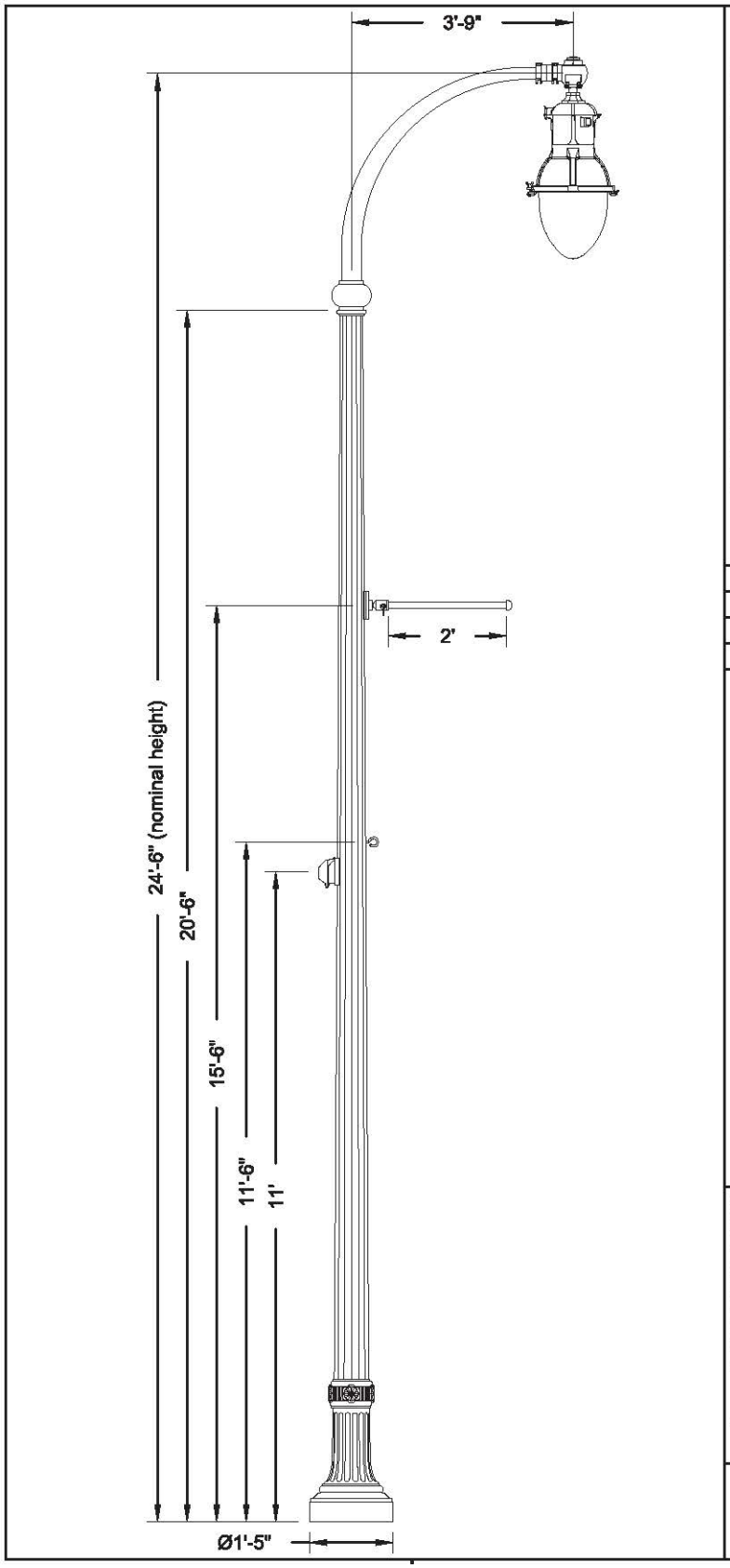


DO NOT USE TO SET ANCHOR BOLTS
CONTACT CUSTOMER SERVICE FOR TEMPLATE

Catalog #'s:
RFD209410
Lum/Lamp: MPL2P20U40KASBKTG3S BHDF13200BKP7 FACT ATT
Arm: CAM72/1CABKH
Pole: NYS21FTB17P05BK R132C S186A E138A
Receptacle: FGIUL-SBKH
Banner Arm: BBA24BOH4MXXBK
Eyebolt: BAEB
Anchor Bolts: AB-31-4

"CUSTOMER: PLEASE VERIFY PLACEMENT OF ACCESSORIES IN THE "ACCESSORY MOUNTING DETAIL" TABLE - INFORMATION NECESSARY FOR ENSURING ORDER IS PLACED AS NEEDED.""

Customer Signature **Date**



Specifications

POST DESCRIPTION
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MATERIALS
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FINISH
The entire post assembly shall be standard Holophane black.

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- 12,000 Lumens w/Uplight, 4 COBs, 4000k CCT, Auto-Sensing Voltage (120-277)
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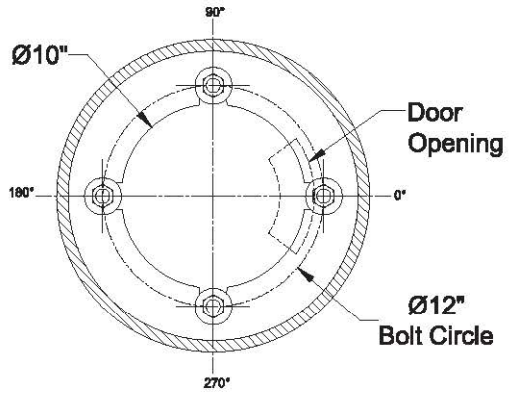
Anchorage Detail

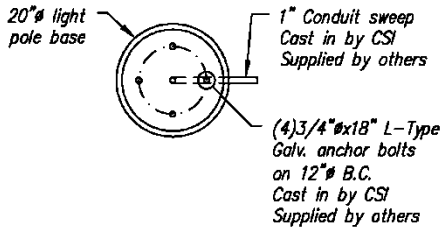


DO NOT USE TO SET ANCHOR BOLTS
CONTACT CUSTOMER SERVICE FOR TEMPLATE

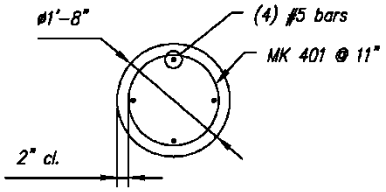
Catalog #'s:
RFD209418
Lum/Lamp: MPL2P20U40KASBKTG3S BHDF13200BKP7 FACT ATT
Arm: OUC45/1CABKH
Pole: NYS21FTB17P15BK R132C S186A E138A
Receptacle: FGIUL-SBKH
Banner Arm: BBA24BOH4MXXBK
Eyebolt: BAEB
Anchor Bolts: AB-31-4

""CUSTOMER: PLEASE VERIFY PLACEMENT OF ACCESSORIES IN THE "ACCESSORY MOUNTING DETAIL" TABLE - INFORMATION NECESSARY FOR ENSURING ORDER IS PLACED AS NEEDED.""

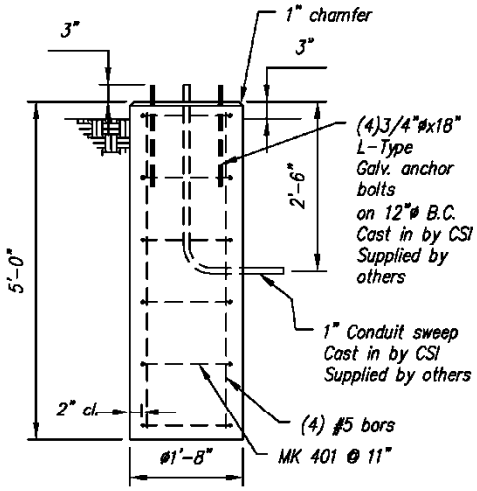
Customer Signature **Date**



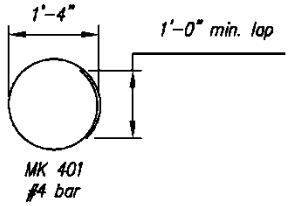
PLAN



REINFORCING DETAIL



ELEVATION



BENDING SCHEDULE

GENERAL NOTES:

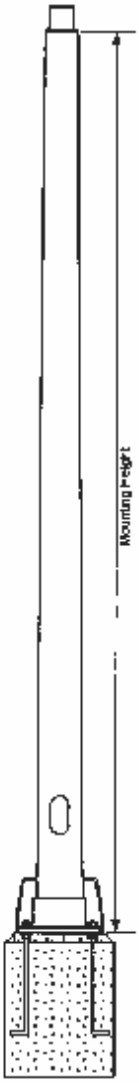
1. Concrete Strength f'c = 4000 psi.
2. Reinforcing Steel: ASTM A615 (rebar) grade 60
3. Contractor to supply anchor bolts, template, conduit sweeps and ground wire conduit. Quantity, size and location of conduit sweeps to be provided to CSI upon or prior to approval of this drawing.
4. Contractor to provide a list of variations (if any) of conduit orientations and/or other variations prior to approval of 20"ø base.

PRECAST CIRCULAR CONCRETE LIGHT POLE BASE

Shakespeare
a valmont BRAND

AS-SERIES

ROUND TAPERED COMPOSITE LIGHT POLE
ANCHOR BASE INSTALLATION



SHAKESPEARE AS-SERIES ANCHOR BASE POLES

MOUNTING HEIGHT	TIP DIAMETER	GROUNDLINE DIAMETER	WEIGHT
10	2.9	4.8	33
11	2.9	4.8	35
12	2.9	4.9	37
13	2.9	5.0	39
14	2.9	5.2	41
15	2.9	5.3	43
16	2.9	5.5	45
17	2.9	5.6	46
18	2.9	5.7	47
19	2.9	5.9	50
20	2.9	6.0	54
21	2.9	6.2	58
22	2.9	6.3	56
23	2.9	6.4	60
24	2.9	6.6	63
25	2.9	6.7	64
26	4.5	8.2	85
27	4.5	8.3	88
28	4.5	8.4	92
29	4.5	8.5	93
30	4.5	8.5	94
31	4.7	8.5	97
32	4.7	8.5	100
33	4.7	8.5	102
34	4.7	8.5	105
35	4.7	8.5	108

- Mounting heights to 35 feet
- Smooth, semi-smooth or natural finish
- 3 standard and 5 special architectural colors available
- High performance UV and weather-resistant pigmented resin system with an additional pigmented polyurethane coating.
- Tenon top or Drilled and Capped
- Standard 2-1/2" x 5" handhole located 12" above grade
- Poles are individually identified with a permanent embossed tag located 9" from tip.
- Sleeved individually for shipment
- Lightweight, easy to install, saves money

POLES LISTED IN SHADED AREA FOR SINGLE POST TOP FIXTURE ONLY AND NOT AVAILABLE CAPPED.

ORDERING INFORMATION

A S 25 — 01 S 1 (*)

- **A** = A = ANCHOR BASE
- **S** = SERIES
- **25** = OVERALL LENGTH
- **01** = TENON
  - 01 = 3" X 3.75" TENON
  - 02 = 2.375" X 2.75" TENON
  - 00 = CAPPED
  - * CONSULT FACTORY FOR OPTIONS
- **S** = FINISH
  - S = SMOOTH
  - V = SEMI-SMOOTH
  - N = NATURAL
- **1** = STANDARD COLORS / PREMIUM COLORS

STANDARD COLORS	PREMIUM COLORS
1 = BLACK	3 = BROWN
2 = GRAY	4 = LIGHT GREEN
5 = DARK BRONZE	6 = SILVER
	7 = WHITE
	8 = DARK GREEN
	9 = CUSTOM

- **(*)** = DIGITS MAY BE ADDED FOR INTERNAL USE

SHAKESPEARE - VALMONT COMPOSITE STRUCTURES, INC. 18645 U.S. HIGHWAY 76 • NEWBERRY, SC 29108 USA
803.276.5004 - 800.800.5008 - FAX: 803.276.9846 SKP-CS.COM

POLE NUMBER AND REFLECTOR INSTALLATION

This Section covers requirements for installing pole number decals and pole reflectors on all metal and fiberglass lighting poles.

Pole Numbers

Every pole shall be numbered using 1½ inch x 3 inch, high intensity white, reflective pole number decals. (STD Item SX20). Pole surface must be clean and dry. Install pole number decals on the roadway side of the pole, 7 feet above finished grade.
Install pole number decals horizontal to each other, • not vertical.

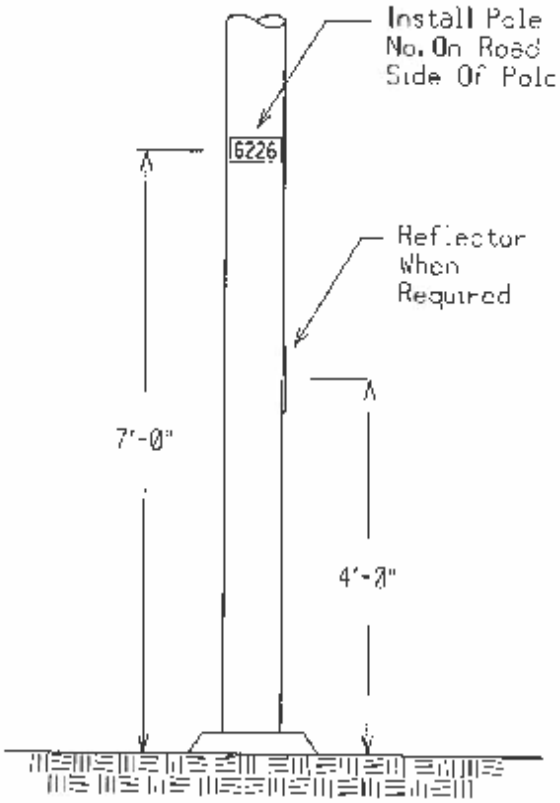
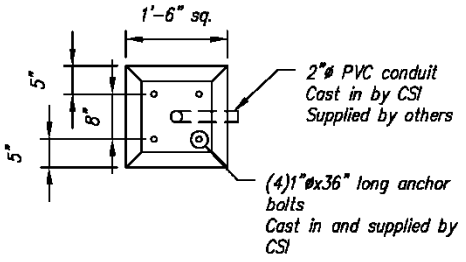


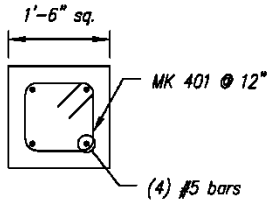
Figure 19
Pole Number Installation

POLE NUMBER & REFLECTOR INSTALLATION

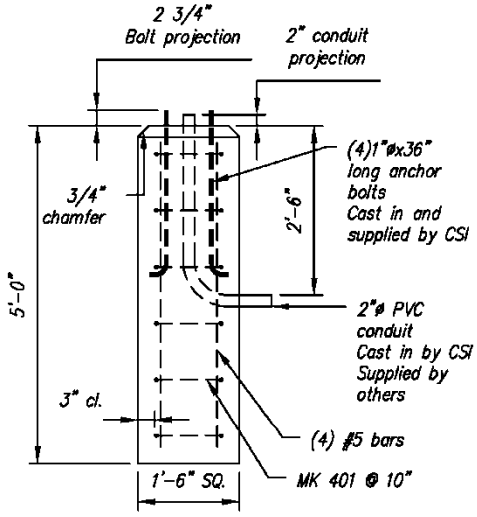
UNDERGROUND CONSTRUCTION STANDARD



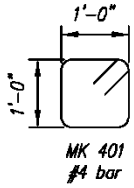
PLAN



REINFORCING DETAIL



ELEVATION



BENDING SCHEDULE

GENERAL NOTES:

1. Concrete Strength f'c = 4000 psi.
2. Reinforcing Steel: ASTM A615 (rebar) grade 60
3. Sweeps supplied by others, cast in by CSI.

PRECAST SQUARE CONCRETE LIGHT POLE BASE

ITEM 820.0000 STREET LIGHT COBRA HEAD

HORIZONTAL ROADWAY LUMINAIRES

Figure 1 - Semi-cutoff Luminaire

Figure 2 - Cutoff Luminaire

D-Series Size 0
LED Area Luminaire

Catalog Number

Notes

Type

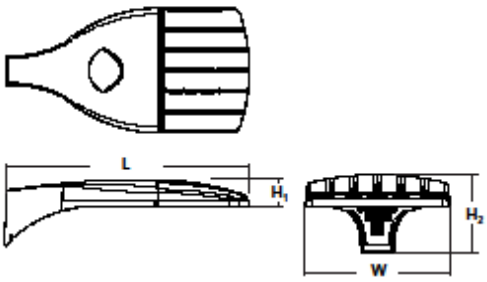
Hit the Tab key or mouse over the page to see all interactive elements

Introduction

The modern styling of the D-Series is striking yet unobtrusive - making a bold, progressive statement even as it blends seamlessly with its environment. The D-Series distills the benefits of the latest in LED technology into a high performance, high efficacy, long-life luminaire. The outstanding photometric performance results in sites with excellent uniformity, greater pole spacing and lower power density. It is ideal for replacing up to 400W metal halide with typical energy savings of 70% and expected service life of over 100,000 hours.

Specifications

EPA:	0.95 ft² (.09 m²)
Length:	26" (66.0 cm)
Width:	13" (33.0 cm)
Height$_1$:	3" (7.62 cm)
Height$_2$:	7" (17.8 cm)
Weight (max):	16 lbs (7.25 kg)



A+ Capable options indicated by this color background.

Ordering Information

EXAMPLE: DSX0 LED P6 40K T3M MVOLT SPA NLTAIR2 PIRHN DDBXD

DSX0 LED

Series	LEDs	Color temperature	Distribution	Voltage	Mounting
DSX0 LED	**Forward optics** P1 P4 P7 P2 P5 P3 P6 **Rotated optics** P10[7] P12[7] P11[7] P13[7]	30K 3000 K 40K 4000 K 50K 5000 K	T1S Type I short T2S Type II short T2M Type II medium T3S Type III short T3M Type III medium T4M Type IV medium TFTM Forward throw medium T5VS Type V very short T5S Type V short T5M Type V medium T5W Type V wide BLC Backlight control[2] LCCO Left corner cutoff[2] RCCO Right corner cutoff[2]	MVOLT[4,5] T20[6] 208[6] 240[6] 277[6] 347[5,6] 480[5,6]	**Shipped included** SPA Square pole mounting RPA Round pole mounting WBA Wall bracket SPUMBA Square pole universal mounting adaptor[8] RPUMBA Round pole universal mounting adaptor[8] **Shipped separately** KMA8 DDBXD U Mast arm mounting bracket adaptor (specify finish)[9]

Control options			Other options	Finish (required)	
Shipped installed		PIR High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 5fc[11,14]	**Shipped installed**	DDBXD	Dark bronze
NLTAIR2 nLight AIR generation 2 enabled[10]		PIRH High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 5fc[11,14]	HS House-side shield[16]	DBLXD	Black
PIRHN Network, high/low motion/ambient sensor[10]		PIR1FC3V High/low, motion/ambient sensor, 8-15' mounting height, ambient sensor enabled at 1fc[11,14]	SF Single fuse (120, 277, 347V)[4]	DNAXD	Natural aluminum
PER NEMA twist-lock receptacle only (control ordered separate)[11]		PIRH1FC3V High/low, motion/ambient sensor, 15-30' mounting height, ambient sensor enabled at 1fc[11,14]	DF Double fuse (208, 240, 480V)[4]	DWHXD	White
PER5 Five-pin receptacle only (control ordered separate)[11,12]		FAO Field adjustable output[13]	L90 Left rotated optics[1]	DDBTXD	Textured dark bronze
PER7 Seven-pin receptacle only (leads exit fixture) (control ordered separate)[11,12]			R90 Right rotated optics[1]	DBLBXD	Textured black
DMG 0-10V dimming extend out back of housing for external control (control ordered separate)			DDL Diffused drop lens[16]	DNATXD	Textured natural aluminum
			Shipped separately	DWHGXD	Textured white
			BS Bird spikes[17]		
			EGS External glare shield[17]		

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1. APPLICATION – Enclosed, horizontal roadway luminaires are the standard luminaires available for use in roadway lighting installations for streets in the City of Worcester.

2. SPECIFICATION – All high intensity discharge, horizontal roadway luminaires shall conform to the following specification, including Table I below:

General – Luminaire, high intensity discharge, enclosed, horizontal roadway, Autobahn Series ATBM (or approved equivalent) in accordance with ANSI C136.14, latest issue.

IES Light Distribution – Luminaires shall have a lamp socket setting that provides a light distribution pattern as

specified in Tables I – III, and shall be in accordance with the latest edition of RP-8. Photometric data shall be provided to the Standards Engineering Department upon request.

Mounting Provision – Luminaire shall include a slip-fitter designed for attachment to a pipe tenon with an outside diameter of 1-1/4 to 2 inches. Slip-fitter shall have a minimum insertion length of 4-3/4 inches and shall include an internal stop to prevent over insertion. Provision shall be made for adjustment of an installed luminaire a minimum of 3 degrees above or below the horizontal. Mounting hardware shall be mechanically galvanized, zinc chromate plated, or stainless steel, and shall be rigid to prevent slippage or rotation of the luminaire in relation to the tenon.

Housing – Luminaire housing shall be die cast aluminum with a hinged lower door assembly. All housing parts shall fit together without excessive voids or openings. The lower door latch shall provide positive indication that the lower door is securely closed and shall provide no-tool access to the lamp compartment. The lower door hinge shall be designed so that a free-swinging door will not accidentally disengage from the upper housing. The lower door shall be removable without the need for tools.

Finish / Color(s) - Luminaire housing shall be painted, both inside and outside, using powder coat paint. Paint finish shall be smooth, semi-gloss. Color shall be GRAY – (RAL #7038).

Wildlife Guard – Luminaire shall have a factory installed wildlife guard designed to prevent animal entry into the luminaire housing. The wildlife guard shall be designed to be difficult to remove to insure it being in place at the time of installation.

Reflector / Refractor – Luminaire shall include a polished, gasketed, reflector designed so that with the lower luminaire door closed, dirt, dust, bugs, etc., cannot enter the lamp compartment. Luminaire shall have a refractor as specified in Tables I through III, and in accordance with ANSI C136.17, latest issue.

Labeling – Luminaire and ballast shall be labeled in accordance with ANSI C136.22, latest issue, for lamp and ballast wiring diagrams. Wiring diagram shall be mounted in a visible location and shall be permanent. Luminaire shall be externally labeled on the lower housing door with a color-coded wattage label in accordance with ANSI C136.15, latest issue. 240 volt and 277 volt luminaires shall have an additional label on the lower housing door to identify the operating voltage. Pulse start metal halide luminaires shall have an additional label on the lower housing door with the legend “PULSE START”. Manufacturer, date of manufacture, supply voltage, lamp type and wattage, shall be identified on the luminaire nameplate.

Terminal Block – Luminaire shall be provided with a three positions, dead back, terminal block with captive screws and washers and mounted such that #14 to #8 AWG stranded copper source conductors can be easily be installed by a lineperson wearing rubber gloves. Luminaire housing shall be grounded with a green conductor connected to the middle terminal.

Photoelectric Control Receptacle – Luminaire to include a 360° adjustable, twistlock, photoelectric control receptacle in accordance with ANSI C136.10, latest issue, but without photoelectric control. Photoelectric control receptacle shall have tin plated bronze contacts.

Ballast – Luminaire shall include a ballast of the type specified in Tables I – III. All ballast shall conform to ANSI 82.4, latest issue. Ballast shall be capable of starting and operating the lamp within manufacturers’ specified limits. During normal lamp failure modes, ballast must protect itself. Ballasts specified as “reactor” shall be capable of operating on circuits regulated to within ± 5% of line voltage. Ballasts specified as “regulated” shall be capable of operating on circuits regulated to within ± 10% of line voltage.

Starting Aid – When required, luminaire shall be provided with a socket and field replaceable plug in solid state starting aid mounted in an easily accessible location.

Capacitor – All capacitors, when used, shall be clearly be labeled “NON-PCB”. Label shall be visible in final capacitor mounting location.

Lamp Socket - Lamp socket shall be a 600-volt class (per ANSI C-136.2, latest edition), mogul base design with a nickel-plated bronze screw shell and center contact. Lamp socket shall be in accordance with ANSI C136.11, latest issue. Screw shell shall prevent lamp unseating from vibration. Lamp socket housing shall be glazed porcelain. Lamp position shall be horizontal.

Shipping – Each luminaire shall be individually boxed and supported during shipment to prevent damage. Shipping carton shall include a label with the luminaire description, manufacturers catalog number, and a one line drawing depicting the shape of the luminaire.

Wireless Controller – A wireless controller shall be attached to each fixture installed, including decorative fixtures.

This controller shall be CIMCON Lighting, Inc. iSLC-3100-7P (or equivalent).

3. ITEM ID – Light Emitting Diode Horizontal Roadway Luminaires – See Table I

TABLE I

Autobahn Series ATBM
Roadway

ORDERING INFORMATION

Series

ATBM Autobahn LED Roadway

Performance Packages

P05 9,700 lumens
P10 11,000 lumens
P20 12,800 lumens
P30 15,500 lumens
P40 17,400 lumens
P50 18,700 lumens
P60 20,000 lumens
P70 21,500 lumens

Voltage

MVOLT Multi-volt, 120-277V
347 347V
480 480V

Optics

R2 Roadway Type II
R3 Roadway Type III
R4 Roadway Type IV
R5 Roadway Type V

Mounting

(Blank) 2 Bolt Mounting
4B 4 Bolt Mounting

Options

Color Temperature (CCT)
(Blank) 4000K CCT, 70 CRI Min.
3K 3000K CCT, 70 CRI Min.
5K 5000K CCT, 70 CRI Min.

Paint
(Blank) Gray
BK Black
BZ Bronze
DDB Dark Bronze
GI Graphite
WH White

Surge Protection
(Blank) Standard 20kV/10kA SPD
MP MOV Pack

Miscellaneous Options
HSS House Side Shield
NL NEMA Label Indicating Wattage
XL Not CSA Certified – No Terminal Block Cover
UMR-XX 8" Horizontal Arm for Round Pole, Painted to match Fixture
UMS-XX 8" Horizontal Arm for Square Pole, Painted to match Fixture
UMR-GALV 8" Horizontal Arm for Round Pole, Painted to match Fixture
UMS-GALV 8" Horizontal Arm for Square Pole, Painted to match Fixture

Control Options
(Blank) 3 Pin NEMA Photocontrol Receptacle
P7 7 Pin Photocontrol Receptacle (dimmable driver included) [1]
NR No Photocontrol Receptacle
AO Field Adjustable Output [3]
DM 0-10V Dimmable Driver [2]
PCSS Solid-State Lighting Photocontrol [4]
PCLL Solid-State Long Life Photocontrol
PCCC Solid-State Long Life Photocontrol with remote control on/off [4]
SH Shorting Cap

Packages
(Blank) Standard Pack
JP Job Pack (36/pallet)

Accessories
ATBMHSS House Side Shield
ATBMLTS Light Trespass Shield
RKATBMMVOLTSPD ATBM Acuity SPD, MVOLT
RKATBMHVSPD ATBM Acuity SPD, 347/480V
RKATBMMVOLTMP ATBM MOV Pack, MVOLT
RKATBMHVMP ATBM MOV Pack, 347/480V

Notes:
1 Dimmable Driver included. Not available with DM or NR.
2 Controls by others. Not available with P7 or AO.
3 Not available with DM.
4 MVOLT only.

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ATBM

4. ITEM ID – Light Emitting Diode Horizontal Roadway Luminaires – See Table II.
TABLE II

Autobahn Series ATBM
Roadway

PERFORMANCE PACKAGE

Performance Package	Distribution	Input Watts	3K (3000K CCT, 70 CRI)					4K/5K (4000K/5000K CCT, 70 CRI)					LLD @ 25°C		
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	25k Hours	75k Hours	100k Hours
P05	R2	68	9,396	138	1	0	2	9,718	143	1	0	2	0.93	0.86	0.83
	R3		9,366	138	1	0	3	9,688	142	1	0	3			
	R4		9,030	133	1	0	3	9,340	137	1	0	3			
	R5		10,334	152	3	0	2	10,689	157	3	0	2			
P10	R2	81	10,635	131	2	0	3	11,299	139	2	0	3	0.93	0.86	0.83
	R3		10,675	132	2	0	3	11,302	140	2	0	3			
	R4		10,391	128	2	0	4	10,994	136	2	0	4			
	R5		11,504	142	3	0	2	12,086	149	3	0	2			
P20	R2	94	12,073	128	2	0	3	12,874	137	2	0	3	0.93	0.86	0.83
	R3		12,065	128	2	0	3	12,818	136	2	0	3			
	R4		11,946	127	2	0	4	12,525	133	2	0	4			
	R5		13,085	139	4	0	2	13,776	147	4	0	2			
P30	R2	118	14,637	124	2	0	3	15,514	131	2	0	3	0.93	0.86	0.83
	R3		14,631	124	2	0	3	15,452	131	2	0	3			
	R4		14,317	121	2	0	4	15,151	128	2	0	5			
	R5		15,775	134	4	0	2	16,685	141	4	0	2			
P40	R2	135	16,233	120	2	0	3	17,493	130	2	0	3	0.93	0.86	0.83
	R3		16,402	121	2	0	3	17,367	129	2	0	3			
	R4		15,911	118	2	0	5	17,008	126	2	0	5			
	R5		17,507	130	4	0	2	18,595	138	4	0	2			
P50	R2	152	17,541	115	2	0	3	18,748	123	2	0	3	0.93	0.86	0.83
	R3		17,677	116	2	0	4	18,712	123	2	0	4			
	R4		17,154	113	2	0	5	18,246	120	2	0	5			
	R5		19,008	125	4	0	2	20,088	132	4	0	2			
P60	R2	168	18,770	112	2	0	3	20,095	120	3	0	3	0.93	0.86	0.83
	R3		18,830	112	2	0	4	20,094	120	3	0	4			
	R4		18,369	109	2	0	5	19,648	117	2	0	5			
	R5		20,350	121	4	0	2	21,505	128	4	0	2			
P70	R2	190	20,190	106	3	0	3	21,565	114	3	0	3	0.93	0.86	0.83
	R3		20,142	106	3	0	4	21,504	113	3	0	4			
	R4		19,660	103	2	0	5	21,024	111	3	0	5			
	R5		21,988	116	4	0	2	23,076	121	4	0	2			

Note: Individual fixture performance may vary. Specifications subject to change without notice.

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ATBM

5. ITEM ID – Non-Standard Horizontal Roadway Luminaires – See Table III and IV.

TABLE III

Autobahn Series ATBS
Roadway & Security Lighting

ORDERING INFORMATION

Series
ATBS Autobahn LED Roadway & Security

Performance Packages
P10 5,500 lumens
P20 6,800 lumens
P30 8,300 lumens
P40 9,400 lumens
P50 10,800 lumens
P60 11,850 lumens

Voltage
MVOLT Multi-volt, 120-277V
347 347V
480 480V

Optics
R2 Roadway Type II
R3 Roadway Type III
R5 Roadway Type V
D3 Type III, Drop Refractor included
D5 Type V, Drop Refractor included

Options

Color Temperature (CCT)
(Blank) 4000K CCT, 70 CRI Min.
3K 3000K CCT, 70 CRI Min.
5K 5000K CCT, 70 CRI Min.

Paint
Blank Gray (Standard)
BK Black
WH White
BZ Bronze

Surge Protection
Blank Standard 20kV/10kA SPD
MP MOV Pack 10kV/5kA

Misc.
HS House Side Shield
NL NEMA Label
XL Not CSA Certified
VR[3] Visual Comfort Optic
UMR-XX 8" Horizontal Arm for Round Pole, Painted to match Fixture
UMS-XX 8" Horizontal Arm for Square Pole, Painted to match Fixture
UMR-GALV 8" Horizontal Arm for Round Pole, Painted to match Fixture
UMS-GALV 8" Horizontal Arm for Square Pole, Painted to match Fixture

Controls
(Blank) 3 Pin NEMA Photocontrol Receptacle
NR[1] No Photocontrol Receptacle
DM[2] 0V-10V Dimmable Driver
P7 7 Pin Photocontrol Receptacle (dimmable driver included)
PCSS[1] DTL DSS Photocontrol
PCL1[1] DTL DLL Photocontrol 120-277V
AO Field Adjustable Output
SH Shorting Cap

Packages
(Blank) Standard Pack
JP Job Pack (54/pallet)

Install Packages
PKGS DTL DSS Photocontrol
PKGL DTL DLL Photocontrol
Packages ship with selected photocontrol, 24", 1 1/4" diameter arm, 5' of prewire and mounting hardware

Accessories
ATBSREF Drop Refractor for field installation
ATBSHSS House Side Shield for field installation
ATBSLTS Light Trespass Shield for field installation
ATBS LOUVER KIT Louver Kit for field installation
ATBSVR-XX Visual Comfort Refractor and painted skirt for field installation

Notes
1. Not available with Install Packages.
2. Not available with AO option.
3. Not available with D3 or D5 option.

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Please contact your sales representative for the latest product information.

TABLE IV

Autobahn Series ATBS
Roadway & Security Lighting

PERFORMANCE PACKAGE

ATBS

Performance Package	Distribution	Input Watts	3K (3000K CCT, 70 CRI)					4K/5K (4000K/5000K CCT, 70 CRI)					LLD @ 25°C		
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	50k Hours	75k Hours	100k Hours
P10	R2	40	5,360	134	1	0	2	5,577	139	1	0	2	0.92	0.89	0.85
	R3		5,287	132	1	0	1	5,524	138	1	0	1			
	R5		5,576	139	3	0	1	5,758	144	3	0	1			
	D3		4,963	124	1	3	3	5,163	129	1	3	3			
	D5		5,372	134	2	3	3	5,590	140	2	3	3			
P20	R2	50	6,707	134	1	0	2	6,809	136	1	0	2	0.92	0.89	0.85
	R3		6,687	134	2	0	2	6,760	135	2	0	2			
	R5		6,926	139	3	0	1	7,108	142	3	0	1			
	D3		6,496	130	2	3	4	6,244	125	1	3	4			
	D5		7,032	141	3	4	4	7,317	146	3	4	4			
P30	R2	60	8,092	135	2	0	2	8,067	134	1	0	1	0.92	0.89	0.85
	R3		7,971	133	2	0	2	8,328	139	2	0	2			
	R5		8,470	141	3	0	2	8,760	146	3	0	2			
	D3		7,491	125	2	3	4	7,795	130	2	3	4			
	D5		8,110	135	3	4	4	8,438	141	3	4	4			
P40	R2	70	9,138	131	2	0	2	9,533	136	2	0	2	0.92	0.89	0.85
	R3		9,136	131	2	0	2	9,355	134	2	0	2			
	R5		9,868	141	3	0	2	9,710	139	3	0	2			
	D3		8,460	121	2	3	4	8,802	126	2	3	5			
	D5		9,158	131	3	4	5	9,529	136	3	4	5			
P50	R2	82	10,628	130	2	0	3	10,829	132	2	0	3	0.92	0.89	0.85
	R3		10,624	130	2	0	2	10,826	132	2	0	2			
	R5		11,450	140	4	0	2	11,181	136	4	0	2			
	D3		10,143	124	2	4	5	10,553	129	2	4	5			
	D5		10,651	130	3	4	5	11,082	135	3	4	5			
P60	R2	92	11,050	120	2	0	3	11,848	129	2	0	3	0.92	0.89	0.85
	R3		10,911	119	2	0	2	11,862	129	2	0	2			
	R5		12,199	133	4	0	2	12,756	139	4	0	2			
	D3		10,230	111	2	4	5	10,644	116	2	4	5			
	D5		11,074	120	3	4	5	11,523	125	3	4	5			

ATBS with VR

Performance Package	Distribution	Input Watts	3K (3000K CCT, 70 CRI)					4K/5K (4000K/5000K CCT, 70 CRI)					LLD @ 25°C		
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	50k Hours	75k Hours	100k Hours
P10	R2 with VR	40	4,450	111	1	0	1	4,561	114	1	0	1	0.92	0.89	0.85
	R3 with VR		4,273	107	1	0	1	4,605	115	1	0	1			
	R5 with VR		4,539	113	2	0	1	4,679	117	2	0	1			
P20	R2 with VR	50	5,491	110	1	0	1	5,550	111	1	0	1	0.92	0.89	0.85
	R3 with VR		5,379	108	1	0	1	5,582	112	2	0	1			
	R5 with VR		5,647	113	2	0	1	5,692	114	2	0	1			
P30	R2 with VR	60	6,479	108	2	0	1	6,530	109	2	0	1	0.92	0.89	0.85
	R3 with VR		6,400	107	2	0	1	6,564	109	2	0	1			
	R5 with VR		6,703	112	3	0	1	6,693	112	2	0	1			
P40	R2 with VR	70	7,307	104	2	0	1	7,561	108	2	0	1	0.92	0.89	0.85
	R3 with VR		7,347	105	2	0	1	7,638	109	2	0	1			
	R5 with VR		7,693	110	3	0	1	7,749	111	3	0	1			
P50	R2 with VR	82	8,552	104	2	0	2	8,711	106	2	0	2	0.92	0.89	0.85
	R3 with VR		8,494	104	2	0	1	8,814	107	2	0	1			
	R5 with VR		8,895	108	3	0	1	8,911	109	3	0	1			
P60	R2 with VR	92	8,989	98	2	0	2	9,815	107	2	0	2	0.92	0.89	0.85
	R3 with VR		8,899	97	2	0	1	9,857	107	2	0	2			
	R5 with VR		9,309	101	3	0	1	10,256	111	3	0	1			

Note: Individual fixture performance may vary. Specifications subject to change without notice.

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6. ITEM ID – Non-Standard Horizontal Roadway Luminaires – See Table V and VI.
TABLE V

Autobahn Series ATBX
Roadway & Security Lighting

ORDERING INFORMATION

Series

ATBX Autobahn LED Roadway & Security

Performance Packages

P10 2,000 lumens
P20 2,500 lumens
P30 3,200 lumens
P40 3,900 lumens
P50 5,600 lumens
P60 6,600 lumens
P70 7,400 lumens

Voltage

MVOLT Multi-volt, 120-277V

Optics

R2 Roadway Type II
R3 Roadway Type III
R4 Roadway Type IV
R5 Roadway Type V
D3 Type III, Drop Refractor included
D5 Type V, Drop Refractor included

Options

Color Temperature (CCT)
(Blank) 4000K CCT, 70 CRI Min.
3K 3000K CCT, 70 CRI Min.
5K 5000K CCT, 70 CRI Min.

Paint
Blank Gray (Standard)
BK Black
WH White
BZ Bronze

Surge Protection
Blank Standard 20kV/10kA SPD
MP MOV Pack

Misc.
VR Visual Comfort Refractor
HSS House Side Shield
NL NEMA Label
XL Not CSA Certified

Controls
(Blank) 3 Pin NEMA Photocontrol Receptacle
NR[1] No Photocontrol Receptacle
DM[2] 0V-10V Dimmable Driver
P7 7 Pin Photocontrol Receptacle (dimmable driver included)
PCSS[1] DTL DSS Photocontrol
PCLL[1] DTL DLL Photocontrol 120-277V
AO Field Adjustable Output
SH Shorting Cap

Packages
(Blank) Standard Pack
JP Job Pack

Install Packages
PKGS DTL DSS Photocontrol
PKGL DTL DLL Photocontrol
Packages ship with selected photocontrol, 24", 1 1/4" diameter arm, 5' of prewire and mounting hardware

Accessories
ATBXREF Drop Refractor for field installation
ATBXHSS House Side Shield for field installation
ATBXLTS Light Trespass Shield for field installation
ATBXVR-XX Comfort Refractor & Uplight Skirt, Select Paint (XX) to Match Fixture

Notes
1. Not available with Install Packages.
2. Not available with A0 option.

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TABLE VI

PERFORMANCE PACKAGE

Performance Package	Distribution	Input Watts	3000K CCT, 70 CRI					4000K & 5000K CCT, 70 CRI					LLD @ 25C		
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	50K Hours	75K Hours	100K Hours
P10	R2	14	1,956	140	1	0	1	2,030	145	1	0	1	0.92	0.89	0.85
	R3		1,955	140	0	0	1	2,011	144	0	0	1			
	R4		1,982	142	1	0	1	1,974	141	1	0	1			
	R5		2,145	153	1	0	0	2,160	154	1	0	0			
	D3		1,908	136	1	2	1	1,963	140	1	2	1			
	D5		2,077	148	1	2	1	2,092	149	1	2	1			
P20	R2	18	2,455	136	1	0	1	2,575	143	1	0	1	0.92	0.89	0.85
	R3		2,473	137	1	0	1	2,547	142	1	0	1			
	R4		2,505	139	1	0	1	2,497	139	1	0	1			
	R5		2,715	151	2	0	0	2,735	152	2	0	0			
	D3		2,414	134	1	2	1	2,486	138	1	2	1			
	D5		2,629	146	1	2	1	2,648	147	1	2	1			
P30	R2	23	3,102	135	1	0	1	3,243	141	1	0	1	0.92	0.89	0.85
	R3		3,125	136	1	0	1	3,232	141	1	0	1			
	R4		3,153	137	1	0	1	3,150	137	1	0	1			
	R5		3,422	149	2	0	1	3,431	149	2	0	1			
	D3		3,050	133	1	2	1	3,155	137	1	2	1			
	D5		3,314	144	1	2	1	3,322	144	1	2	1			
P40	R2	28	3,603	129	1	0	1	3,790	135	1	0	1	0.92	0.89	0.85
	R3		3,705	132	1	0	1	3,890	139	1	0	1			
	R4		3,640	130	1	0	2	3,817	136	1	0	2			
	R5		3,971	142	2	0	1	4,167	149	2	0	1			
	D3		3,617	129	1	2	2	3,797	136	1	2	2			
	D5		3,845	137	2	2	1	4,035	144	2	2	1			
P50	R2	41	5,426	132	2	0	2	5,425	132	2	0	2	0.92	0.89	0.85
	R3		5,248	128	1	0	2	5,615	137	1	0	2			
	R4		5,300	129	1	0	2	5,462	133	1	0	2			
	R5		5,647	138	3	0	1	6,033	147	3	0	1			
	D3		5,123	125	1	3	2	5,481	134	1	3	2			
	D5		5,468	133	2	3	2	5,842	142	2	3	2			
P60	R2	51	6,392	125	2	0	2	6,416	126	2	0	2	0.92	0.88	0.84
	R3		6,208	122	1	0	2	6,635	130	1	0	2			
	R4		6,207	122	1	0	2	6,432	126	1	0	2			
	R5		6,690	131	3	0	1	7,127	140	3	0	1			
	D3		6,059	119	1	3	2	6,477	127	1	3	2			
	D5		6,478	127	2	3	2	6,901	135	3	3	2			
P70	R2	60	7,133	140	2	0	2	7,246	142	2	0	2	0.92	0.88	0.84
	R3		6,967	137	1	0	2	7,449	146	1	0	2			
	R4		6,957	136	1	0	2	7,235	142	1	0	2			
	R5		7,492	147	3	0	1	7,939	156	3	0	1			
	D3		6,800	133	2	3	2	7,271	143	2	3	2			
	D5		7,255	142	3	3	2	7,688	151	3	3	2			

American Electric Lighting
AEL Headquarters, 3825 Columbus Road, Granville, OH 43023
www.americanelectriclighting.com
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Warranty Five-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions
Actual performance may differ as a result of end-user environment and application.
All values are design or typical values, measured under laboratory conditions at 25 °C.
Specifications subject to change without notice.

Please contact your sales representative for the latest product information.

TABLE VI (cont.)

PERFORMANCE DATA with VISUAL COMFORT REFRACTOR

Performance Package	Distribution	Input Watts	3000K CCT, 70 CRI					4000K & 5000K CCT, 70 CRI					LLD @ 25C		
			Lumens	LPW	B	U	G	Lumens	LPW	B	U	G	50K Hours	75K Hours	100K Hours
P10	R2 with VR	14	1,686	120	1	0	1	1,747	125	1	0	1	0.92	0.89	0.85
	R3 with VR		1,669	119	1	0	1	1,698	121	1	0	1			
	R4 with VR		1,602	114	1	0	1	1,626	116	1	0	1			
	R5 with VR		1,814	130	1	0	1	1,862	133	1	0	1			
P20	R2 with VR	18	2,124	118	1	0	1	2,205	123	1	0	1	0.92	0.89	0.85
	R3 with VR		2,104	117	1	0	1	2,138	119	1	0	1			
	R4 with VR		2,019	112	1	0	1	2,053	114	1	0	1			
	R5 with VR		2,290	127	1	0	1	2,346	130	1	0	1			
P30	R2 with VR	23	2,684	117	1	0	1	2,788	121	1	0	1	0.92	0.89	0.85
	R3 with VR		2,659	116	1	0	1	2,699	117	1	0	1			
	R4 with VR		2,553	111	1	0	1	2,594	113	1	0	1			
	R5 with VR		2,892	126	2	0	1	2,969	129	2	0	1			
P40	R2 with VR	28	3,240	116	1	0	1	3,369	120	1	0	1	0.92	0.89	0.85
	R3 with VR		3,204	114	1	0	1	3,261	116	1	0	1			
	R4 with VR		3,081	110	1	0	2	3,124	112	1	0	2			
	R5 with VR		3,495	125	2	0	1	3,584	128	2	0	1			
P50	R2 with VR	41	4,633	113	1	0	2	4,818	118	1	0	2	0.92	0.89	0.85
	R3 with VR		4,499	110	1	0	2	4,617	113	1	0	2			
	R4 with VR		4,343	106	1	0	2	4,504	110	1	0	2			
	R5 with VR		4,869	119	2	0	1	5,117	125	2	0	1			
P60	R2 with VR	51	5,495	108	2	0	2	5,710	112	2	0	2	0.92	0.88	0.84
	R3 with VR		5,330	105	1	0	2	5,490	108	1	0	2			
	R4 with VR		5,145	101	1	0	2	5,328	104	1	0	2			
	R5 with VR		5,771	113	3	0	1	6,061	119	3	0	1			
P70	R2 with VR	60	6,167	121	2	0	2	6,396	125	2	0	2	0.92	0.88	0.84
	R3 with VR		5,978	117	1	0	2	6,110	120	1	0	2			
	R4 with VR		5,772	113	1	0	2	5,962	117	1	0	2			
	R5 with VR		6,482	127	3	0	1	6,799	133	3	0	2			

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Warranty Five-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/customer-support/terms-and-conditions
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Specifications subject to change without notice.

Please contact your sales representative for the latest product information.

PRECAST CONCRETE STREET LIGHTING FOUNDATION 11½" BOLT CIRCLE – FOR ROADWAY CLASS POLES

Specifications

1. APPLICATION - This STANDARD covers precast concrete street lighting foundations used for mounting all anchor bases, roadway class street lighting poles that have an 11-1/2" bolt circle.

2. SPECIFICATION - All precast concrete foundations with an 11-1/2" bolt circle shall conform to the following specification, including Figure 1.

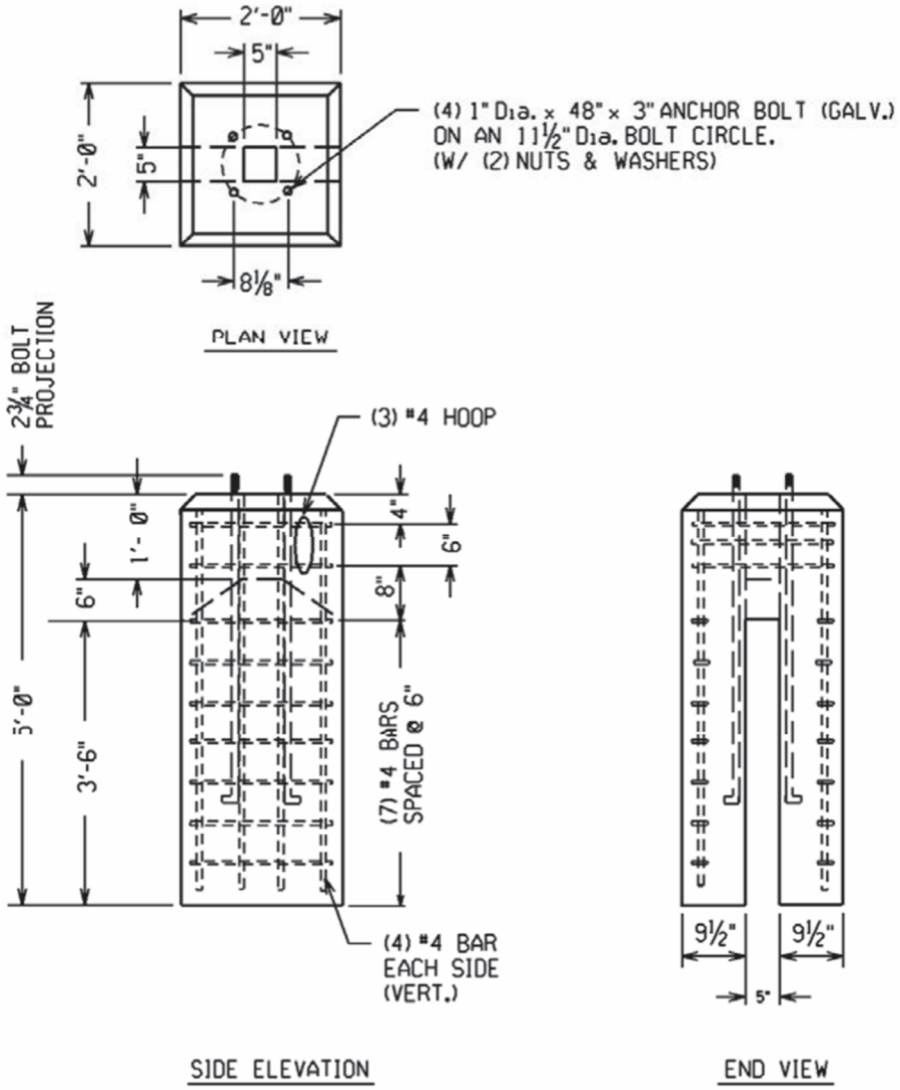

Figure 1 – Precast Concrete Street Lighting Foundation - 11½" Bolt Circle

General - Precast concrete street lighting foundation, overall size = 24 inch square x 60"depth, with 45 degree chamfer around top edge. Approximate weight = 2,500 pounds.

Minimum Concrete Strength - 5,000 PSI @ 28 days. Type III.

Steel Reinforcement - Steel reinforcement rods shall be #4 bars – ASTM A615 Grade 60, and in accordance with Figure 1.

Anchor Bolt Detail - Provide four 1-inch diameter x 48" x 3" "L" shaped galvanized steel anchor bolts, each one with (2) heavy hex head nuts and (2) round washers. All hardware shall conform to ASTM A36, A563, and F844, respectively and shall be hot-dip galvanized per A153. Bolt circle diameter shall be 11-1/2-inch. Each anchor bolt shall have a minimum 12-inch thread length and shall project 2-3/4-inches above the top of the foundation.

Wiring Access - Provide a 5-inch x 5-inch opening in the center of the foundation for conduit installation by others, as shown in Figure 1.

3. ITEM ID - See Table I.
TABLE I

Standard Item	Item ID	Description
SF10	5821035	Precast Concrete Street Lighting Foundation – for roadway class poles with an 11-1/2" bolt circle.

ANCHOR BASE, PENDANT ARM, STREET LIGHTING POLES, Aluminum Specifications
1. APPLICATION – Anchor base, aluminum, pendant streetlighting poles are available for outdoor lighting installations supplied by underground wiring. Typical applications are in commercial "downtown" areas and along main highways.
2. SPECIFICATIONS - All anchor base, aluminum, pendant streetlighting poles shall conform to the following specifications, including Figures 1, 2, 3, 4, and Table 1.

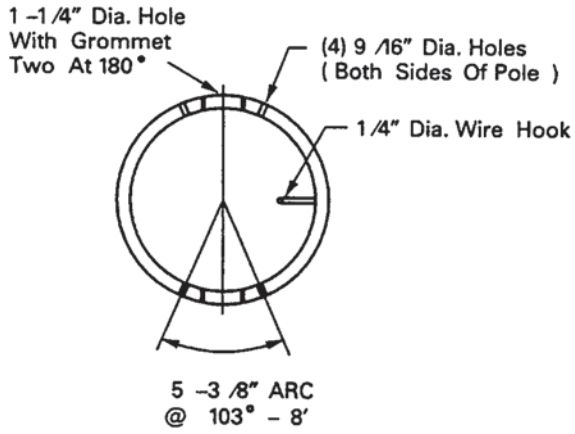

Figure 1 – Pole Top Detail
Top Detail
(Top View)

(Side View)

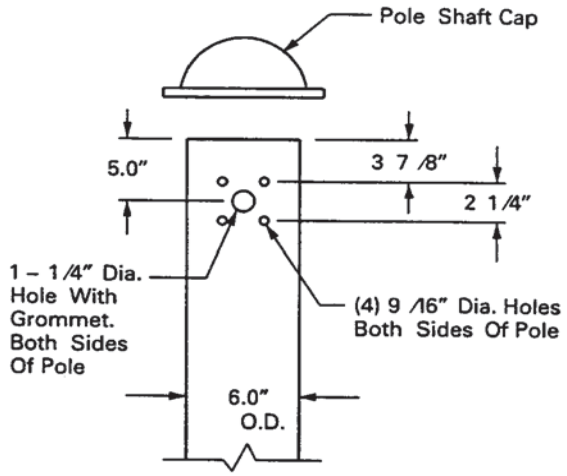

Figure 2 – Pole

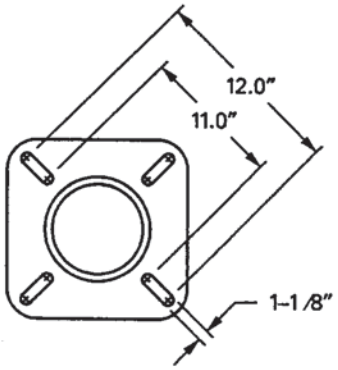

Figure 3 – Base Flange Detail
Detail

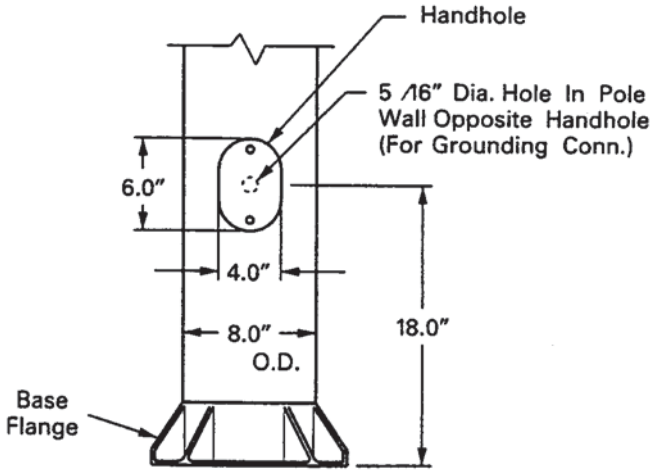

Figure 4 – Handhole

General - Pole, aluminum, anchor base, pendant, for roadway lighting use. Includes base flange, handhole, grounding provision, shaft cap, and arm attachment hardware. Pole height as specified.

Base Flange - The base flange shall be a one piece cast aluminum alloy, joined to the shaft by complete circumferential welding. The base flange shall include four 1⅛" diameter slotted holes, to enable pole installation on a precast concrete foundation with four 1" diameter anchor bolts arranged in an 11½" bolt circle. Anchor bolts are to be supplied by others. Four 1/16" aluminum shims and four aluminum anchor bolt covers, including stainless steel attachment hardware shall be included with every pole. The anchor bolt covers shall provide adequate inside clearance to cover 1" diameter anchor bolts with a 2¾" projection above the top of the precast concrete foundation. The central area of the base flange shall be open to allow wiring access.

Handhole - Every pole shall be provided with a 4" x 8" oval shaped handhole centered 18 inches above the bottom of the shaft, and located 90 degrees from the plane of the luminaire arms as viewed from the pole top. Handhole shall be reinforced with a cast aluminum frame. Handhole cover shall be secured by two stainless steel pinned Allen head attachment screws.

Grounding - Pole shall be furnished with one 5/16" hole positioned opposite the center line of the handhole and one Fargo # 5006-P connector for grounding purposes.

Shaft: The pole shaft shall be a seamless, round tapered tube, and shall be full length heat treated after welding to produce a T6 temper. The outside diameter shall be 8.0" at the base and taper to 6.0" at the top. See Table 1 for nominal wall thickness. A ¼" diameter wire hook shall be welded to the inside of the shaft, at the pole top, to provide mechanical support for the luminaire wiring.

Finish / Color - The shaft shall have a satin etched finish, free of dents and scratches and requiring no surface preparation, painting, or maintenance.

Festoon Outlet - When specified, pole shall be provided with a single outlet box mounted in a welded frame with a weatherproof hinged cover located 15'-0" above the base flange on the same face of the pole as the handhole. Electrical receptacle shall be provided by others.

Strength - Pole shall meet latest AASHTO requirements for intended use. At minimum, pole shall be capable of supporting two horizontal roadway style luminaires (each one with an effective projected area of 2.0 square feet and weighing 80 pounds), each one mounted on a 12-foot truss style arm, when subjected to a sustained 90-MPH wind.

Welding - All welding shall be shop welded using the inert gas shielded metal arc method with consumable electrode in accordance with AWS Specification D1.2, Structural Welding Code – Aluminum.

Arm Attachment - The shaft shall be factory drilled to enable installation of two luminaire arms mounted 180 degrees apart. Factory drilling for each arm shall include four 9/16" holes for arm attachment and one 1¼" diameter gromotted hole for wiring access. See Figures 1 and 2 for arm attachment details. An aluminum plate shall be provided which blanks off one set of arm attachment holes in the event only one arm is to be installed. The plate shall be provided attached in place on the pole using (4) ½" x 1-1/2" long stainless steel hex head bolts, nuts, washers, & lock washers.

Shaft Cap - A cast aluminum cap shall be provided with each pole. The cap shall be attached to the pole shaft by means of three stainless steel screws mounted 120 degrees apart.

Identification - Every pole shall be identified with the manufacturer's I.D. on the base flange in a location where the manufacturer can easily be determined when the pole is installed on a precast concrete foundation.

Shipping / Protection - Poles shall be blocked, supported, and protected during shipment to prevent warping, excessive flexure, abrasion or damage to the finish. All hardware, fasteners, handhole doors, and accessory attachments shall be shipped installed in place. All poles shall be shipped on a flatbed truck.

Drawings - Manufacturer shall provide detailed drawing(s) of the pole with all component parts. Drawing shall include one general drawing depicting the pole with all critical dimensions and materials identified; a list identifying the quantity and description of all accessory materials, and when appropriate, an exploded view of all to-be-assembled parts showing the proper sequence of assembly. Drawing shall also include information to enable the user to identify the pole's maximum capacity with respect to arm and luminaire effective projected area and weight loading when subjected to a sustained 90 MPH wind. Drawing shall also include the weight in pounds of the pole. When requested, manufacturer shall submit product samples for Standards Department evaluation.

3. ITEM ID – See Table I.

TABLE I

STANDARD ITEM	ITEM ID	DESCRIPTION	NOMINAL WALL THICKNESS
ST01F	0811022	25 Foot, Anchor Base, Aluminum, Pendant.	0.156 inches
ST01F1	0810919	25 Foot, Anchor Base, Aluminum, Pendant.	0.188 inches
ST01G	5821833	30 Foot, Anchor Base, Aluminum, Pendant.	0.188 inches
ST01G1	9202005	30 Foot, Anchor Base, Aluminum, Pendant.	0.250 inches
ST01H	5821834	35 Foot, Anchor Base, Aluminum, Pendant.	0.250 inches

STREETLIGHT ARMS FOR ALUMINUM PENDANT POLES, Specifications

1. APPLICATION – Aluminum streetlight arms are used to install horizontal roadway luminaires on aluminum pendant poles.

2. SPECIFICATIONS - All aluminum streetlight arms for aluminum pendant poles shall conform to the following specifications, including Figures 1 and 2 and Table I.

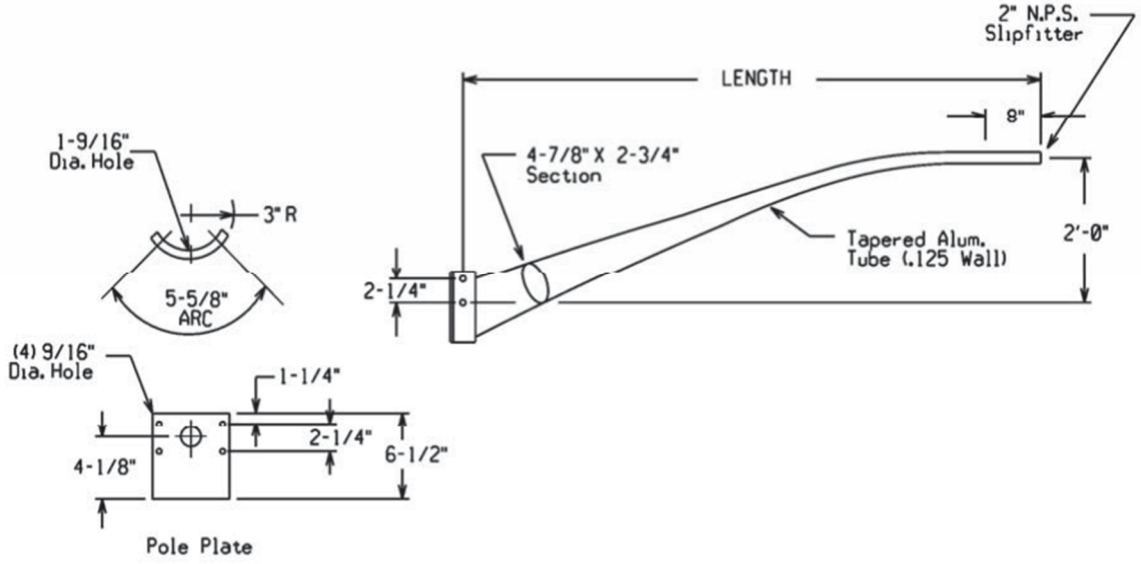

Figure 1 – Tapered Elliptical Aluminum Arm

Figure 2 – Tapered Truss Aluminum Arm

A General

Arm, streetlight, aluminum, for installation on aluminum pendant pole. Arms shall be in accordance with Figures 1 or 2, and Table 1.

Pole Attachment - All arms shall be designed to be attached to an aluminum pole with an outside diameter of 6.0 inches.

TAPERED ELLIPTICAL ARMS - These arms shall have one welded, fixed pole plate. This plate shall accommodate attachment to the aluminum pole with (4) ½" x 1½" long, stainless steel, hex head bolts, nuts, washers, and lock washers. All hardware is to be provided attached in place on the arm.

TAPERED TRUSS ARMS - Each truss member shall have a fixed, welded pole plate. The upper pole plate shall accommodate attachment to the aluminum pole with four ½" x 1½" long, stainless steel, hex head bolts, nuts, washers and lock washers. The lower pole plate shall clamp around the perimeter of the pole using a pole band and (4) ½" x 2½" long stainless steel, hex head, bolts, nuts, washers and lock washers. All hardware is to be provided attached in place on the truss arm.

Luminaire Attachment - The luminaire end of all arms shall accommodate a horizontal roadway style luminaire. The arm tenon shall be 2" O.D. and be in accordance with ANSI C136.3, latest issue.

Finish / Color - All arms shall have a natural finish, free of dents and scratches, and requiring no surface preparation, painting, or maintenance.

Wiring Access - All arms shall accommodate internal wiring. All pipe ends which will carry conductors shall be chamfered to avoid cutting or nicking the wiring insulation. Tapered truss arms shall use the upper truss member as the wiring path.

Welding – All aluminum welding shall be shop welded using inert metal-arc welding process in accordance with A. W. S. Specification D10.7, latest issue. Filler metal shall conform to the A. W. S. Specification A5.10, latest issue.

Strength - All arms shall be rated capable of supporting a horizontal roadway luminaire with a maximum weight of 80 pounds and a maximum effective projected area of 2.0 square feet when subjected to a sustained 90 MPH wind.

Identification - All arms shall be permanently stamped in a field readable location near the pole end with the manufacturer I.D. and date of manufacturer.

Shipping / Protection – Arms shall be blocked, supported, and protected during shipment to prevent any damage to the arm.

Drawings – Manufacturer shall submit detailed drawings of each arm with all component parts. Drawing shall include all dimensions, material specifications, manufacturing and welding procedures. Drawing shall also include a table showing the maximum effective projected area and maximum weight luminaire that each arm can support based on a sustained 90 MPH wind. Drawing shall also include the weight, in pounds, of each arm. When requested, manufacturer shall submit product samples for Standards Department evaluation.

B MEASUREMENT AND PAYMENT

Payment for this item shall be paid per each, complete in place.

3. ITEM ID - See Table I.
TABLE I

STANDARD ITEM	ITEM ID	DESCRIPTION
ST01X1	0811023	6 Foot Tapered Elliptical Arm for Aluminum Pendant Pole
ST01X2	0811024	8 Foot Tapered Elliptical Arm for Aluminum Pendant Pole
ST01X3	0811026	10 Foot Tapered Truss Arm for Aluminum Pendant Pole
ST01X4	0811025	12 Foot Tapered Truss Arm for Aluminum Pendant Pole
ST01X5	9202269	16 Foot Tapered Truss Arm for Aluminum Pendant Pole

ITEM 821.2000 STREET LIGHTING CONTROL LOAD CENTER

A. GENERAL

The work under this item shall conform to the relevant portions of Section 820 (MSSHB) and the following:

The work shall include the furnishing and installation of Street Lighting Control Load Center with all control equipment for the street lighting system in accordance with the plans and as directed by the Engineer.

The quantity of street lighting control load center estimated under this pay item is for the comparison of bids only and is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon the actual conditions encountered as provided for in Section 4.06 (MSSHB).

B. MATERIALS

Refer to the plans for all specific materials associated with the street lighting control load center. All material is as stated on the plans or approved equal.

C. CONSTRUCTION METHODS

Street lighting control load center shall be installed per Section 820 (MSSHB), and per applicable codes, using the material specified or approved equals.

D. MEASUREMENT AND PAYMENT

Street Lighting Control Load Center will be measured for payment by each complete, functioning unit in place.

Street Lighting Control Load Center will be paid for at the contract unit bid price per each, which price shall include all labor, material, tools and equipment, for furnishing and installing NEMA Cabinet, main breaker panel with main breaker, service panel with all required breakers, lighting contactor, lightening arrestor, conduit, time clock, auto-control switch, grounding, wire ways, light, switches, receptacles, meter socket, and all incidental costs required to complete the work.

EL743BR Series
ITS Equipment Cabinet

EAGLE
Traffic Control Systems

Description

The Eagle EL743BR series is designed to house and protect equipment for ITS installations. The cabinet is constructed from aluminum and designed for protection from all weather conditions.

EL743BR Series ITS Equipment Cabinet

Features

- 3/16" thick 5052-H32 Aluminum Construction
- 19" rack rails for equipment mounting
- Three-point latching system with #2 lock
- Continuously welded seams for maximum protection against contaminants
- **Double-flanged** cabinet shell for increased water protection
- Sun shield to help regulate cabinet and equipment temperature
- Side and back equipment mounting panels for additional mounting space
- Thermostatically controlled ventilation fan and air filter
- NEMA 3R rated and UL-approved design

Eagle Traffic Control Systems continues our 80+ year history of providing excellence in the ever evolving traffic industry. All of Eagle's products are developed with the highest standards of engineering and manufacturing. Eagle maintains a superior level of integrity in interactions with all of our business partners and customers. We also take tremendous pride in being model corporate citizens.

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ITEM 822.0000 SPOT DIGS (EACH)

A. GENERAL

A Spot Dig includes all work related to an excavation to repair a streetlight cable fault. This includes the investigation of and finding the fault, laying out the excavation work, mobilization of the excavation crew, saw cutting/jack hammering, excavating, repairing the fault, road plating (if necessary), verifying the problem is fixed, proper and appropriate backfill and compaction or control density fill (when necessary). Includes all labor, all materials, all latent subsurface conditions and any time needed to coordinate or work in conjunction with National Grid or their designer when necessary.

B. *MEASUREMENT AND PAYMENT*

Payment under this item shall be at the contract unit bid price per each location.

ITEM 823.0000 STREET LIGHT AS-BUILT PLANS

A. *GENERAL*

As-built Street Lighting Layout Plans

It will be the responsibility of the Contractor to provide the Contract Officer with as-built street lighting layout plans indicating all changes made during the construction. The plans shall indicate the location of all street light equipment installed including, light posts, controller cabinets, conduit, pull boxes, and service connections. The plans shall also indicate the final configuration of the load center panel board, with circuits appropriately labeled, and meter number.

Electronic files of as-built drawings of the street light system shall be provided in the latest version of AutoCAD. These files shall be submitted prior to final acceptance of the project.

As-built photos shall include internal components of the load center cabinet.

In addition to the above the Contractor shall provide an Operation and Maintenance Manual.

Upon completion of the work of this Contract, deliver to the Contract Officer two (2) copies of an Operation and Maintenance (O & M) Manual. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 2-inch, 3-ring vinyl covered binders, with pocket folders for folded sheet information. Include a separate section for each system or sub-system. Sections shall be separated by heavy plastic dividers with tabs that identify the material in each section. Place a permanent label or title block on each binder for identification.

The information to be provided is considered incidental to the lighting installation.

1. Include the following information on the label:
    a. O & M Manual for __ (Project name)
    b. Date
    c. Name and address of Engineer
    d. Name and address of Contractor
    e. Name and address of Sub-Contractor
2. Provide the following in each manual:
    a. Table of Contents
    b. Listing of all service agents with addresses and telephone numbers
    c. Description of systems operation
    d. Emergency instructions for equipment and/or systems where appropriate
    e. Wiring diagrams and piping diagrams specific to systems installed.
    f. Manufacturers' operating and maintenance instructions for each piece of equipment installed
    g. Inspection procedures
    h. Spare parts list
    i. Copies of all panelboard circuit indexes.
    j. Copies of all warranties and guarantees.
    k. Copies of submittals and shop drawings.
3. Provide the following information, in Microsoft Excel format, for each installed street light pole, as they are installed

Street Name	
Pole Number	
Pole Type (Wood, Metal, Decorative)	
Source Type (Underground Overhead)	
SLC Number	
SLC MAC ID	
Replacement Fixture Type (Type, Wattage)	

B. *MEASUREMENT AND PAYMENT*

Payment under this item shall be at the contract unit bid price per lump sum.

Pencell Plastics - LB-080820

1-800-287-8448 Rocky Mount, NC

Industry Category
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CaTV
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Water

PenCell Plastics

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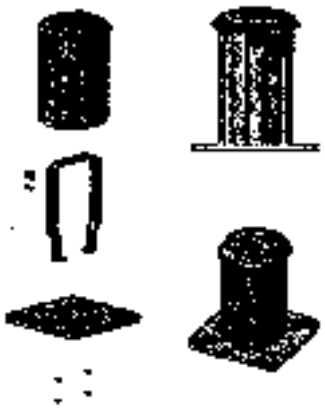

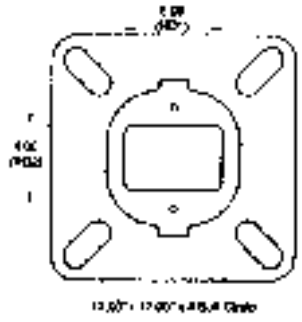

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EMAIL: info@pencell.com
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ITEM 825.0000 U-COVER SPECIFICATIONS

Universal
Hand Hole Cover

Reduce your costs & liability

Covering hand holes and restricting access to the dangerous high voltage wires within light poles is a problem for all utility companies and municipalities.

Emergency crews often encounter metal hand hole covers with oxidized screws, requiring the crews to break or pry the cover off the pole. The crew is then unable to secure a cover on the hand hole because of the broken screw tabs or stripped threads.

The U-Cover was invented by an emergency crew supervisor who was faced with this situation day after day.

The patented design of the U-Cover allows crews to use one inventory item to secure hand holes on flanged and unflanged poles 6" to 12" in diameter. The universal design eliminates the need to stock several size covers for various size poles or hand holes.

Storekeepers and crews can easily manage stock and ensure every effort is made to safe-guard the public from exposed wires. The durable high impact no-break co-polymer polypropylene U-Cover stands up to harsh weather conditions, extreme temperatures, and vandals.

Installation
The U-Cover is easily installed by one person. Place over the hand hole and keep in place with your knee, the stainless steel band surrounds the pole and cover. A Penta head security bolt is placed through the holes in the band (different holes accommodate the different diameter poles).

The Penta bolt threads into a brass nut molded into the bottom of the cup on the U-Cover.

The Benefits of U-Cover

- Easily secured by one person
- Adapts to 6" to 12" diameter light poles
- Adapts to different style and size hand holes
- A quick and efficient S.O.P.
- Secures from the outside with no exposed metal inside
- Durable, reusable and water resistant
- Vandal resistant
- Reduces Liability
- An excellent light duty assignment
- Save on inventory
- An economical solution to reduce inventory needs

There is no exposed metal within the pole that could create electrical hazards for crews or pedestrians.

As the Penta bolt is tightened, the strap secures the U-Cover tightly and flush to the pole.

ITEM 826.0000 WOODEN UTILITY POLE SPECIFICATIONS

All wood poles will be a CLASS 4, with a 35 foot minimum pole subject to conditions of installation.

SECTION 900 - LUMP SUM RESERVE

ITEM 900.0000 LUMP SUM RESERVE FOR CITY USE

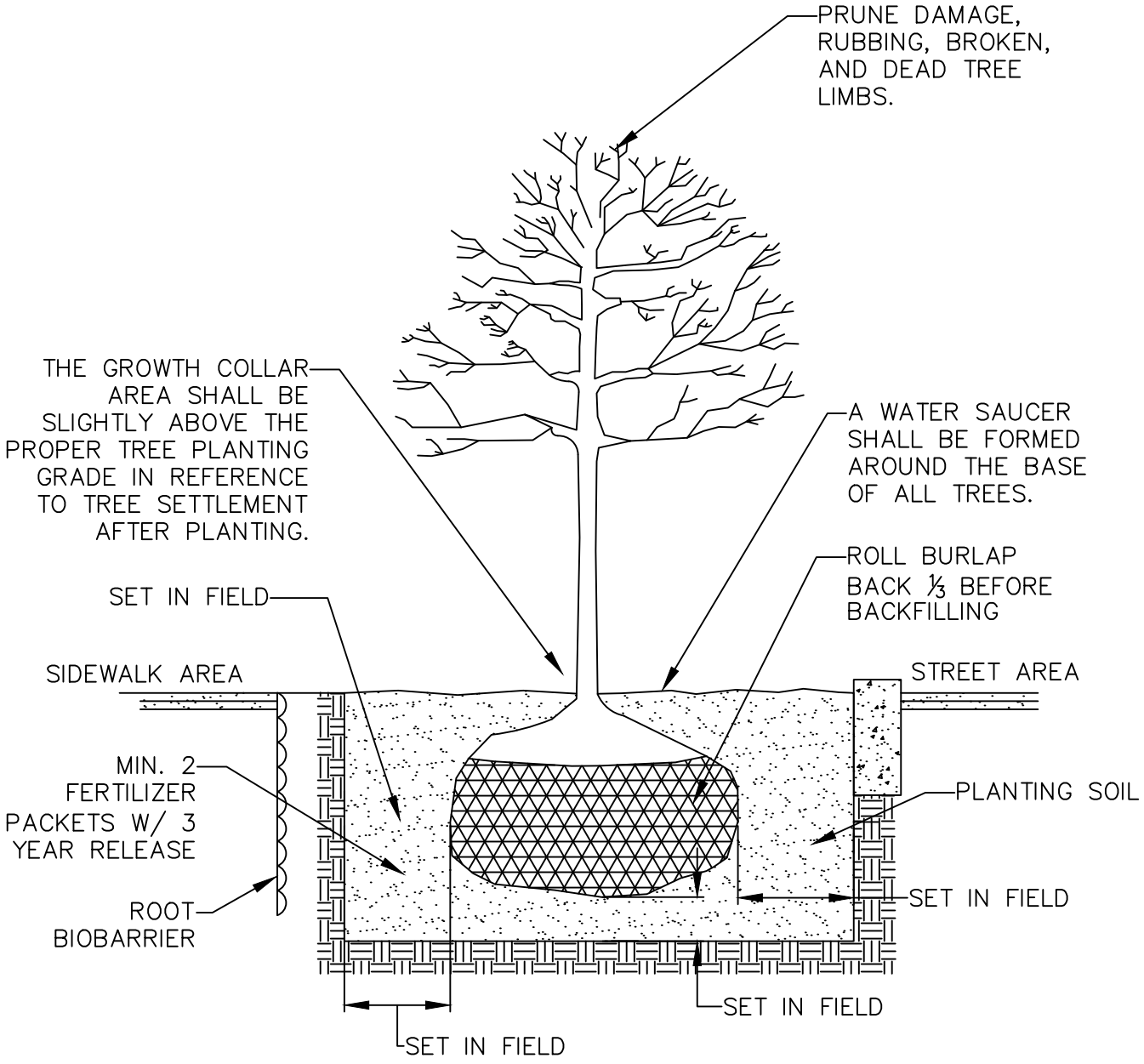
A GENERAL

Lump Sum Reserve for Contingency Work - The Contractor is advised that the lump sum reserve for contingency work shall be utilized, as required by the City of Worcester, for additional work that may be required by the City and agreed to by the Contractor. Any reserve balance remaining at the end of the contract will return to the City of Worcester.

Lump Sum Reserve for Testing - The Contractor is advised that, where indicated by the City of Worcester, independent laboratory tests may be required of materials incorporated into the project. The tests will be performed by an independent laboratory selected by the City and compensated for directly by the City under the Lump Sum Reserve for Testing items. The Contractor is to cooperate fully with the City to make available any material and samples necessary to perform the independent tests. Upon completion of the contract all amount not utilized will return to the City of Worcester.

Lump Sum Reserve for Traffic Police - The Contractor is advised that the City of Worcester will designate the number and need for Traffic Police throughout the duration of the contract. The City will compensate directly for Traffic Police, as ordered, under the Lump Sum Reserve for Traffic Police. Upon completion of the contract all amount not utilized will return to the City of Worcester

APENDIX A – DETAILS & DRAWINGS

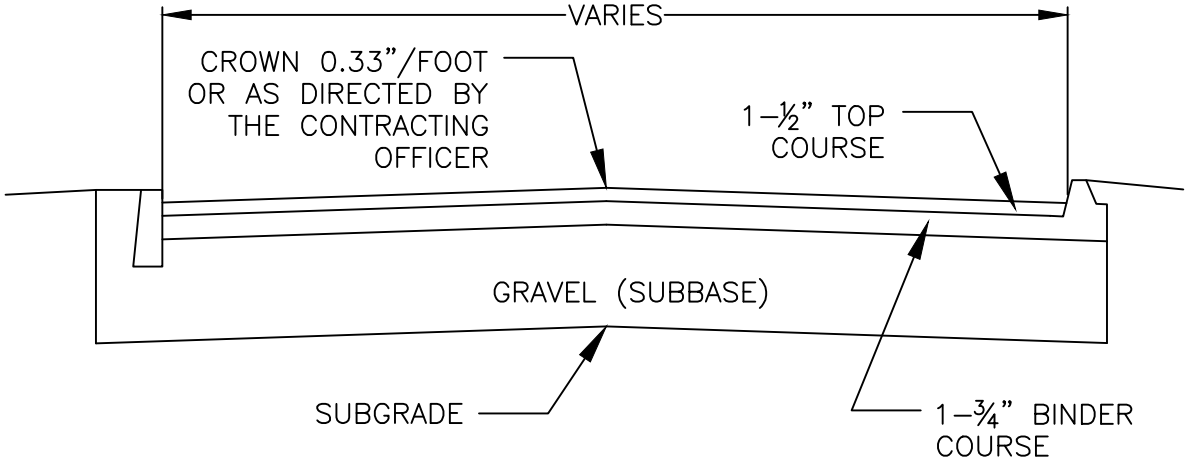


NOTES:

1. CONTRACTOR TO LOCATE ALL UNDERGROUND UTILITIES, SPRINKLER SYSTEMS, CITY WATER GATES, AND ETC. BEFORE DIGGING TREE PLANTING PITS.
2. NO TREE STAKES AND NO WRAP IS REQUIRED.
3. ROOT BALL SHALL BE SET ON COMPACTED SOIL AREA TO REDUCE SETTLEMENT OF THE TREE.

TREE PLANTING DETAIL

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604				
TREE PLANTING DETAIL						
NOT TO SCALE						
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



ITEM 116 EXCAVATION – (SECTION 120)

WHEN EXCAVATING TO A SPECIFIC PAY LINE (SUBGRADE) THE CONTRACTOR SHALL PROSECUTE THE WORK SO AS TO PREVENT THE PONDING OF WATER. EACH LIFT OF EXCAVATION SHALL BE VISIBLY CROWNED TO ALLOW DRAINAGE OF SURFACE AND RAIN WATER.

ITEM 402 FINE GRADING, ROLLING AND FINISHING – (SECTION 170 PARAGRAPH 170.61)

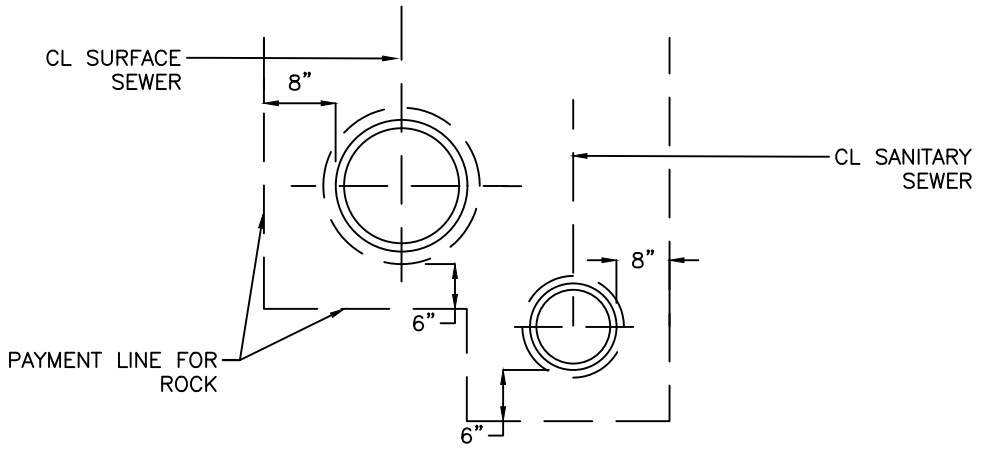
WHEN EXCAVATING TO A PAY LINE THAT REQUIRES 6 INCHES OR MORE NEW GRAVEL BASE THE CONTRACTOR SHALL ADHERE TO PARAGRAPH 170.61 IN MA STATE STANDARD SPECIFICATION OF 1988. IN SUCH CASES WHERE THE PAY LINE REQUIRES LESS THAN 6 INCHES OF NEW GRAVEL THE CONTRACTOR WILL FINE GRADE, ROLL AND FINISH AT THE SUBBASE LINE AND BE PAID ITEM 402 FINE GRADE, ROLL AND FINISH.

ITEM 126 GRAVEL BORROW – (SECTION 405)

THE CONTRACTOR WHEN PLACING GRAVEL SUBBASE SHALL SPREAD AND COMPACT IN ACCORDANCE TO PARAGRAPHS 405.20 & 405.60 IN MA STATE STANDARD SPECIFICATIONS OF 1988.

EXCAVATION & GRADING POLICY TYPICAL SECTION

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
EXCAVATION & GRADING POLICY TYPICAL SECTION		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			1	01/2016	UPDATED TO MATCH REVISED CITY SPECS	CPM
			NO.	DATE	DESCRIPTION	BY



TYPICAL TRENCH SECTION IN ROCK

LIMITS OF NORMAL EXCAVATION

THE LIMITS OF NORMAL WIDTH AND DEPTH OF EXCAVATION SHALL BE AS DESCRIBED BELOW UNLESS OTHER LIMITS ARE INDICATED ON THE DRAWINGS AS SPECIFIED.

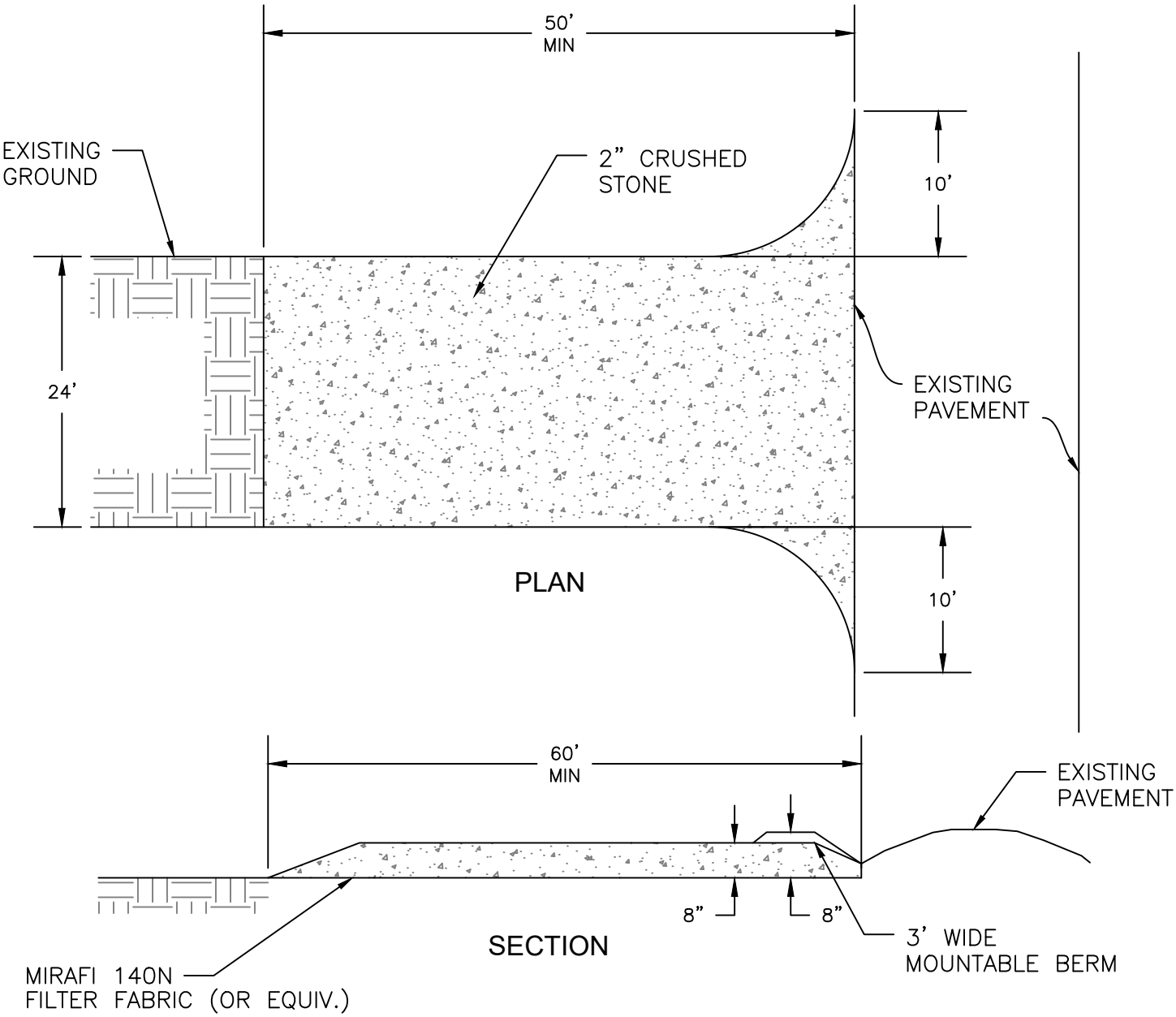
FOR PIPES IN TRENCH, THE NORMAL WIDTH OF THE TRENCH SHALL BE MEASURED BETWEEN VERTICAL PLANES WHICH ARE A DISTANCE APART EQUAL TO THE SUM OF 18" PLUS $1\frac{1}{3}$ TIMES THE NOMINAL INSIDE DIAMETER OF THE PIPE. IF THE WIDTH SO COMPUTED IS LESS THAN 3 FEET, A WIDTH OF 3 FEET SHALL BE TAKEN AS THE NORMAL WIDTH OF PAYMENT. THE NORMAL DEPTH SHALL BE MEASURED TO A DISTANCE OF 0.5 FEET BELOW THE BOTTOM OF THE OUTSIDE OF THE PIPE IN EARTH AND ROCK UNLESS THERE BE A CRADLE UNDERNEATH THE PIPE, IN WHICH CASE THE NORMAL DEPTH SHALL BE MEASURED TO THE UNDERSIDE OF THE CRADLE. THE WIDTH OF THE TRENCH FOR THE CRADLE SHALL BE ASSUMED TO BE THAT ABOVE SPECIFIED FOR PIPES IN TRENCH.

FOR PIPES IN TRENCH, THE NORMAL WIDTH OF THE TRENCH SHALL BE MEASURED BETWEEN VERTICAL PLANES WHICH ARE A DISTANCE APART EQUAL TO THE SUM OF 18" PLUS $1\frac{1}{3}$ TIMES THE NOMINAL INSIDE DIAMETER OF THE PIPE. IF THE WIDTH SO COMPUTED IS LESS THAN 3 FEET, A WIDTH OF 3 FEET SHALL BE TAKEN AS THE NORMAL WIDTH OF PAYMENT. THE NORMAL DEPTH SHALL BE MEASURED TO A DISTANCE OF 0.5 FEET BELOW THE BOTTOM OF THE OUTSIDE OF THE PIPE IN EARTH AND ROCK UNLESS THERE BE A CRADLE UNDERNEATH THE PIPE, IN WHICH CASE THE NORMAL DEPTH SHALL BE MEASURED TO THE UNDERSIDE OF THE CRADLE. THE WIDTH OF THE TRENCH FOR THE CRADLE SHALL BE ASSUMED TO BE THAT ABOVE SPECIFIED FOR PIPES IN TRENCH.

NO ALLOWANCE WILL BE MADE FOR ADDITIONAL WIDTH OR DEPTH OF TRENCH FOR BELL HOLES OR AT THE MANHOLES.

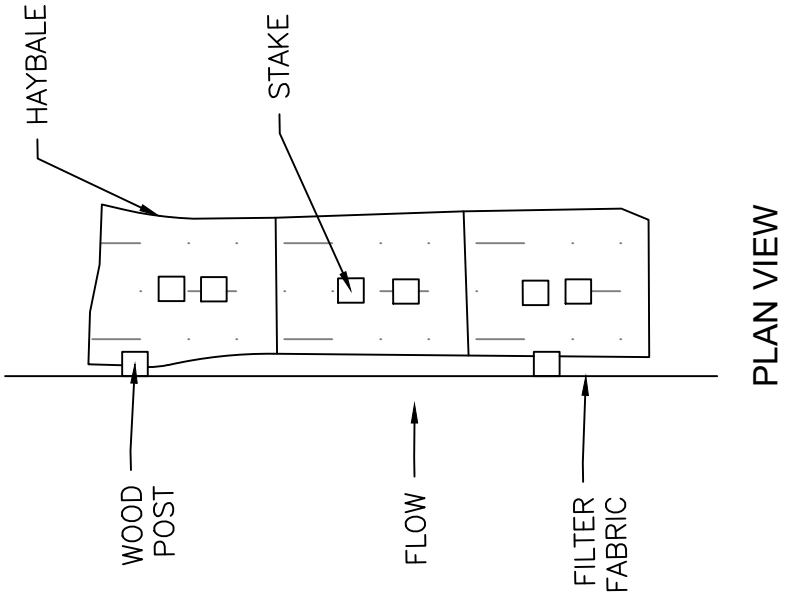
FOR OTHER STRUCTURES, THE NORMAL WIDTH SHALL BE MEASURED BETWEEN VERTICAL PLANES 1 FOOT OUTSIDE THE NEAT LINES OF THE SEVERAL PARTS OF THE STRUCTURE, EXCEPT THAT THE WIDTH AT ANY ELEVATION SHALL BE MEASURED NOT LESS THAN THE WIDTH AT A LOWER ELEVATION. THE NORMAL DEPTH SHALL BE MEASURED TO THE UNDERSIDE OF OF THAT PART OF THE STURCURE FOR WHICH THE EXCAVATION IS MADE.

FEBRUARY 26, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	TRENCH SECTION IN ROCK	MW
121 - TRENCH SECTION IN ROCK		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

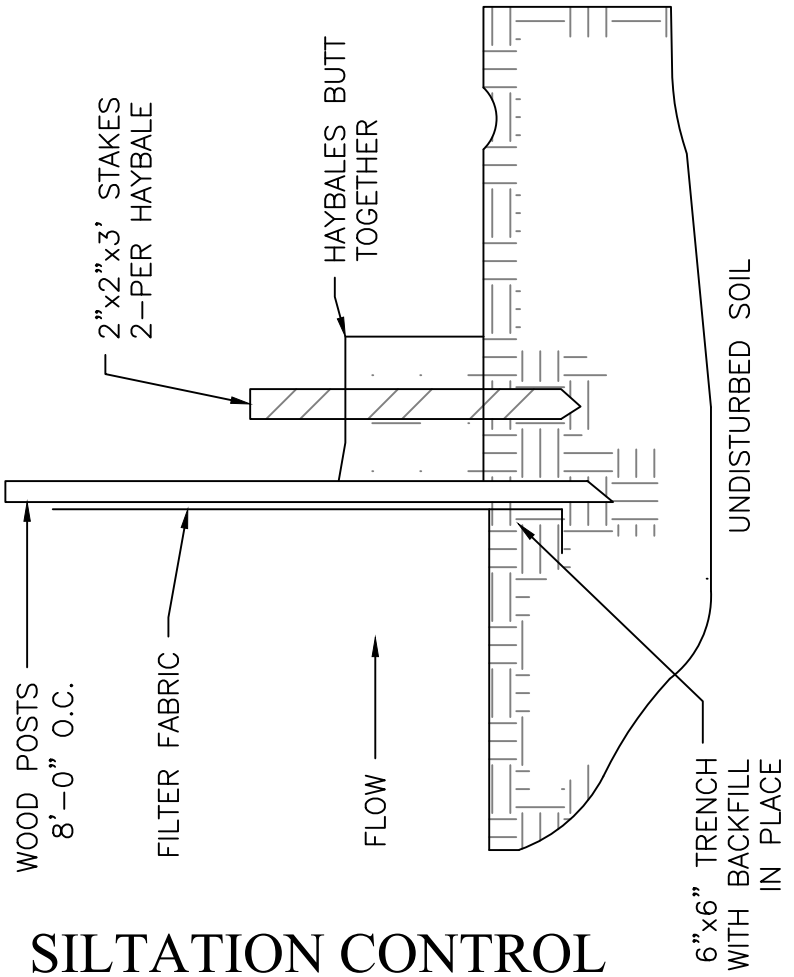


STABILIZED CONSTRUCTION ENTRANCE

FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/4/2025	STABILIZED CONSTRUCTION ENTRANCE	MW
ITEM 170 - STABILIZED CONSTRUCTION ENTRANCE					
NOT TO SCALE					
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



PLAN VIEW



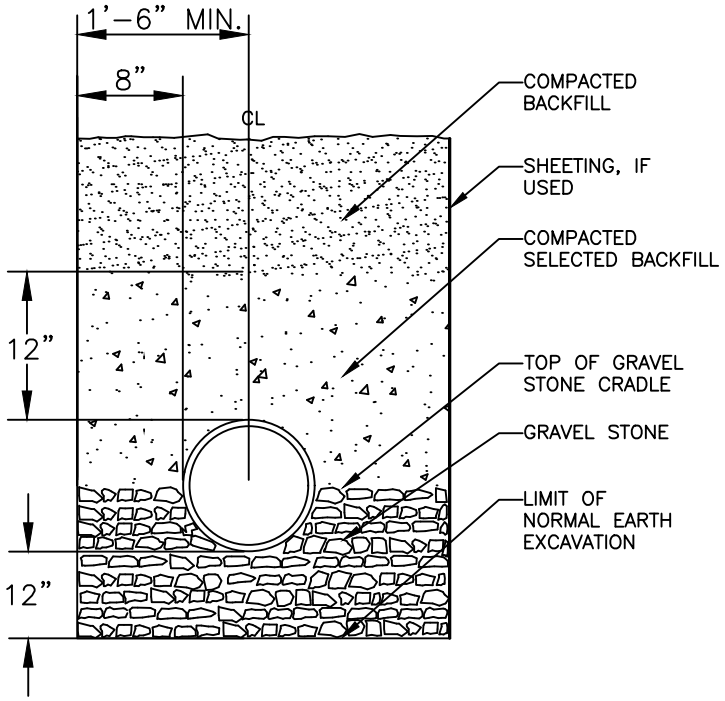
CROSS SECTION

SILTATION CONTROL

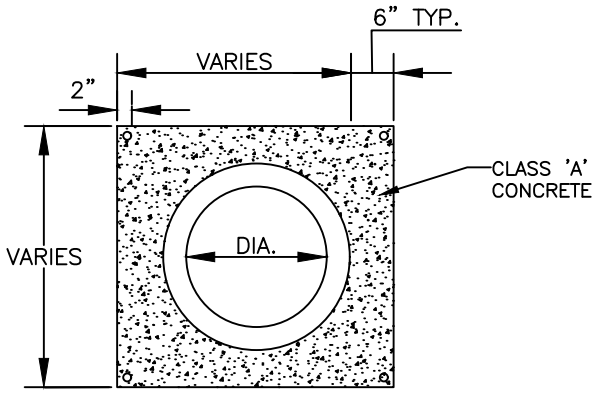
FEBRUARY 26, 2025			
ITEM 171 - SILTATION CONTROL			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

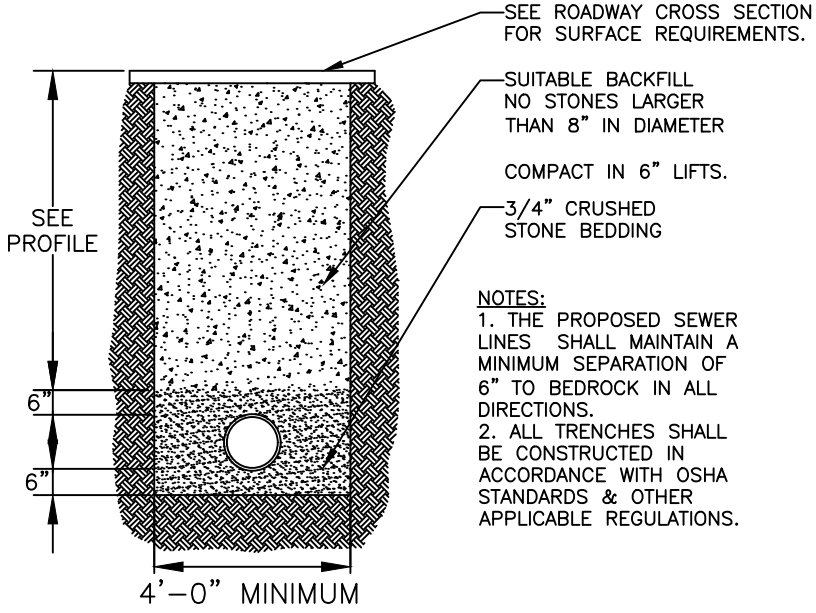
NO.	DATE	DESCRIPTION	BY
1	3/4/2025	SILTATION CONTROL	MW



TYPICAL DRAIN MAIN TRENCH



CONCRETE ENCASEMENT DETAIL

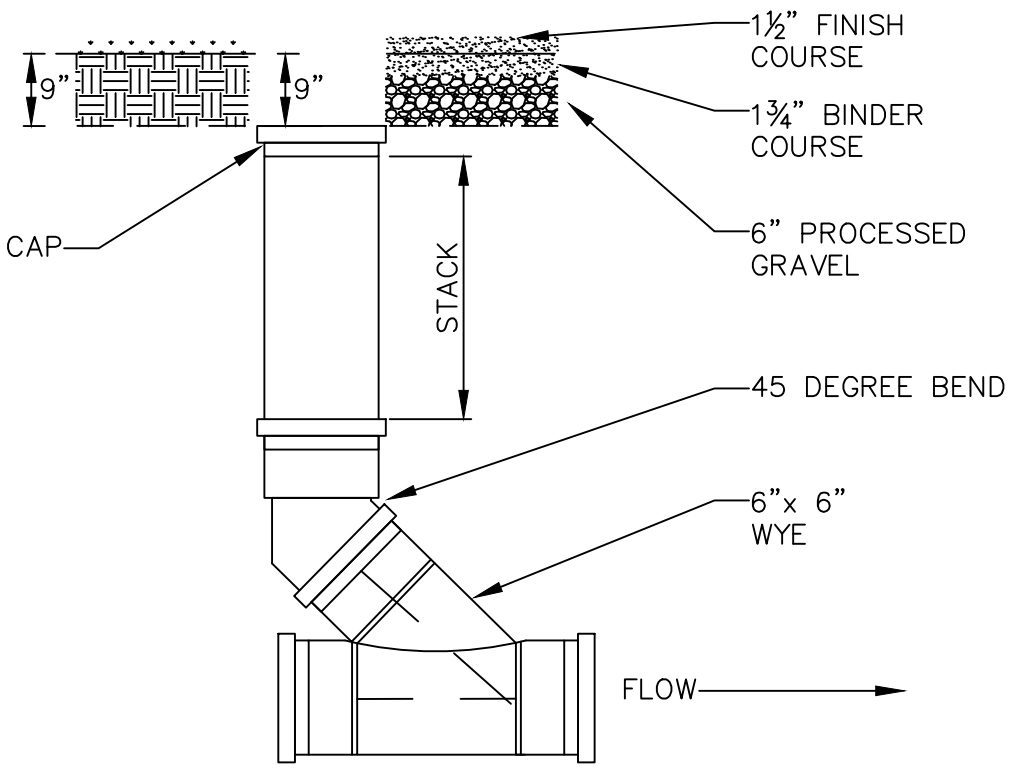


TYPICAL SEWER MAIN TRENCH

TYPICAL TRENCH DETAILS

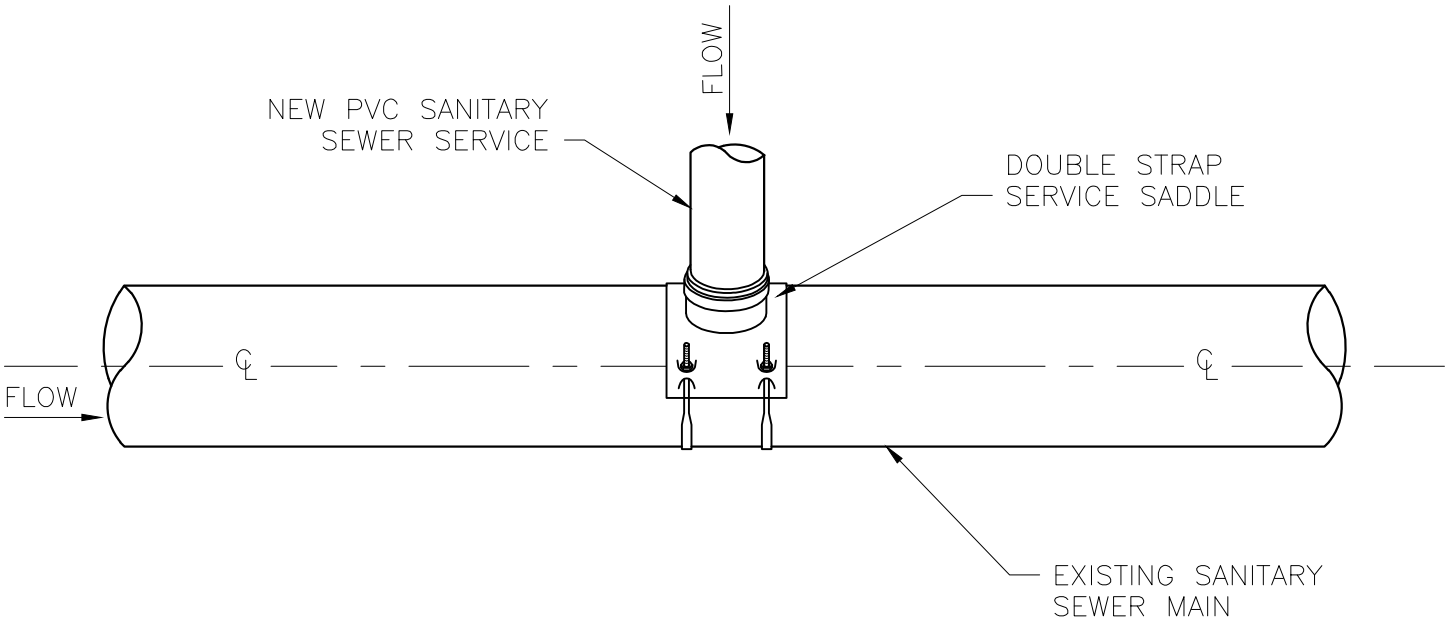
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/4/2025	TYPICAL TRENCH	MW
ITEM 222 - TYPICAL TRENCH					
NOT TO SCALE					
SHEET 1 OF 1					
		NO.	DATE	DESCRIPTION	BY

ON PROPERTY IN BIT. CONC.

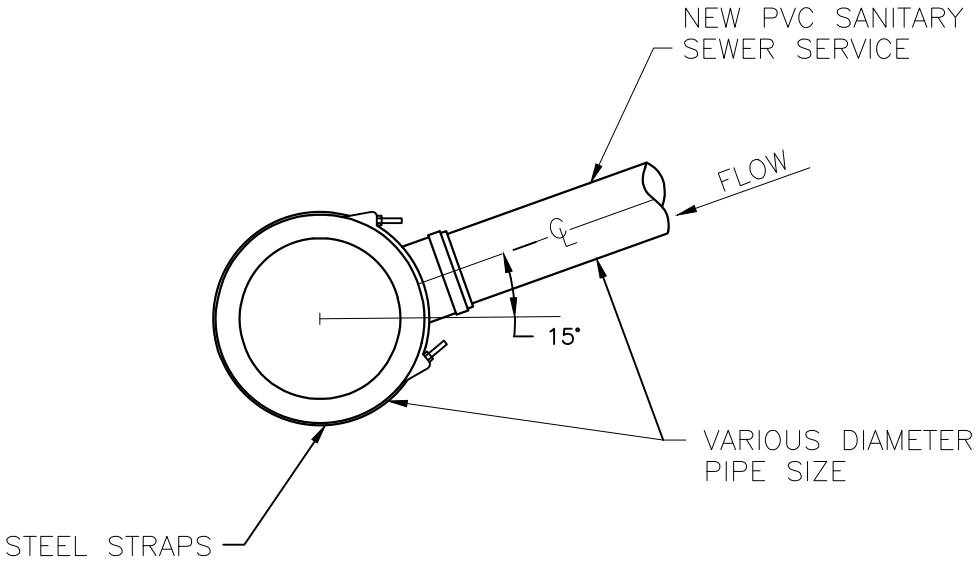


TYPICAL CLEANOUT

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
TYPICAL CLEANOUT		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			1	01/2016	UPDATED TO MATCH REVISED CITY SPECS	CPM
			NO.	DATE	DESCRIPTION	BY



PROFILE
N.T.S.



SECTION
N.T.S.

NOTE:

EXISTING SANITARY SEWER MAIN SHALL BE CORED AND SERVICE SADDLE SHALL BE INSTALLED AT PROPER ANGLE TO ALLOW 1% OR GREATER SLOPE TO THE NEW SANITARY SEWER SERVICE PIPE.

TYPICAL DETAIL OF SADDLES FOR 6" LATERAL SEWER CONNECTIONS

FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/4/2025	WYE & TEE LATERAL SEWER CONNECTION	MW
WYE & TEE SADDLES FOR 6" LATERAL SEWER CONNECTIONS					
NOT TO SCALE					
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

TABLE 1

SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSUER DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

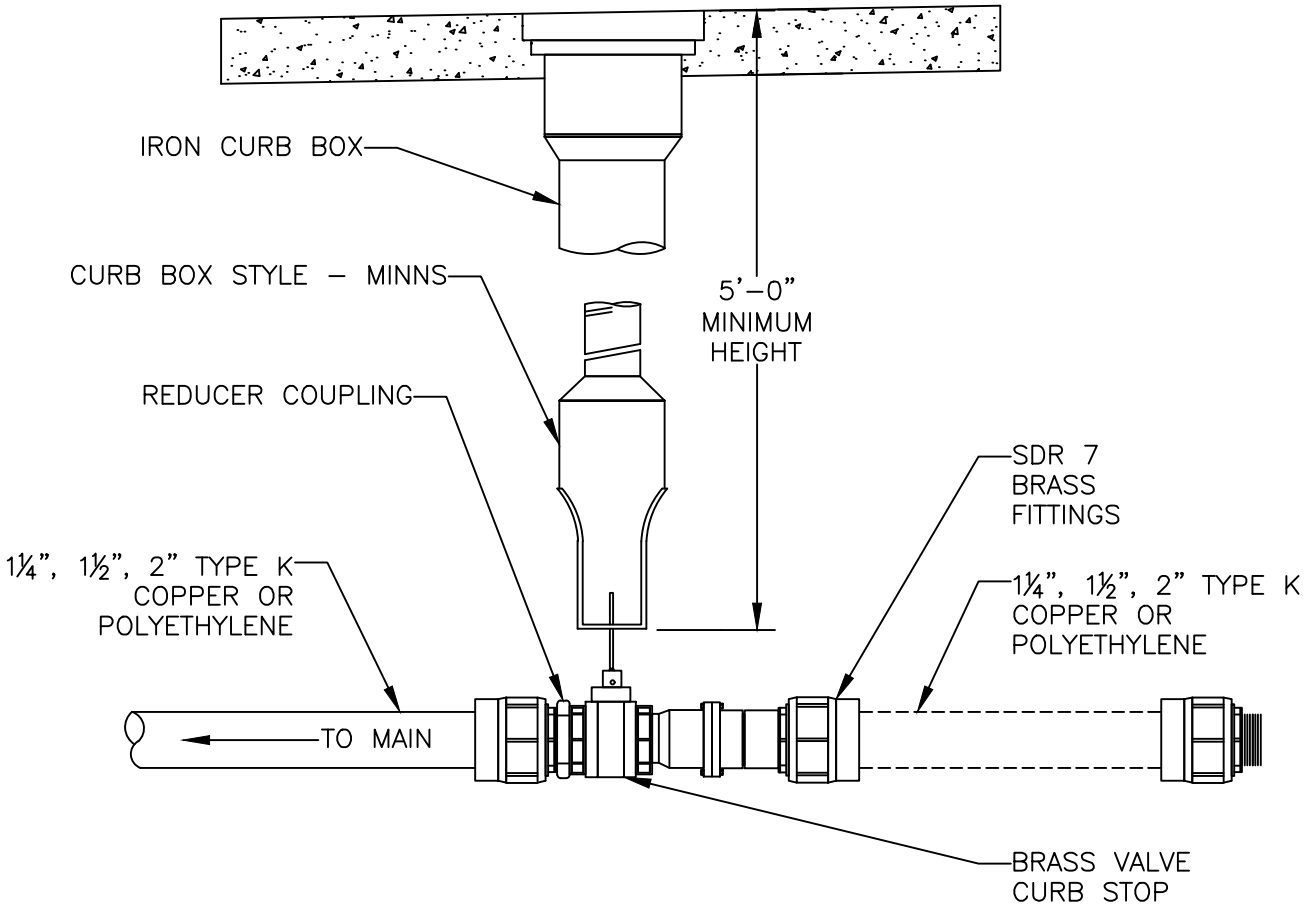
PIPE DIAMETER (INCHES)	MINIMUM TIME (MIN:SEC)	LENGTH FOR MINIMUM TIME (FT)	LENGHT FOR LONGER LENGTH (SEC)	100 FEET	150 FEET	200 FEET	250 FEET	300 FEET	350 FEET	400 FEET	450 FEET
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.52L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15.49	17.48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22.47	25.38
15	14:10	159	5.342L	14:10	14:10	17:48	22:15	26:42	31:09	31:09	35:36
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.673L	22:47	34:11	45:34	56:58	68:22	79.46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172.21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179.29	205:07	230:46

TABLE 2

SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSUER DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015

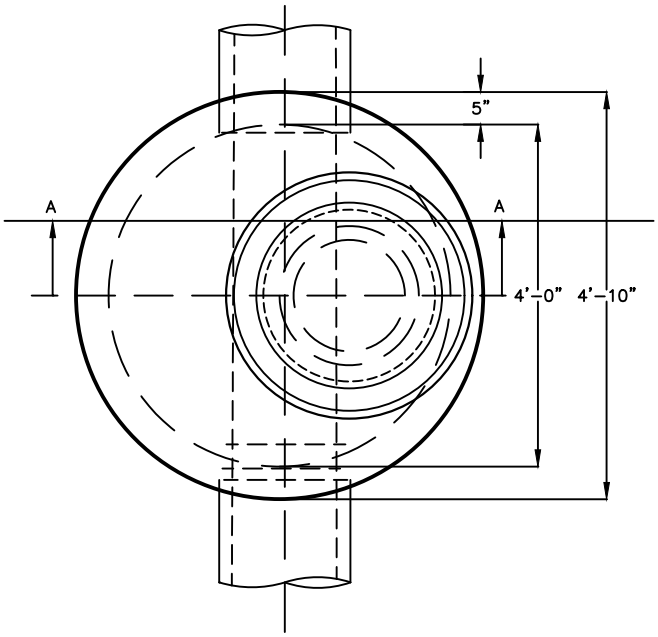
PIPE DIAMETER (INCHES)	MINIMUM TIME (MIN:SEC)	LENGTH FOR MINIMUM TIME (FT)	LENGHT FOR LONGER LENGTH (SEC)	100 FEET	150 FEET	200 FEET	250 FEET	300 FEET	350 FEET	400 FEET	450 FEET
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	26:26	25:38	28:51
21	9:55	114	5.235L	9:55	13.00	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17.57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	46:54
30	14:10	80	10.683L	17:48	38:28	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926L	21:33	64:38	43:56	53:25	64:28	75:24	86:10	96:57
36	17:00	66	15.384L	25:39	76:55	51:17	64:06	76:55	89.44	102:34	115:23

NOTE:
DETAIL SHOWN FOR REFERENCE PURPOSES ONLY.
DETAIL SHOWN IS OF TYPICAL SERVICE BOX WHEN LOCATED IN ROADWAY.

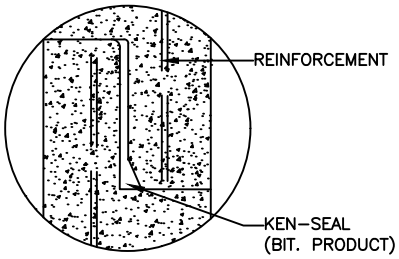


TYPICAL SEWER SERVICE BOX IN ROADWAY

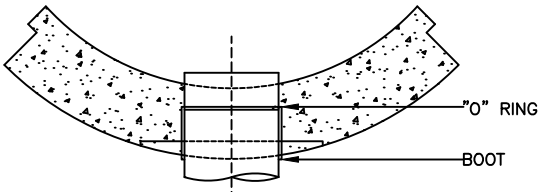
OCTOBER 14, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	SERVICE CURB STOP & BOX	MCR
SEWER SERVICE CURB STOP & BOX		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



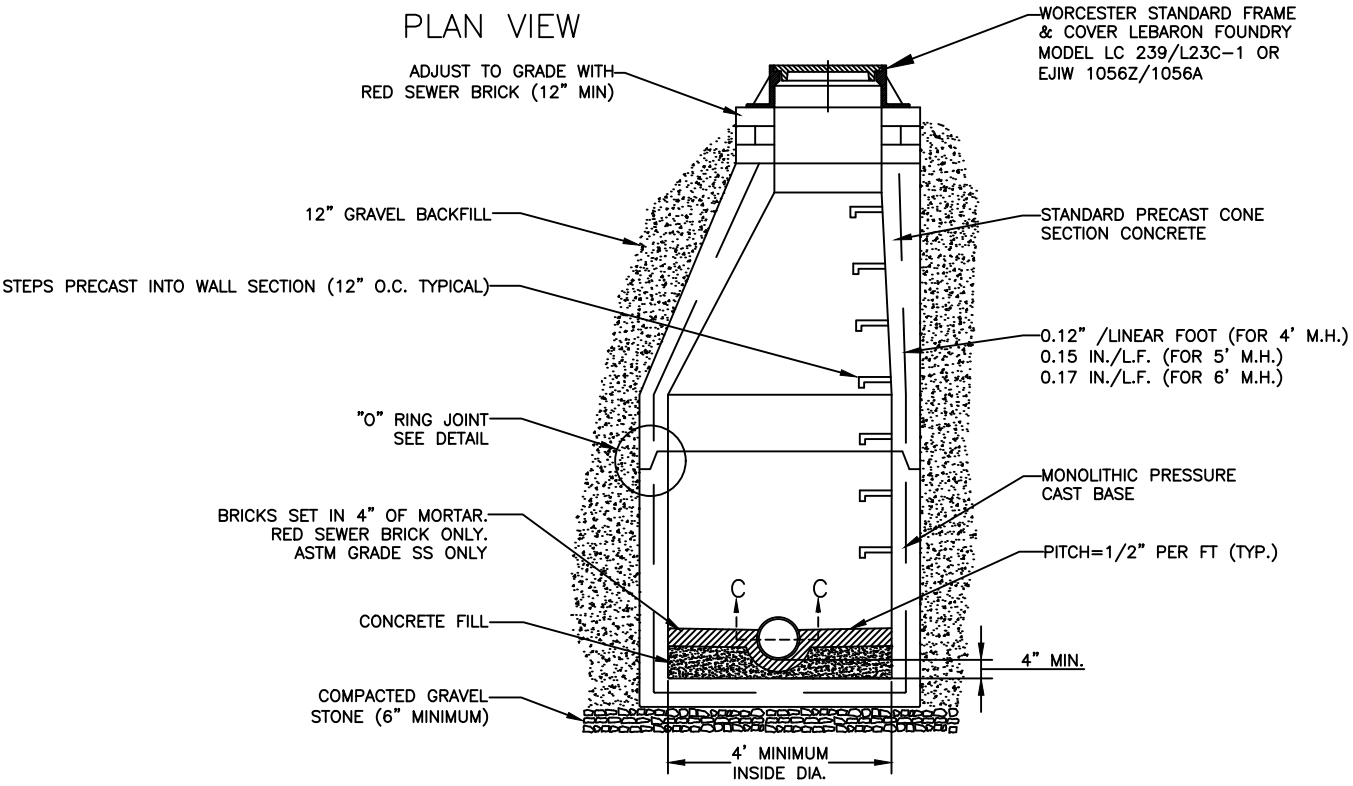
PLAN VIEW



"O" RING JOINT DETAIL



SECTION C-C

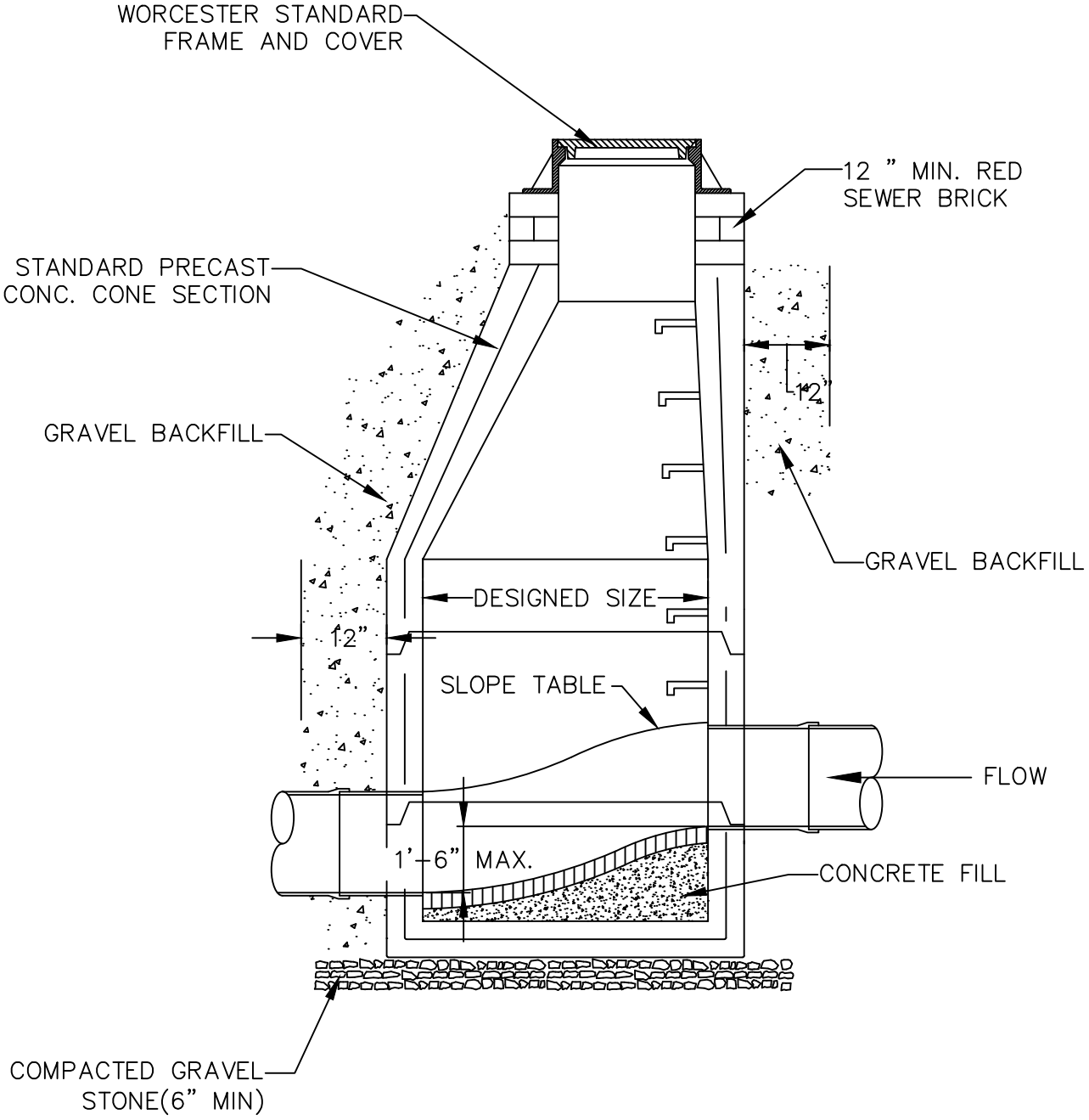


SECTION A-A

MARCH 21, 2025			
TYPICAL MANHOLE			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	03/25	TYPICAL MANHOLE	MCR

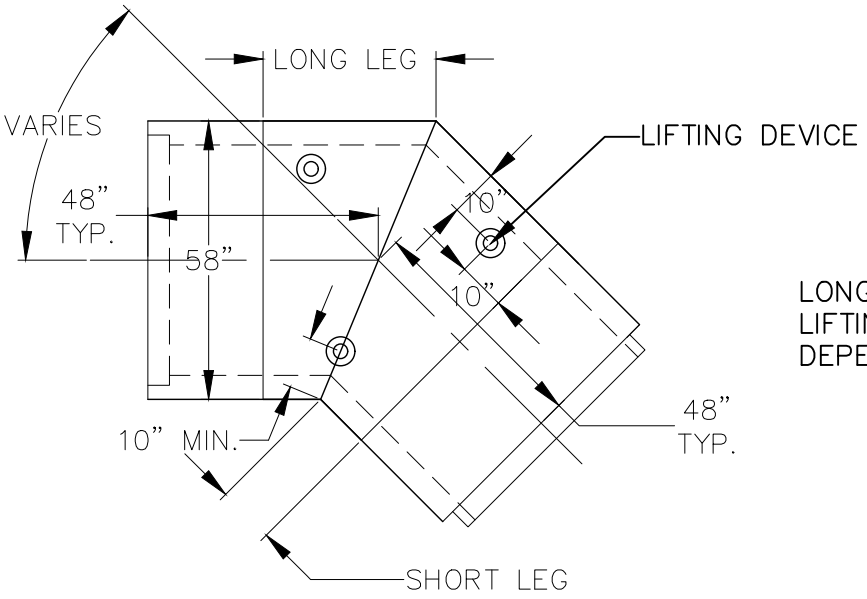


TYPICAL STEP MANHOLE

SEPTEMBER 25, 2009			
TYPICAL STEP MANHOLE			
NOT TO SCALE			
SHEET 1 OF 1			

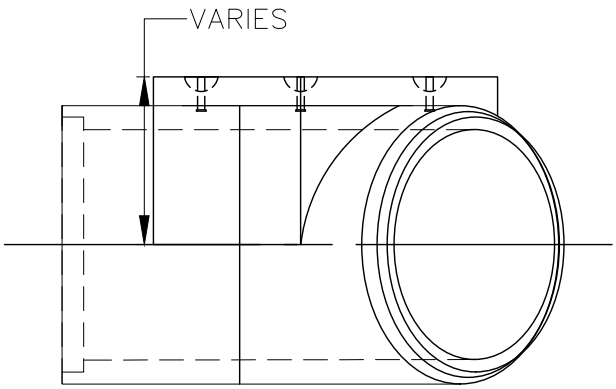
DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY

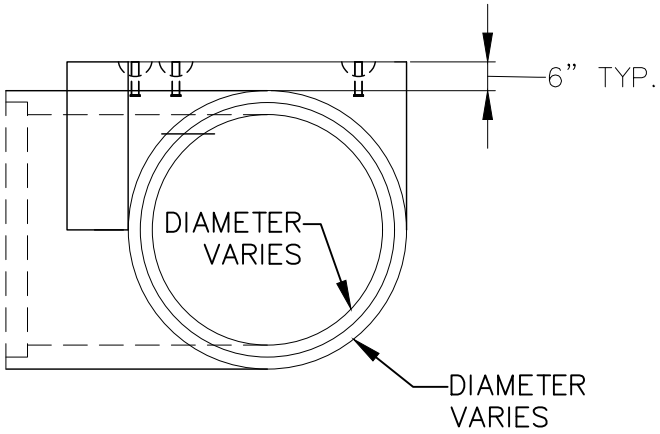


PLAN

LONG LEG + SHORT LEG = 48" TYP.
LIFTING DEVICES IN PATTER OF 3 OR DEPENDING ON ANGLE.



PROFILE

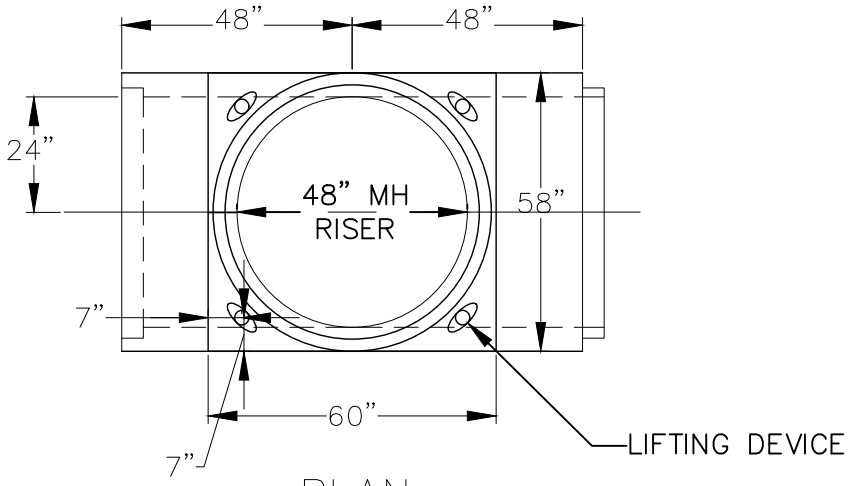


SPIGOT

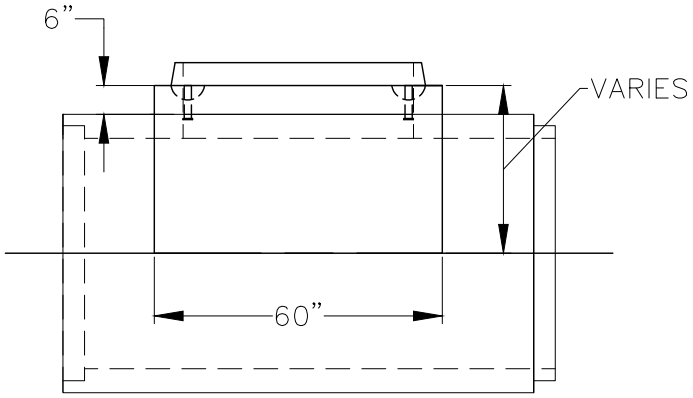
NOTES:
1.) PIPE & CLASS SHALL BE IN ACCORDACE WITH ASTM C76.
2.) STEEL SHALL BE GRADE 60 STEEL PER ASTM A615.
3.) DESIGNED TO RESIST HS20-44 LIVE LOADS.
4.) THIS LAYOUT PROVIDED AS A GUIDE FOR DISTRIBUTION AND INSTALLATION. FIELD ADJUSTMENTS MUST BE MADE AS NECESSARY.
5.) DRAWINGS TO SCALE BASED ON 45DEGREE MITER BEND & 8' PIPE USING 4' LEGS.

PRECAST MITER BEND TEE WITH FLAT TOP

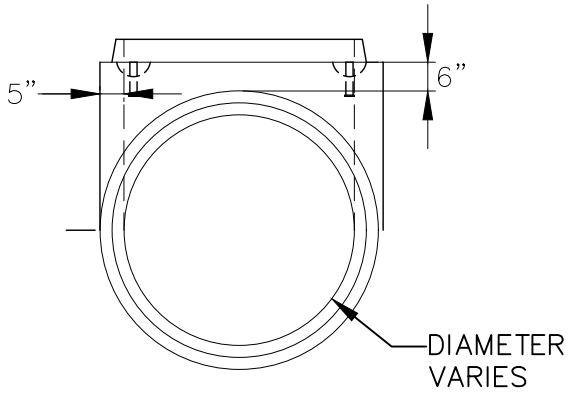
SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
PRECAST MITER BEND WITH FLAT TOP		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



PLAN



PROFILE



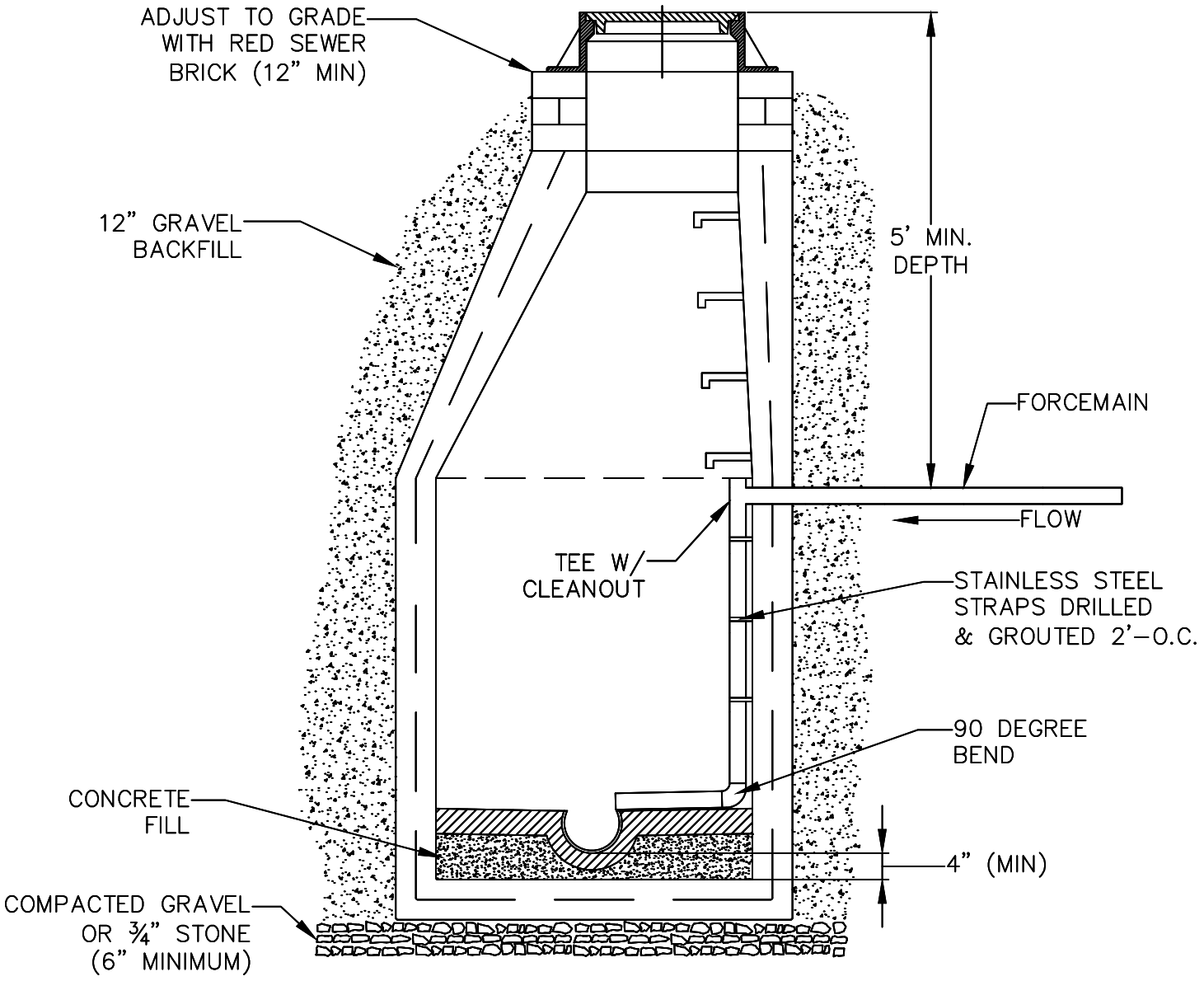
SPIGOT

NOTES:

1.) PIPE & CLASS SHALL BE IN ACCORDACE WITH ASTM C76.
2.) STEEL SHALL BE GRADE 60 STEEL PER ASTM A615.
3.) DESIGNED TO RESIST HS20-44 LIVE LOADS.
4.) THIS LAYOUT PROVIDED AS A GUIDE FOR DISTRIBUTION AND INSTALLATION. FIELD ADJUSTMENTS MUST BE MADE AS NECESSARY.
5. DRAWINGS TO SCALE BASED ON 45 DEGREE MITER BEND & 8' PIPE USING 4' LEGS.

PRECAST MANHOLE TEES WITH FLAT TOP

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
PRECAST MANHOLE TEES WITH FLAT TOP		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

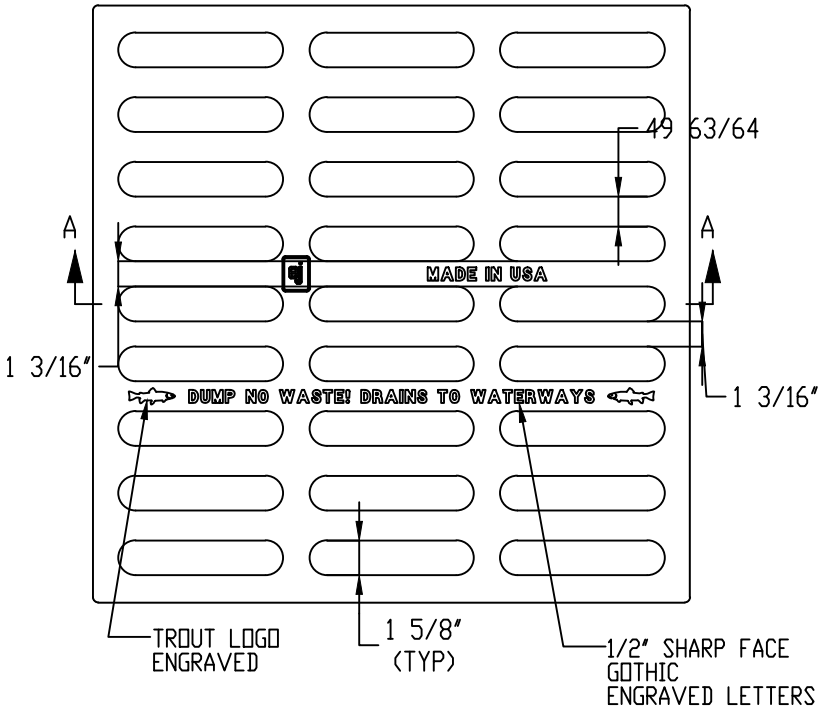


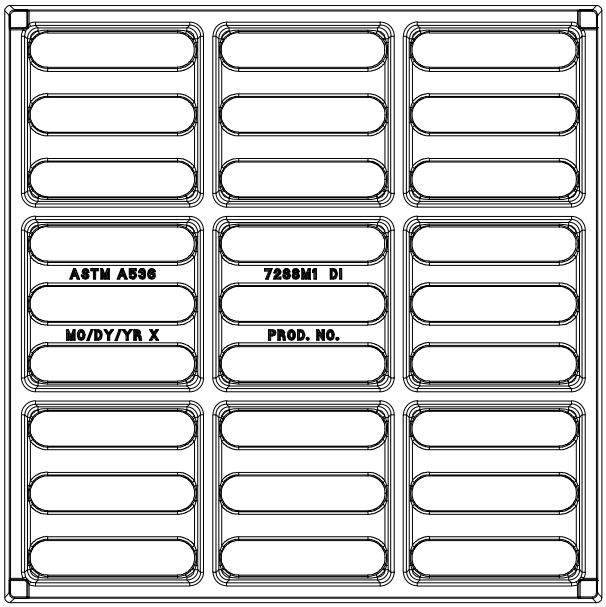
REMODELED MANHOLE SHOWING FORCEMAIN

SEPTEMBER 25, 2009			
REMODELED MANHOLE SHOWING FORCEMAIN			
NOT TO SCALE			
SHEET 1 OF 1			

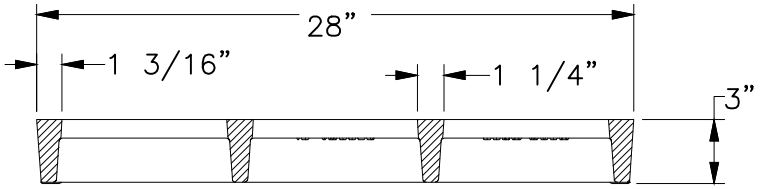
DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	01/2016	UPDATED TO MATCH REVISED CITY SPECS	CPM





BOTTOM VIEW

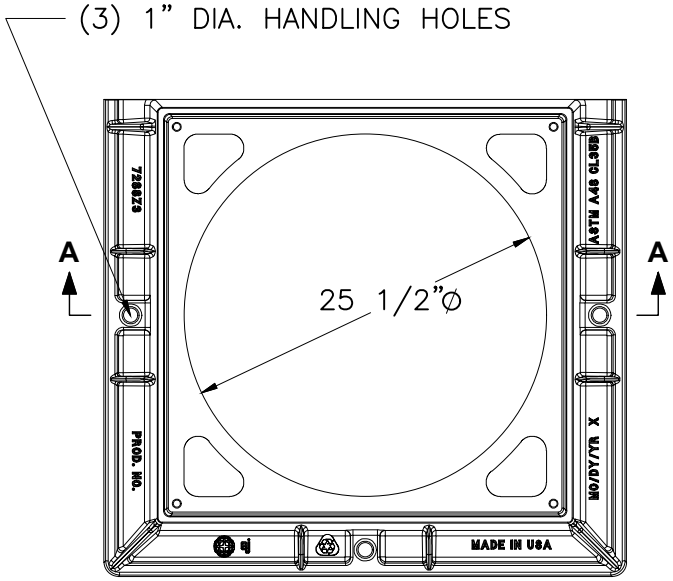


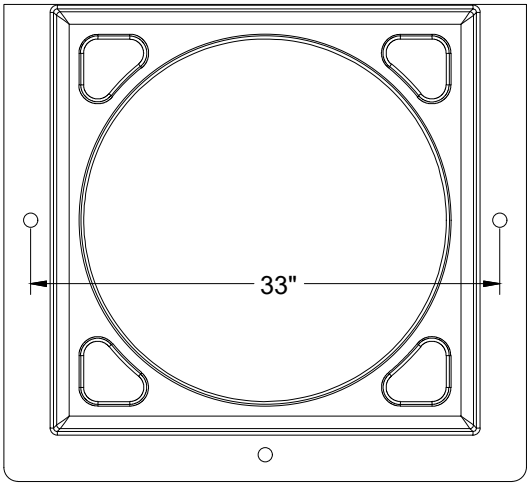
SECTION A-A

CATCH BASIN GRATE

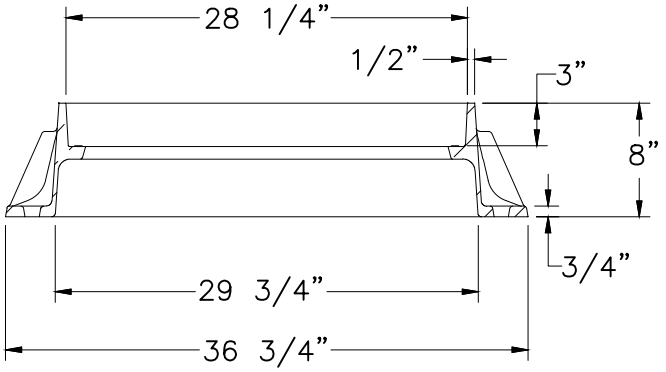
EJ 7288M1, OR EQUAL

DECEMBER 5, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	12/5/2025	UPDATED TO EJ 7288M1	MW
ITEM 235 - CATCH BASIN FRAME		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY





BOTTOM VIEW

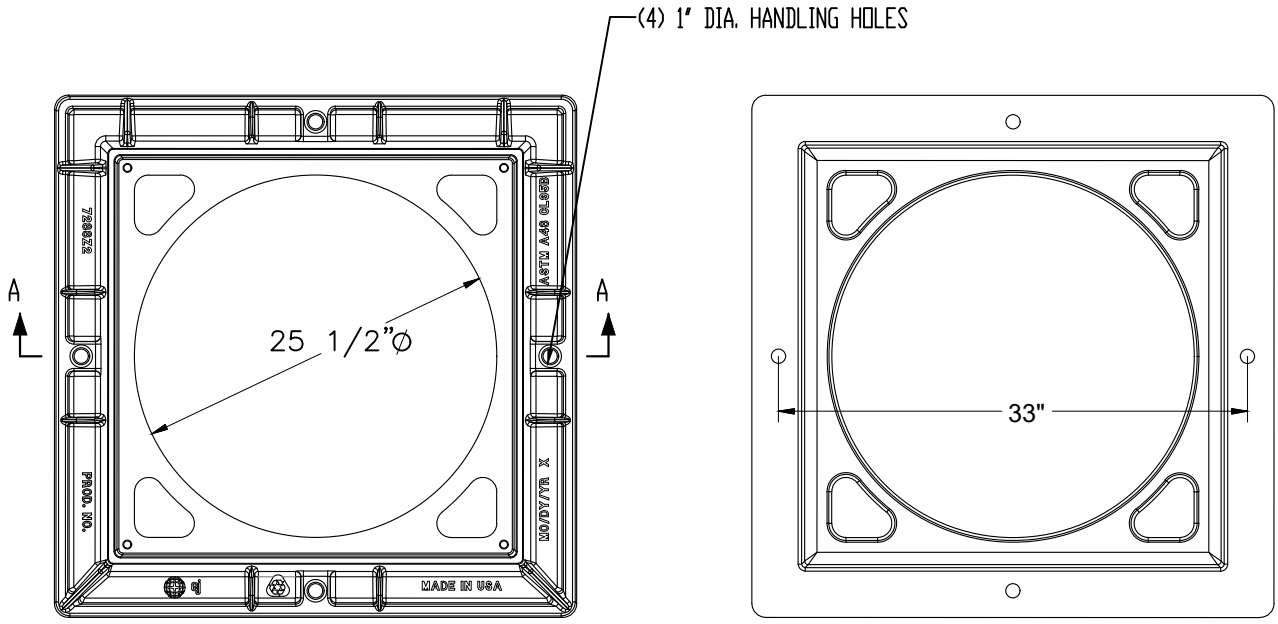


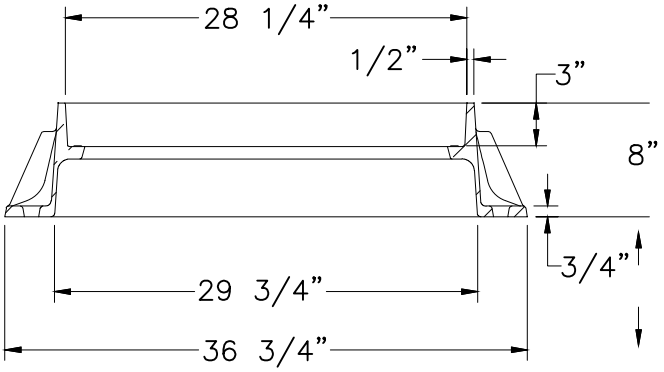
SECTION A-A

CATCH BASIN FRAME

EJ 7288Z3 (3 FLANGE),
EJ 7288Z2 (4 FLANGE), OR
EQUAL

FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/4/2025	CATCH BASIN FRAME	MW
ITEM 235 - CATCH BASIN FRAME					
NOT TO SCALE					
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY





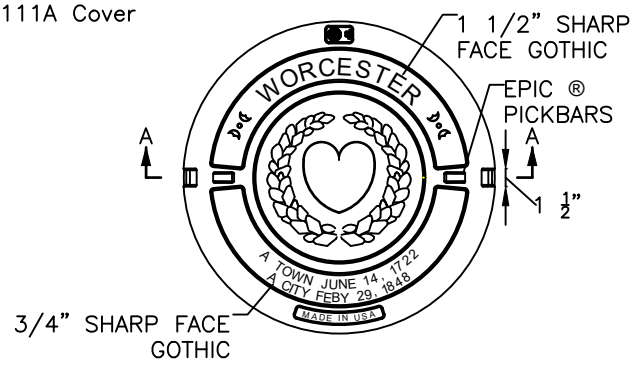
SECTION A-A

CATCH BASIN FRAME

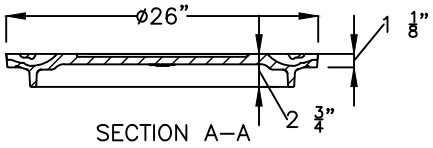
EJ 7288Z3 (3 FLANGE),
EJ 7288Z2 (4 FLANGE), OR
EQUAL

FEBRUARY 26, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	CATCH BASIN FRAME	MW
ITEM 235 - CATCH BASIN FRAME		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

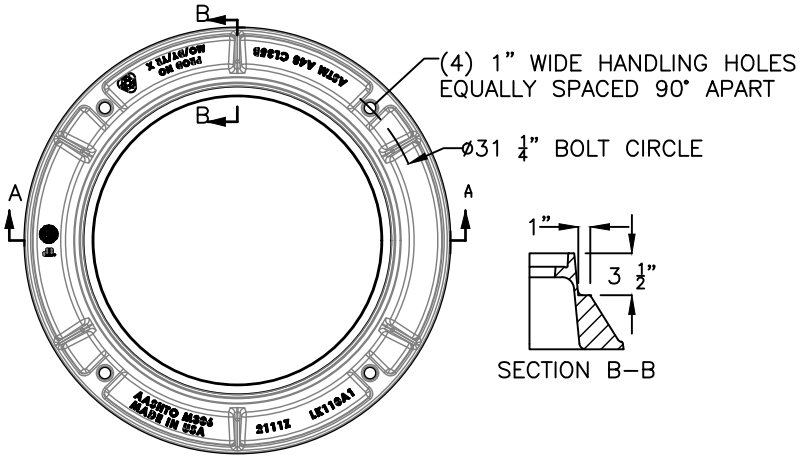
2111A Cover



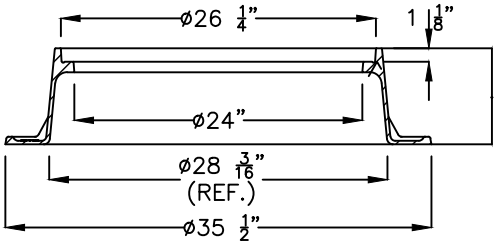
BOTTOM VIEW



SECTION A–A



SECTION B–B



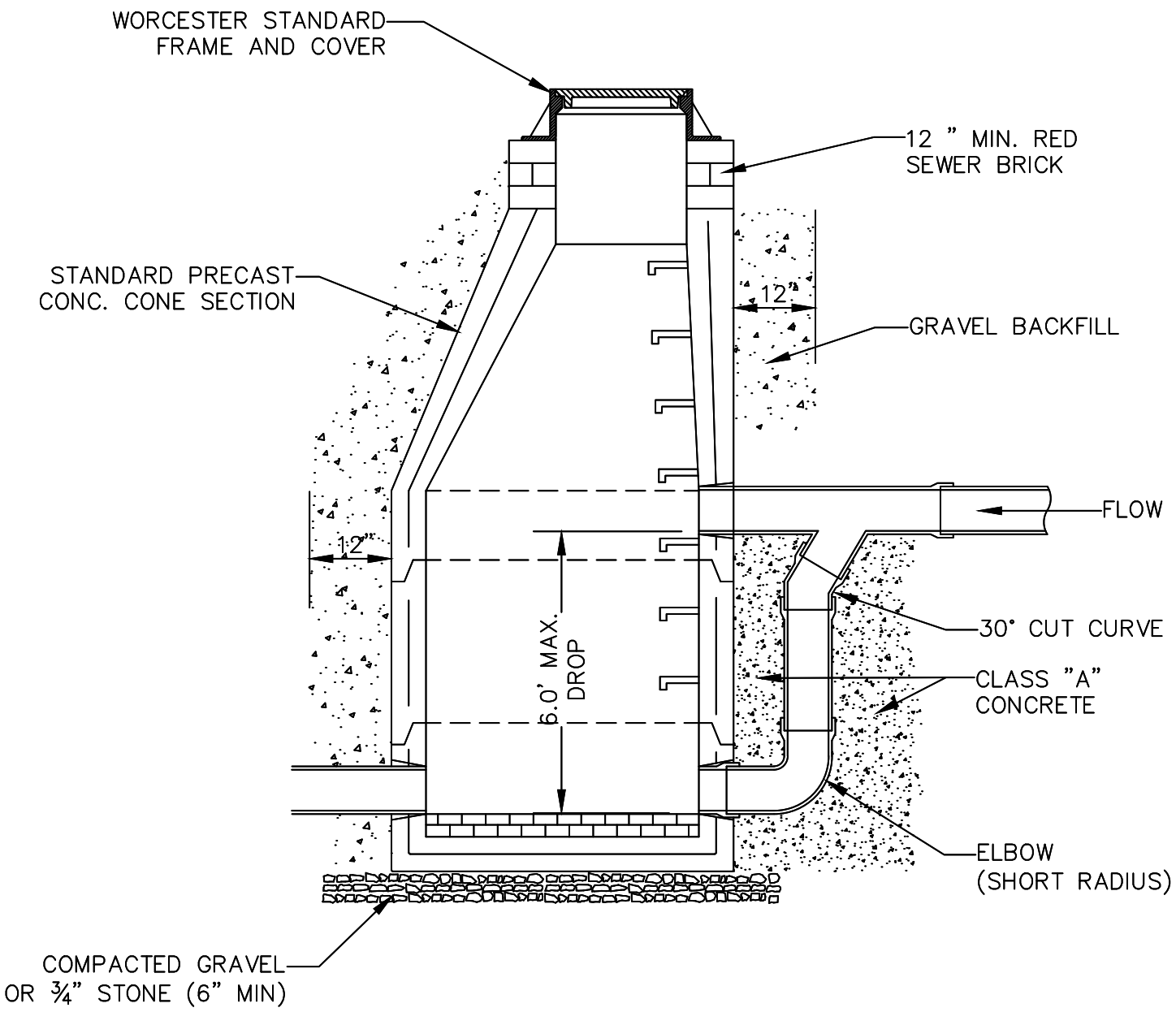
SECTION A–A

2111Z Frame

MANHOLE FRAME & COVER

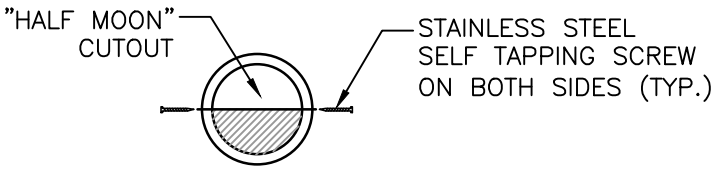
MANHOLE COVER EJ 2111A,
MANHOLE FRAME EJ 2111Z, OR
EQUAL

FEBRUARY 26, 2025		1	3/4/2025	MANHOLE FRAME & COVER	MW
ITEM 236 - MANHOLE FRAME & COVER	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604				
NOT TO SCALE					
SHEET 1 OF 1					
		NO.	DATE	DESCRIPTION	BY

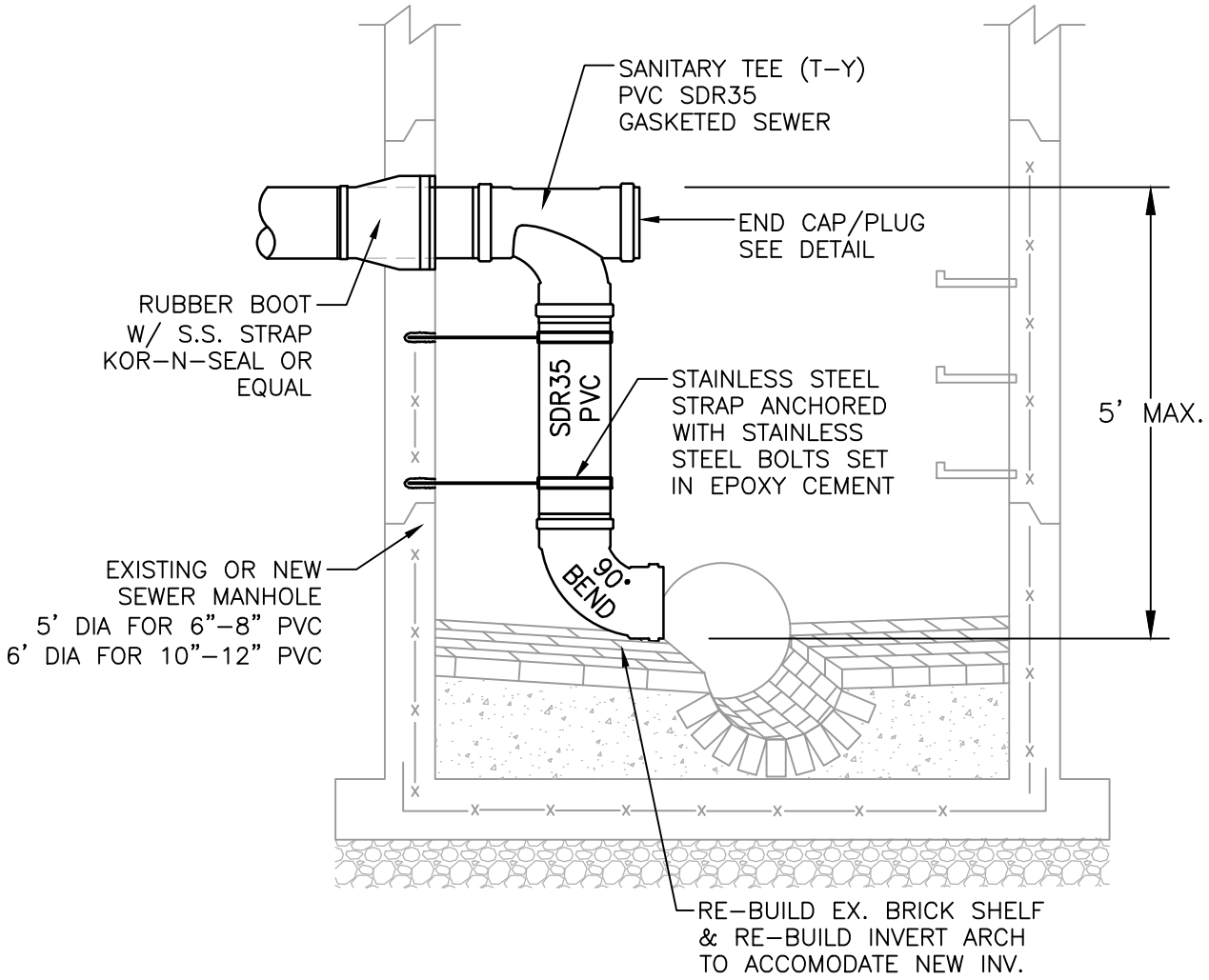


TYPICAL DROP MANHOLE

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
TYPICAL DROP MANHOLE		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			1	01/2016	UPDATED TO MATCH REVISED CITY SPECS	CPM
			NO.	DATE	DESCRIPTION	BY



END CAP/PLUG DETAIL

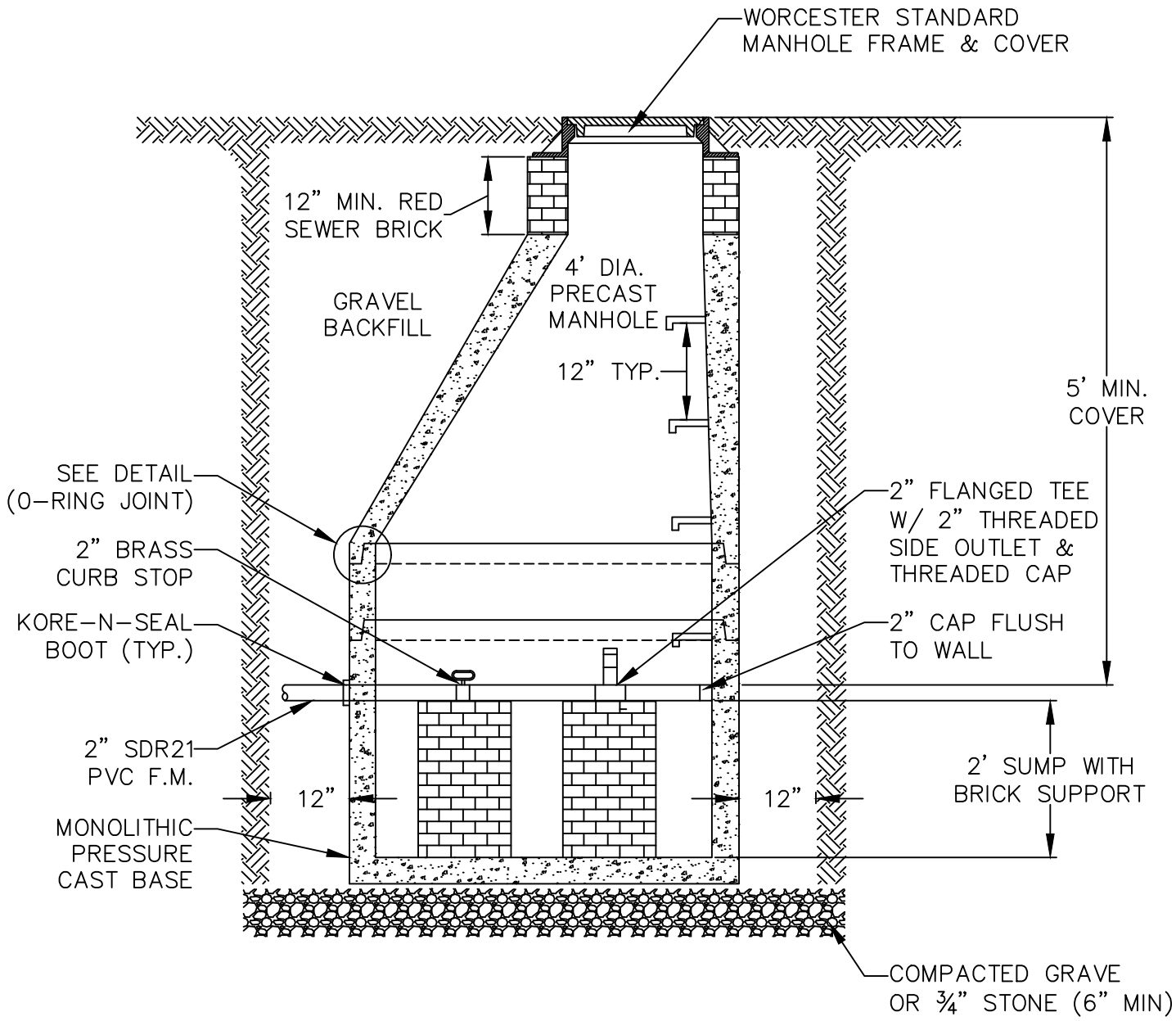


NOTES:

1. ALL NEW PIPE PENETRATIONS INTO EXISTING MANHOLE SHALL BE MACHINE CORE DRILLED & RUBBER BOOTED.
2. WHEN THE NEW PIPE DIAMETER IS SMALLER THAN THE EXISTING PIPE DIAMETER THE CROWN OF THE NEW PIPE SHALL MATCH THE CROWN OF THE EXISTING PIPE.
3. A DROP PIPE SHALL BE PROVIDED FOR A SEWER ENTERING A MANHOLE AT AN ELEVATION OF 24 INCHES OR MORE ABOVE THE MANHOLE INVERT.
4. INTERIOR DROP PIPE SHALL BE USED ONLY WHEN AN EXTERNAL DROP IS UNABLE TO BE INSTALLED.

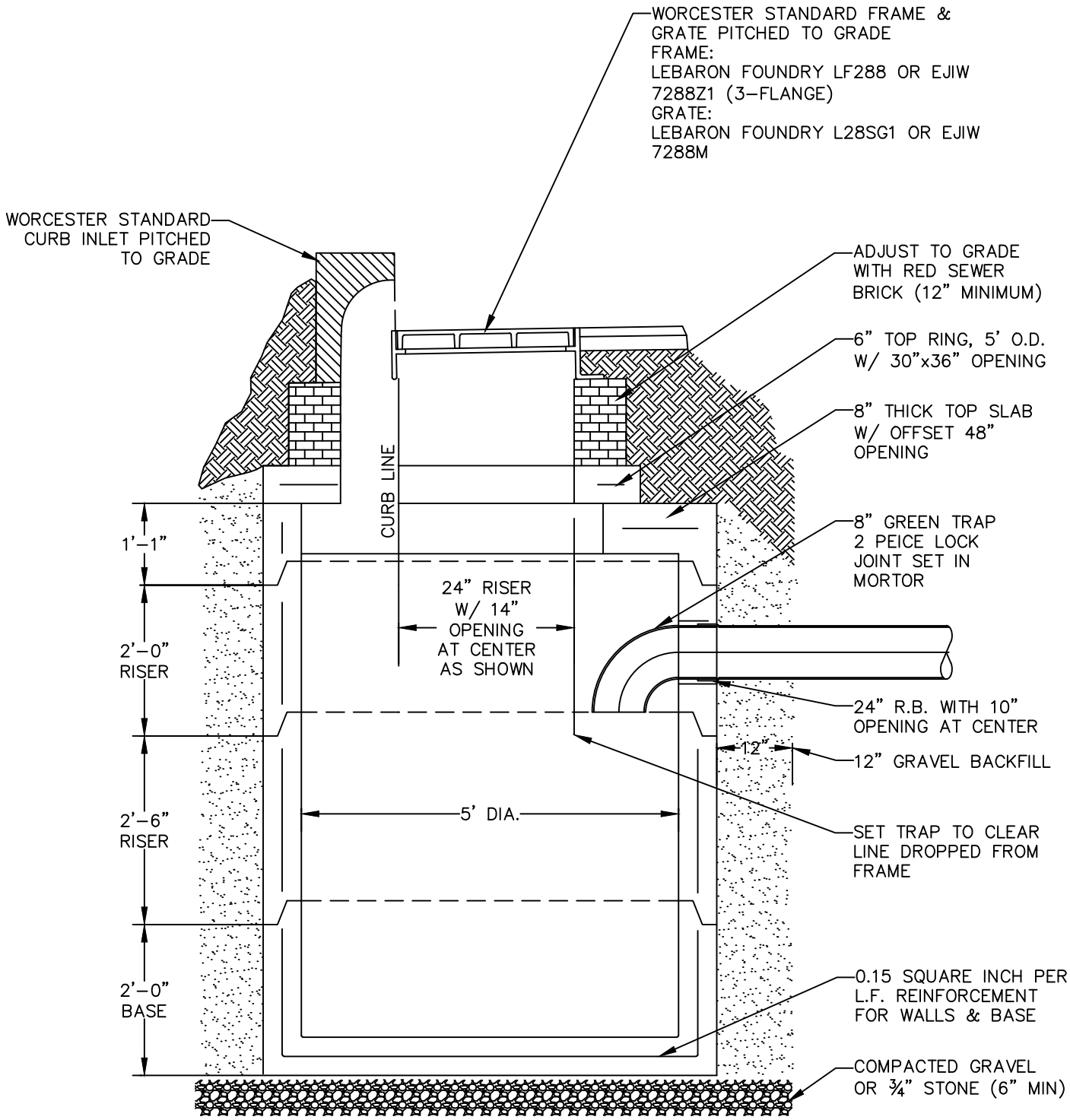
TYPICAL INSIDE DROP MANHOLE

FEBRUARY 26, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
ITEM 237.0000		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



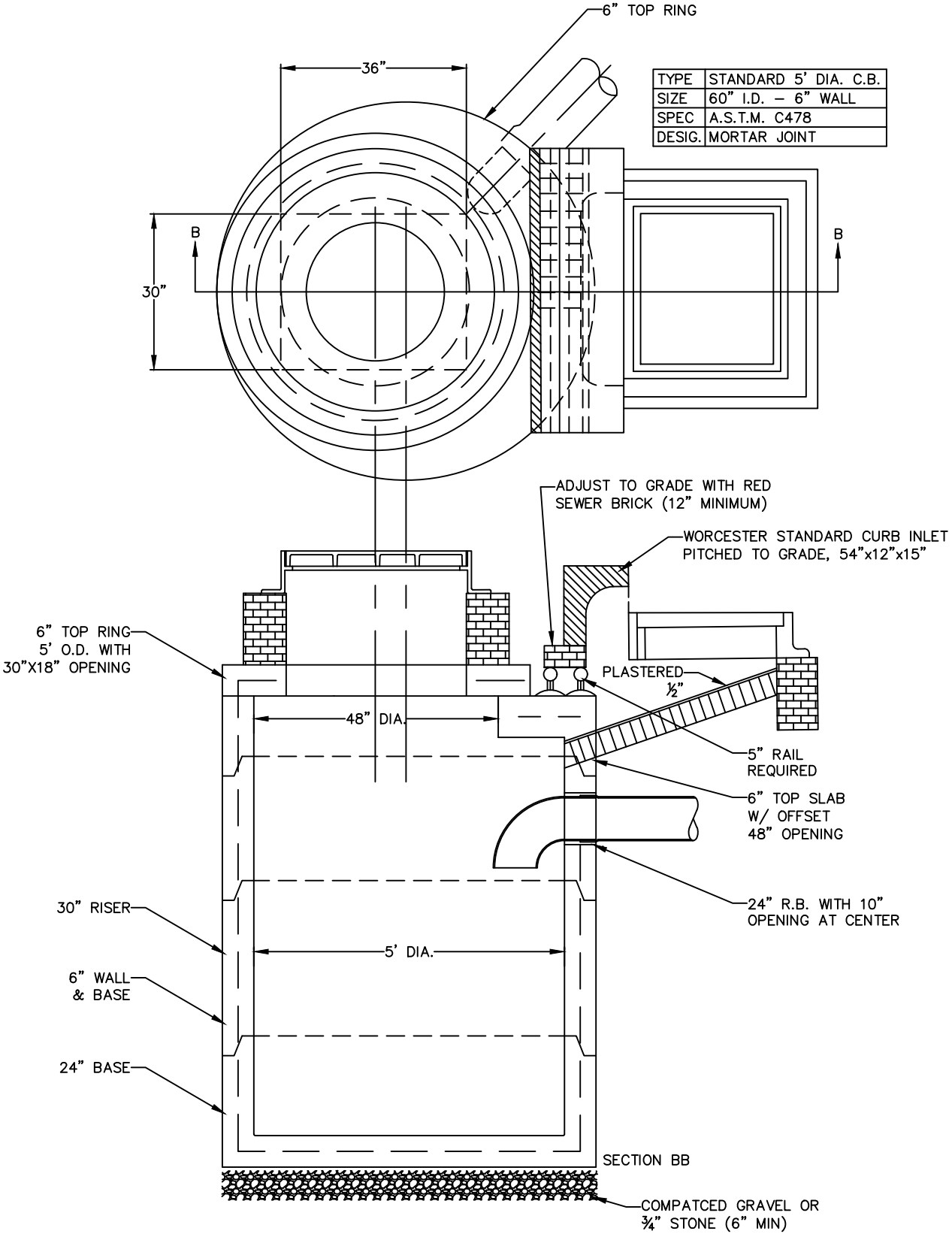
TYPICAL TERMINAL CLEANOUT-MANHOLE (FORCE MAIN)

SEPTEMBER 25, 2009	**DEPARTMENT OF PUBLIC WORKS AND PARKS**		
TYPICAL TERMINAL CLEANOUT MANHOLE (FORCE MAIN)	**Engineering Division**		
NOT TO SCALE	20 East Worcester St, Worcester MA 01604		
SHEET 1 OF 1		1 / 01/2016 / UPDATED TO MATCH REVISED CITY SPECS / CPM	
		NO. / DATE / DESCRIPTION / BY	



TYPICAL PRECAST CATCH BASIN

MAY 22, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**			
TYPICAL PRECAST CATCH BASIN		**Engineering Division**			
NOT TO SCALE		20 East Worcester St, Worcester MA 01604			
SHEET 1 OF 1			1	5/2025	UPDATED TO MATCH REVISED CITY SPECS — MFW
			NO.	DATE	DESCRIPTION — BY

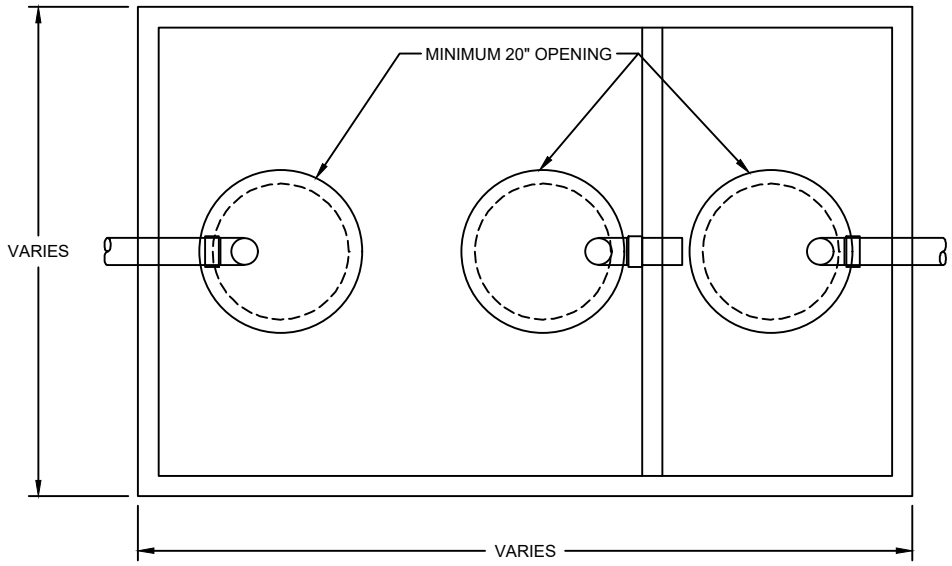


CATCH BASIN ALTERNATE TYPE

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**			
CATCH BASIN ALTERNATE TYPE		**Engineering Division**			
NOT TO SCALE		20 East Worcester St, Worcester MA 01604			
SHEET 1 OF 1			1	01/2016	UPDATED TO MATCH REVISED CITY SPECS	CPM
			NO.	DATE	DESCRIPTION	BY

WORCESTER STANDARD 2 COMPARTMENT GREASE INTERCEPTOR

(1000 GALLON MINIMUM)



GENERAL NOTES:

CONCRETE SPECIFICATIONS:

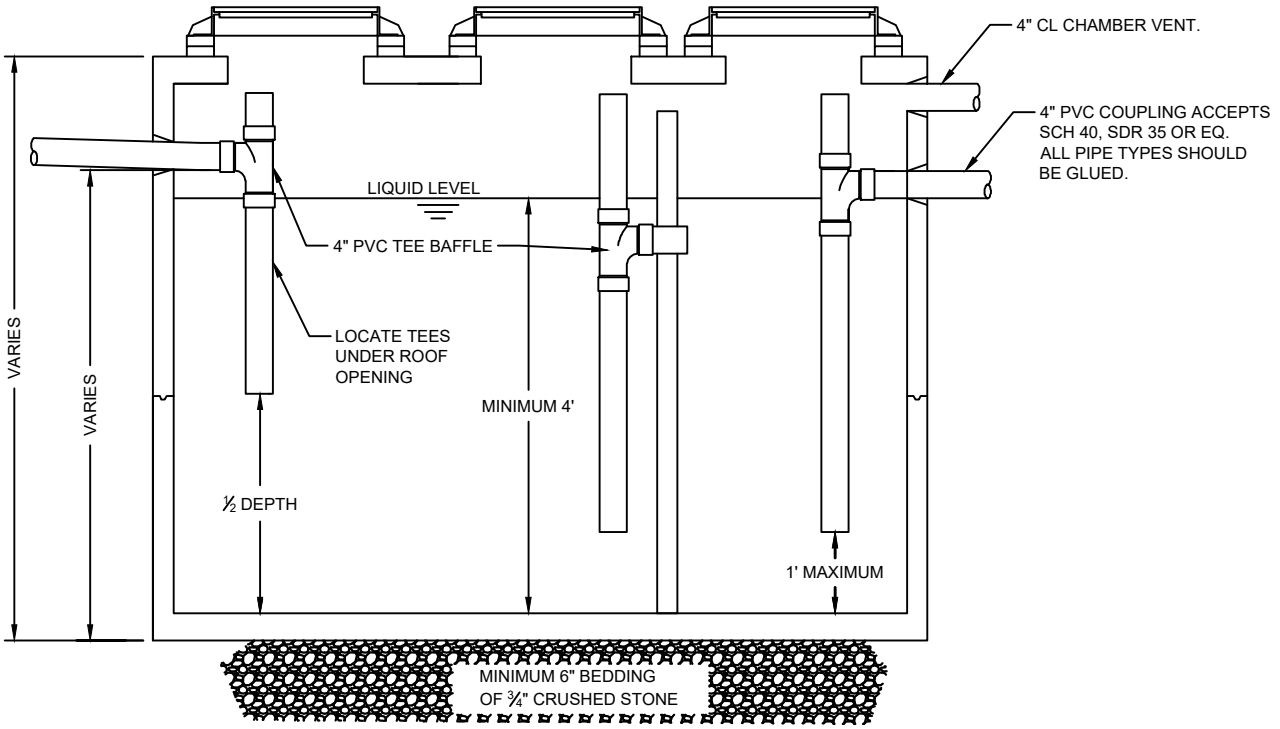
1. 4000 PSI @ 28 DAYS
2. 4%-6% ENTRAINED AIR
3. TANK PENETRATIONS ARE INTEGRALLY CAST
4. ALL JOINTS SEALED WITH BUTYL RUBBER JOINT SEALANT

GREASE TRAP INFORMATION:

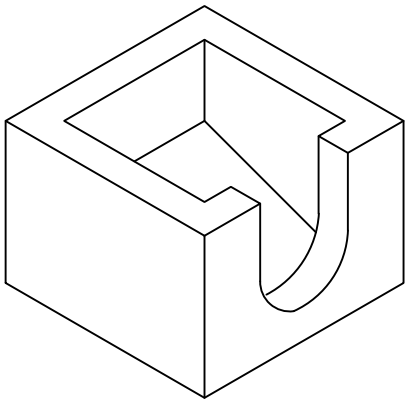
1. TANKS SHOULD BE PUMPED AS NEEDED
2. ACCESS COVERS SHOULD HAVE RISERS TO BRING COVER ACCESS TO GRADE

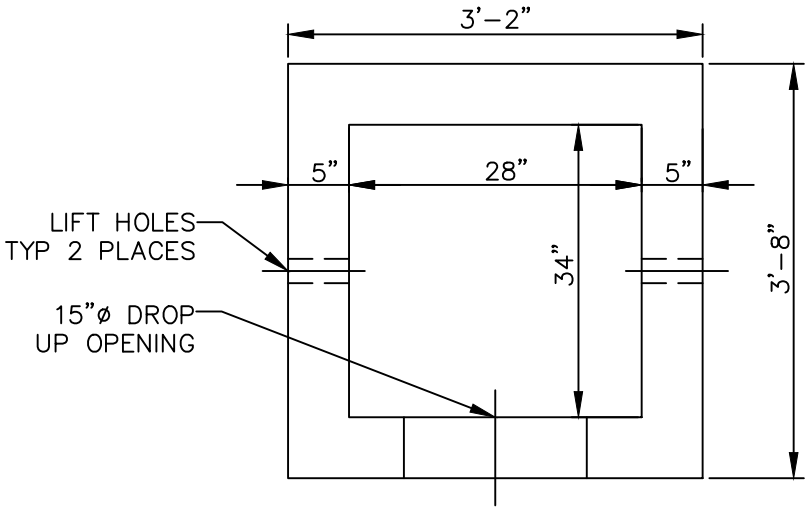
CHAMBER VENT INFORMATION:

1. THE REQUIRED CHAMBER VENTS SHALL BE PIPED INTO THE BUILDING PER 248 CMR10.16.5(e)
2. THE VENT SHALL BE OF CAST IRON, AND HAVE A MINIMUM DIAMETER OF 4"



FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	7/24/25	GREASE INTERCEPTOR	MW
ITEM 256 - GREASE INTERCEPTOR	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



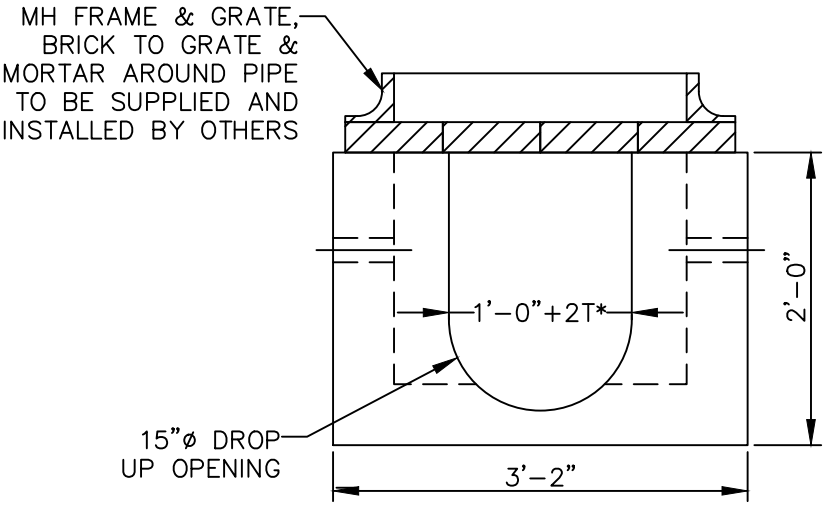


PLAN

MORTAR	SECTION JOINT	B1
MORTAR BY CONTRACTOR	PIPE SIZE	C1

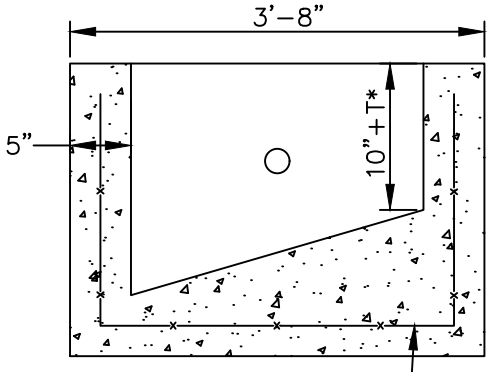
NON SHRINK GROUT BY CONTRACTOR

CSI ID #	QUANTITY
CONCRETE	.38 YDS
RM–00098	15 LBS



*T=WALL THICKNESS OF 12" RCP

ELEVATION

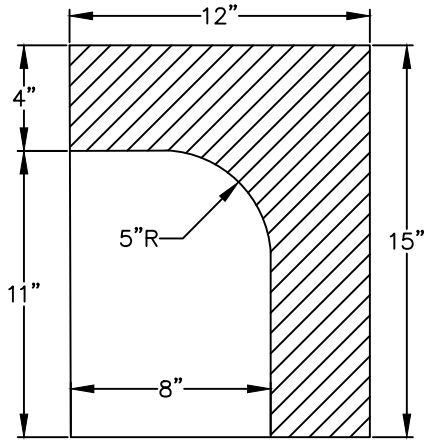


*T=WALL THICKNESS OF 12" RCP

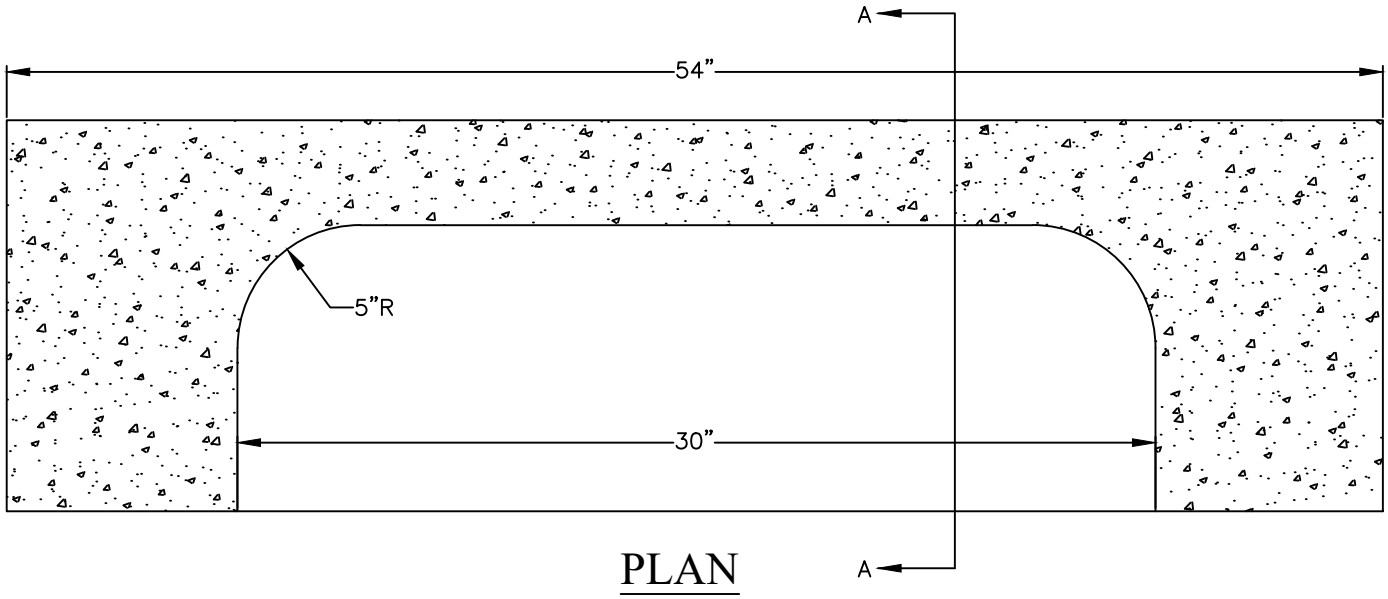
SECTION

DROP INLET DETAIL

JANUARY 2016		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	NO.	DATE	DESCRIPTION	BY
DROP INLET DETAIL		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1						



SECTION A-A



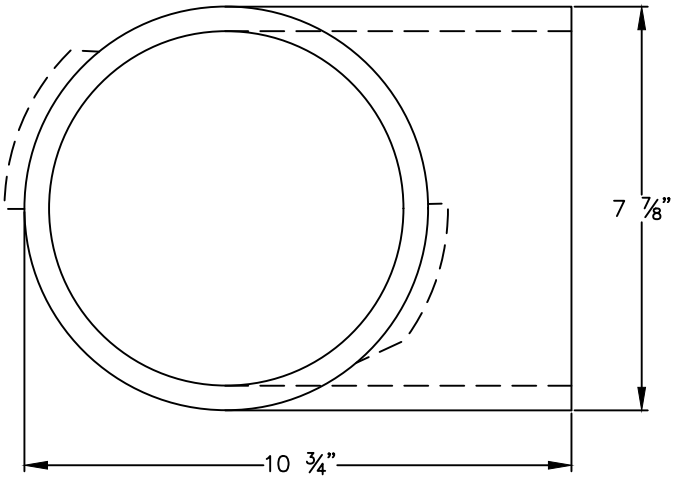
PLAN

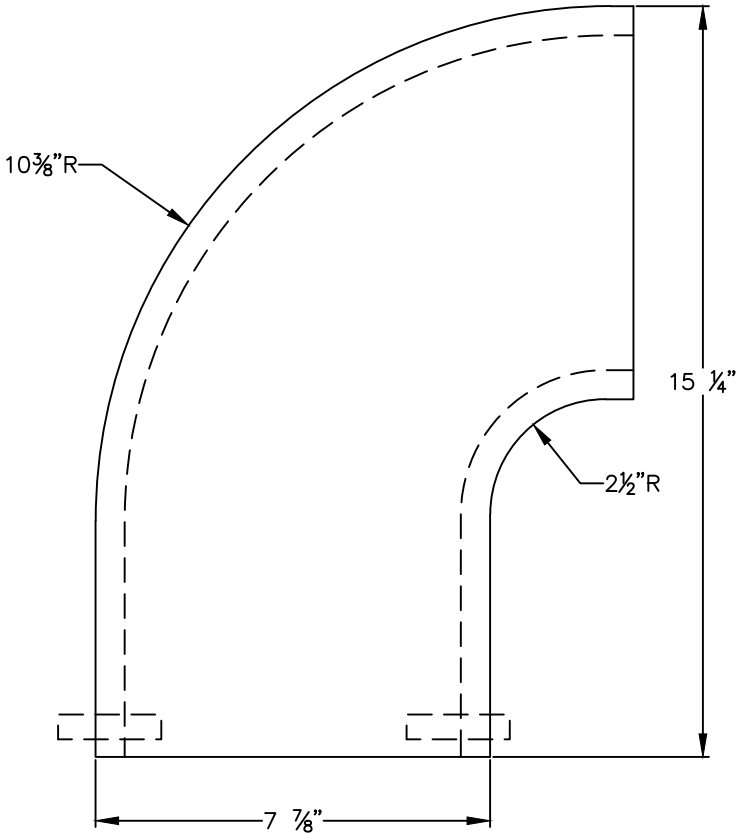
GRANITE INLET STONE

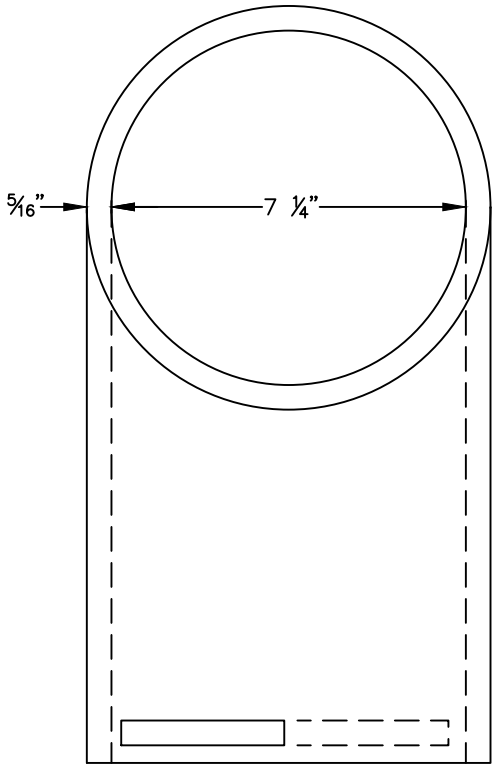
TYPICAL HEADSTONE FOR CATCH BASIN

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	
TYPICAL HEADSTONE FOR CATCH BASIN		**Engineering Division**	
NOT TO SCALE		20 East Worcester St, Worcester MA 01604	
SHEET 1 OF 1			

NO.	DATE	DESCRIPTION	BY

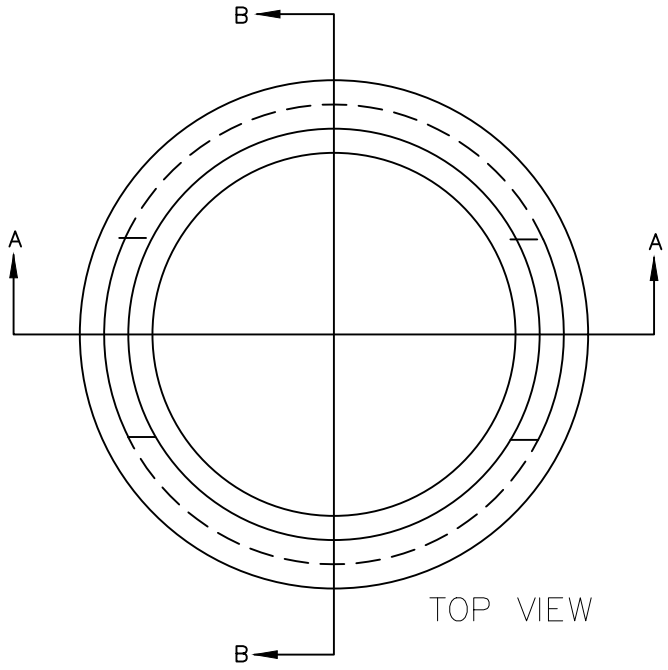




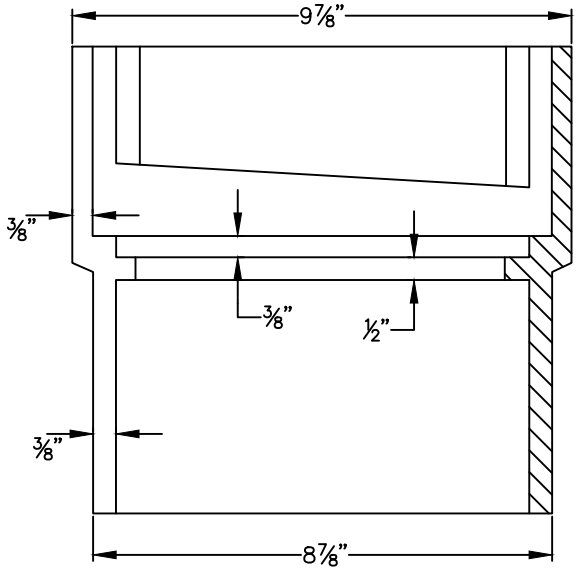


BODY FOR 8" TRAP

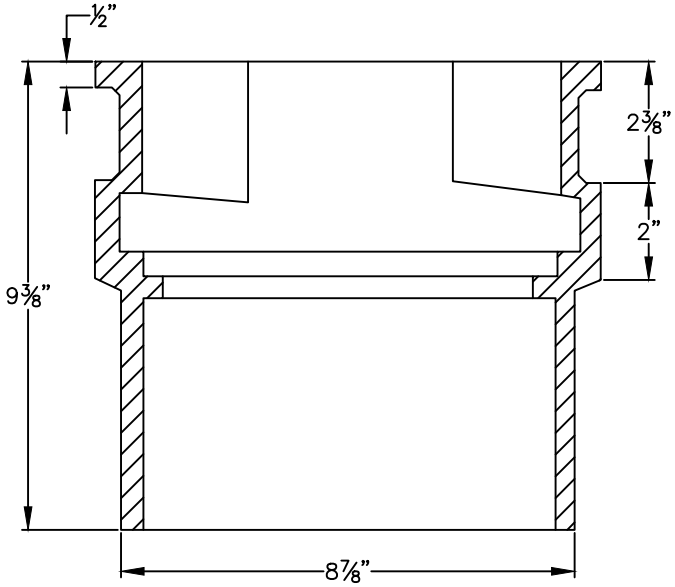
SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	NO.	DATE	DESCRIPTION	BY
BODY FOR 8" TRAP						
NOT TO SCALE						
SHEET 1 OF 1						



TOP VIEW



SECTION A–A

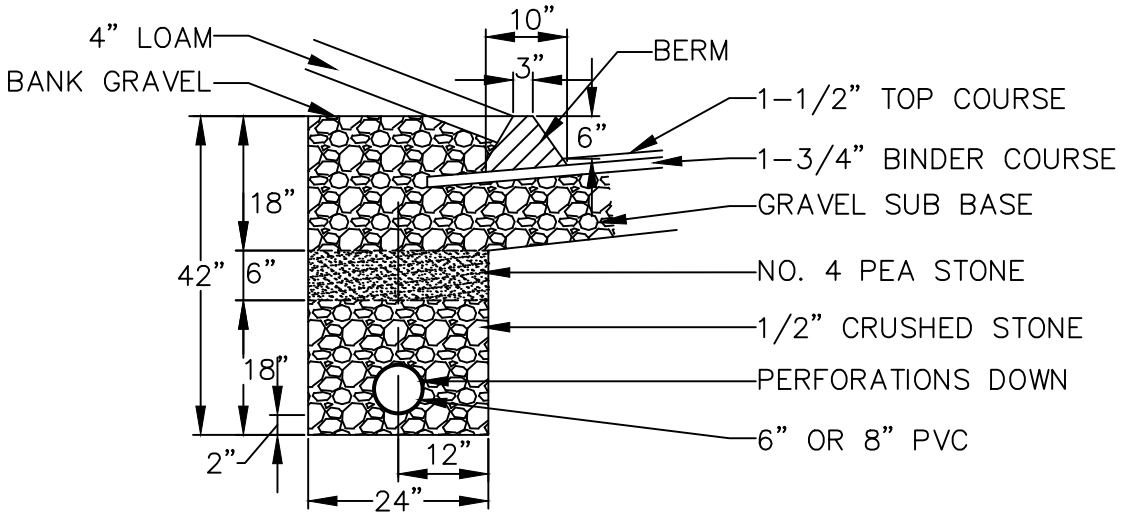


SECTION B–B

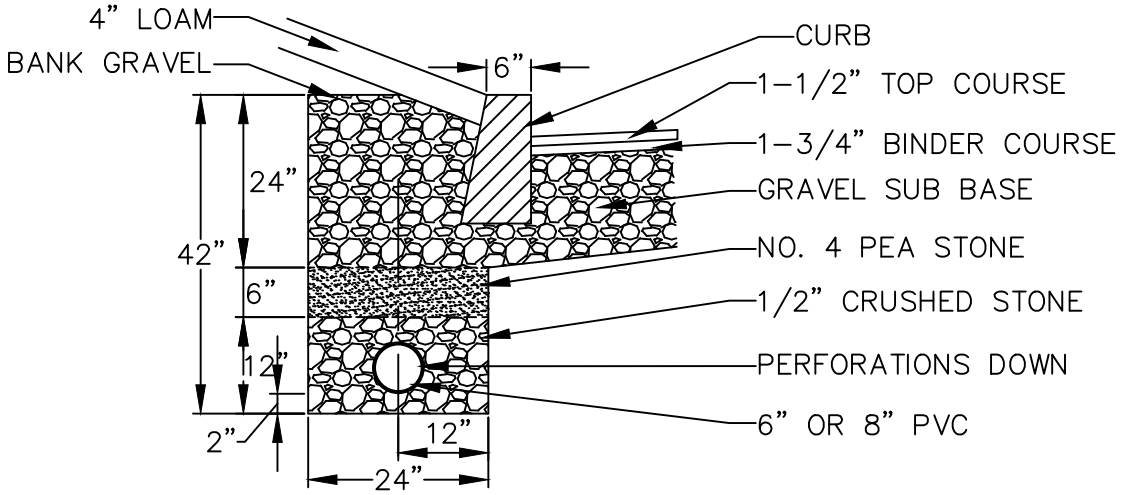
COLLAR FOR 8" TRAP

SEPTEMBER 25, 2009		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	
COLLAR FOR 8" TRAP		**Engineering Division**	
NOT TO SCALE		20 East Worcester St, Worcester MA 01604	
SHEET 1 OF 1			

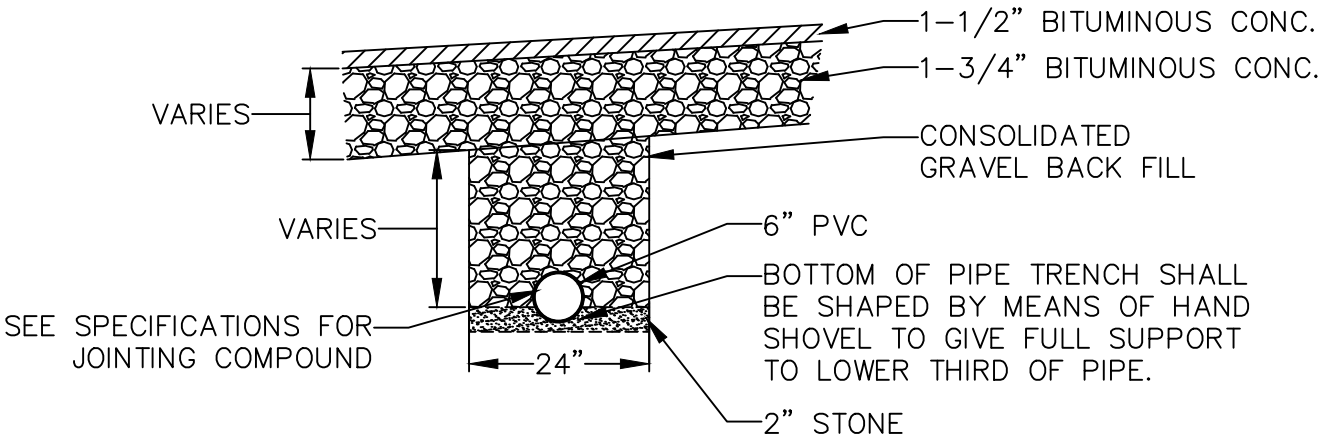
NO.	DATE	DESCRIPTION	BY



TYPICAL SUB-DRAIN DETAIL BEHIND ASPHALT BERM

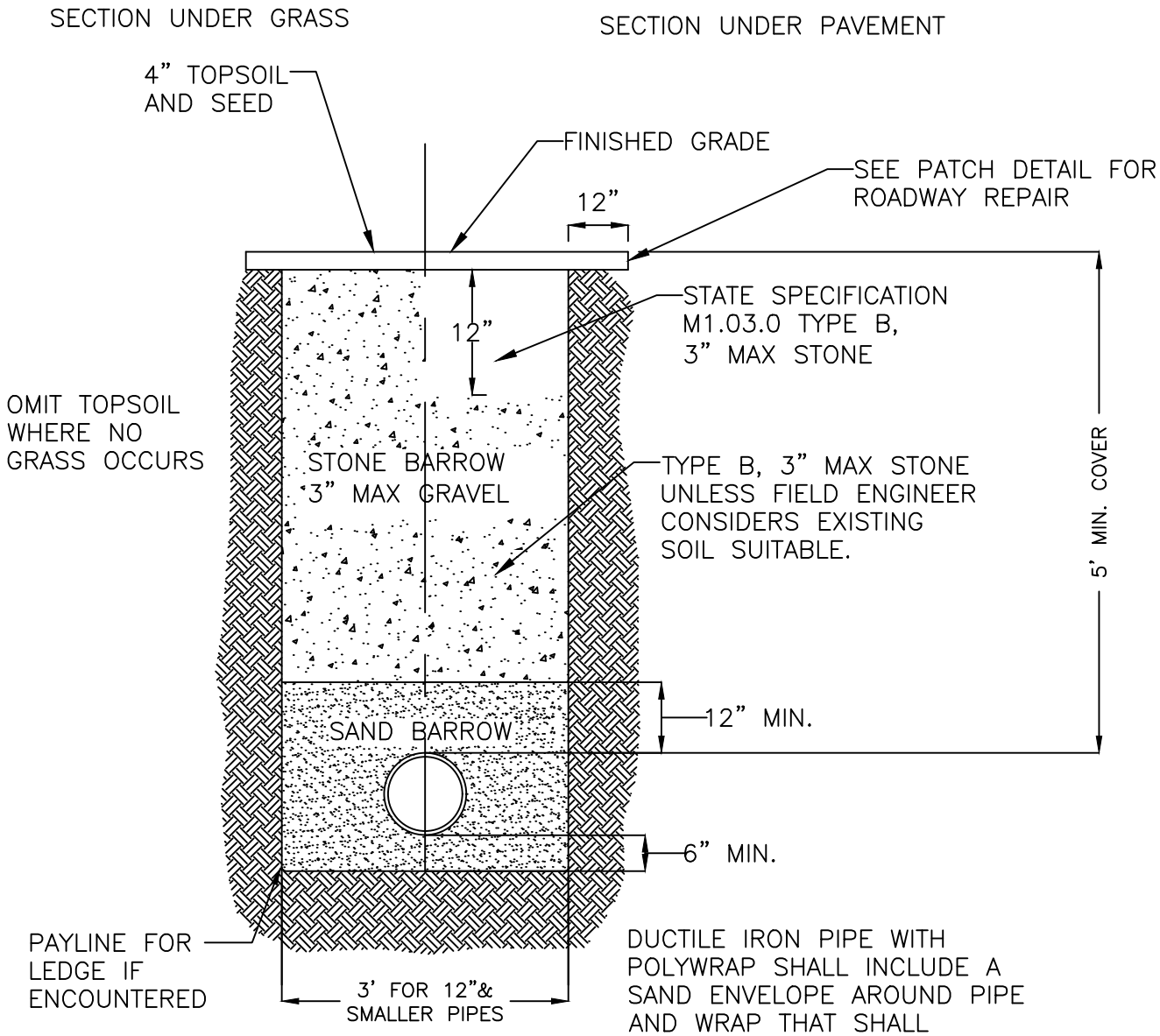


TYPICAL SUB-DRAIN DETAIL BEHIND GRANITE CURB



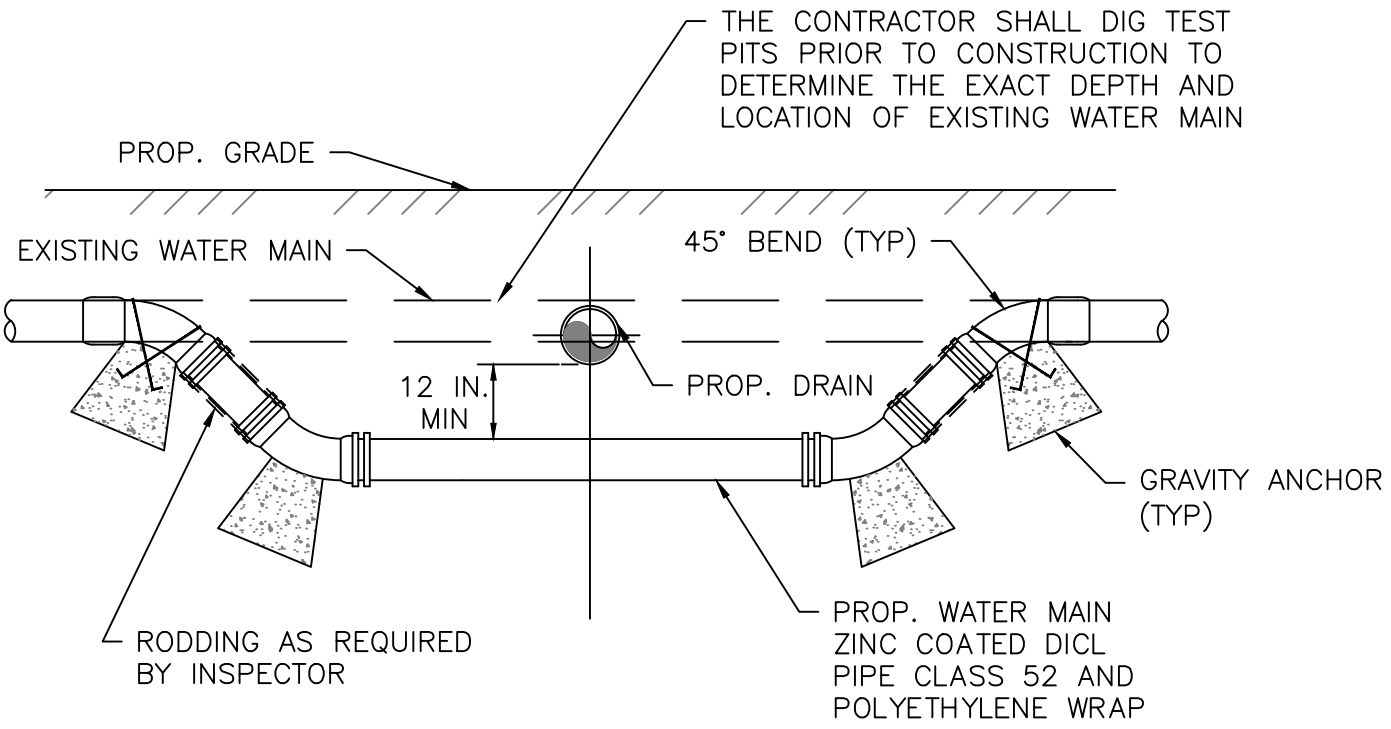
TYPICAL SUB-DRAIN DETAIL

SEPTEMBER 25, 2009	**DEPARTMENT OF PUBLIC WORKS AND PARKS**		
TYPICAL SUB-DRAIN DETAIL	**Engineering Division**		
NOT TO SCALE	20 East Worcester St, Worcester MA 01604		
SHEET 1 OF 1		1 / 01/2016 / UPDATED TO MATCH REVISED CITY SPECS / CPM	
		NO. / DATE / DESCRIPTION / BY	



TYPICAL WATER TRENCH

WATER DETAIL W-5			
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	TYPICAL WATER TRENCH	MW
TYPICAL WATER TRENCH	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

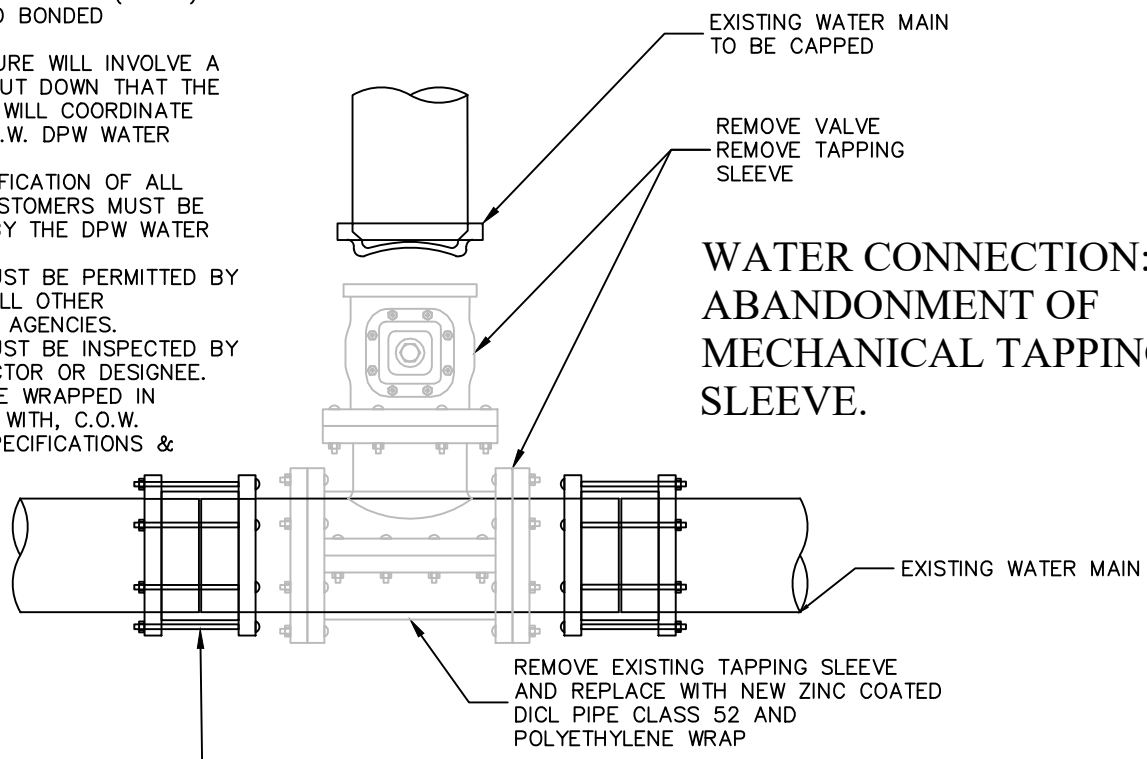


TYPICAL WATER MAIN OFFSET

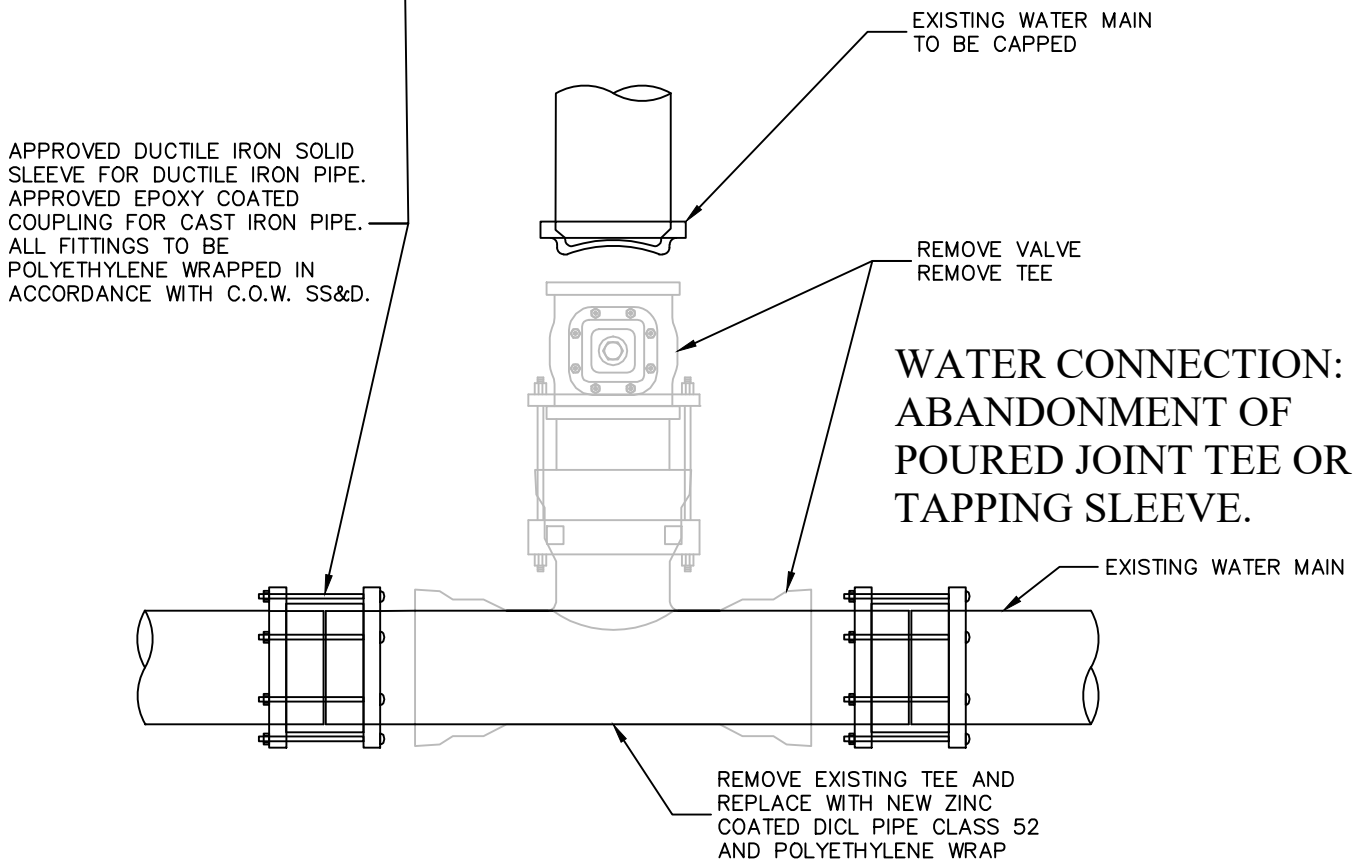
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/4/2025	WATER MAIN OFFSET	MW
ITEM 303 - WATER MAIN OFFSET					
NOT TO SCALE					
SHEET 1 OF 1					
		NO.	DATE	DESCRIPTION	BY

NOTES:

1. ALL WORK MUST BE PERFORMED BY A CITY OF WORCESTER (C.O.W.) LICENSED AND BONDED CONTRACTOR.
2. THIS PROCEDURE WILL INVOLVE A MAIN LINE SHUT DOWN THAT THE CONTRACTOR WILL COORDINATE WITH THE C.O.W. DPW WATER ENGINEER.
3. WRITTEN NOTIFICATION OF ALL AFFECTED CUSTOMERS MUST BE PERFORMED BY THE DPW WATER ENGINEER.
4. ALL WORK MUST BE PERMITTED BY C.O.W. AND ALL OTHER APPROPRIATE AGENCIES.
5. ALL WORK MUST BE INSPECTED BY C.O.W. INSPECTOR OR DESIGNEE.
6. POLYETHYLENE WRAPPED IN ACCORDANCE WITH, C.O.W. STANDARD SPECIFICATIONS & DETAILS.



WATER CONNECTION: ABANDONMENT OF MECHANICAL TAPPING SLEEVE.



WATER CONNECTION: ABANDONMENT OF POURED JOINT TEE OR TAPPING SLEEVE.

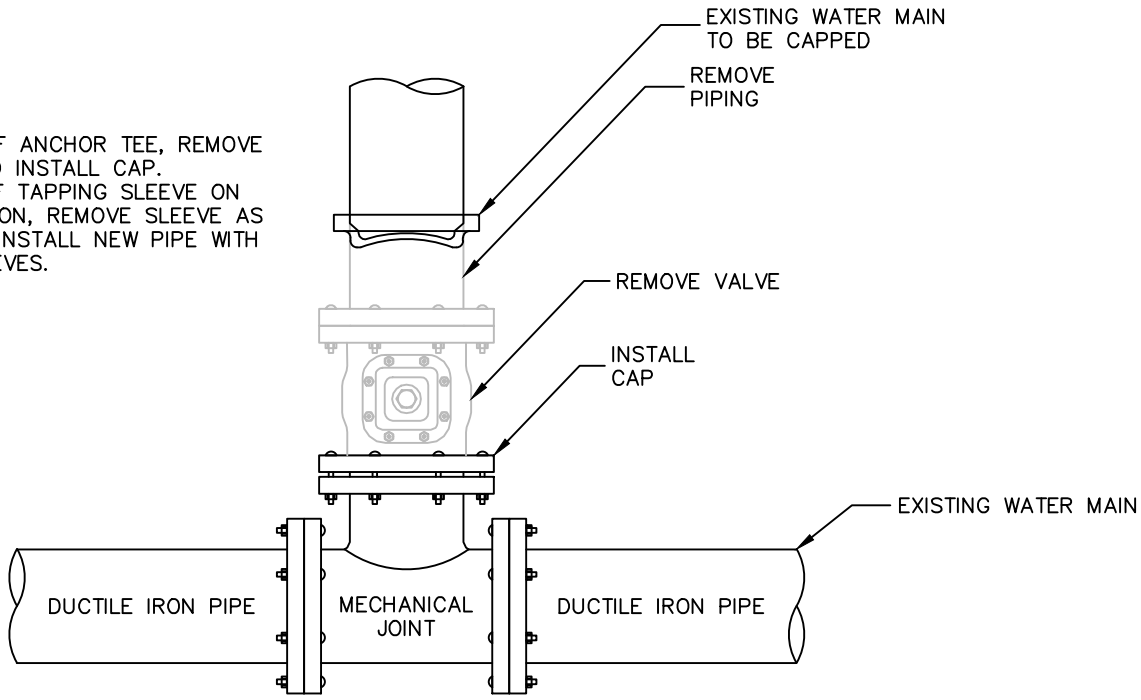
DECEMBER 2, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	12/2/2025	ABANDONMENT OF WATER CONNECTION 3" & GREATER	MW
ABANDONMENT OF WATER CONNECTION 3" & GREATER	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

NOTES:

1. ALL WORK MUST BE PERFORMED BY A CITY OF WORCESTER (C.O.W.) LICENSED AND BONDED CONTRACTOR.
2. THIS PROCEDURE WILL INVOLVE A MAIN LINE SHUT DOWN THAT THE CONTRACTOR WILL COORDINATE WITH THE C.O.W. DPW WATER ENGINEER.
3. WRITTEN NOTIFICATION OF ALL AFFECTED CUSTOMERS MUST BE PERFORMED BY THE DPW WATER ENGINEER.
4. ALL WORK MUST BE PERMITTED BY C.O.W. AND ALL OTHER APPROPRIATE AGENCIES.
5. ALL WORK MUST BE INSPECTED BY C.O.W. INSPECTOR OR DESIGNEE.
6. POLYETHYLENE WRAPPED IN ACCORDANCE WITH, C.O.W. STANDARD SPECIFICATIONS & DETAILS.

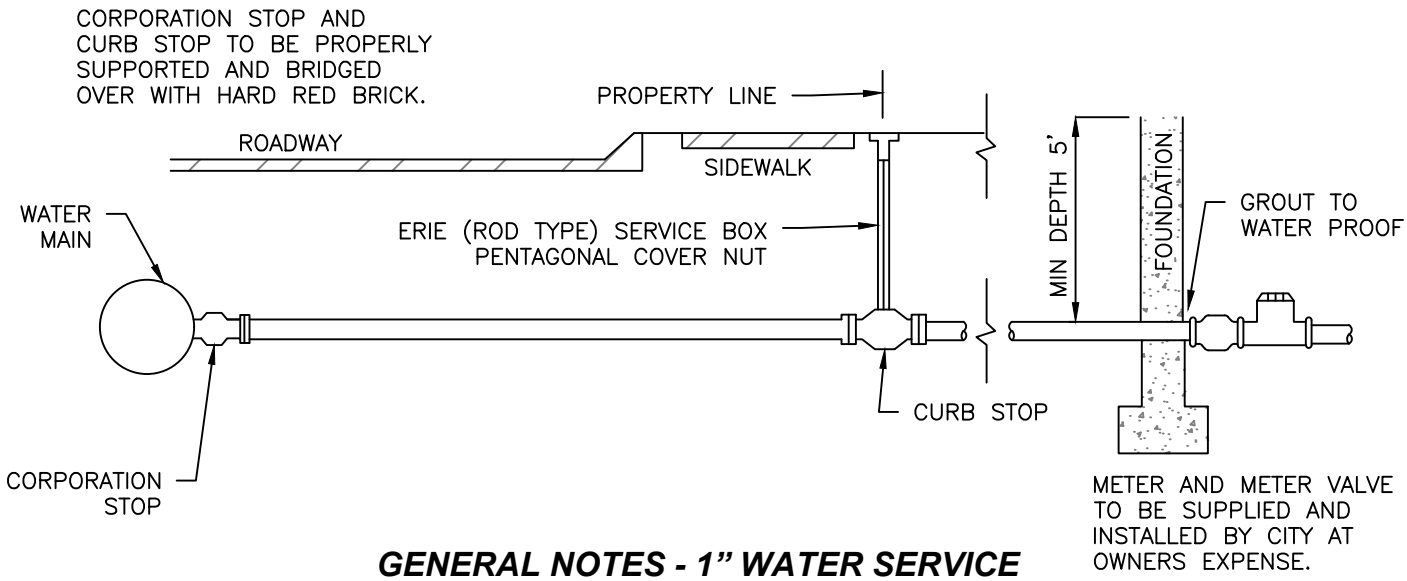
* IN CASE OF ANCHOR TEE, REMOVE VALVE AND INSTALL CAP.

** IN CASE OF TAPPING SLEEVE ON DUCTILE IRON, REMOVE SLEEVE AS ON CAST, INSTALL NEW PIPE WITH SOLID SLEEVES.



WATER CONNECTION: ABANDONMENT AND CAPPING OF MECHANICAL JOINT TEE.

DECEMBER 2, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	12/2/2025	ABANDONMENT OF WATER CONNECTION 3" & GREATER	MW
ABANDONMENT OF WATER CONNECTION 3" & GREATER	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



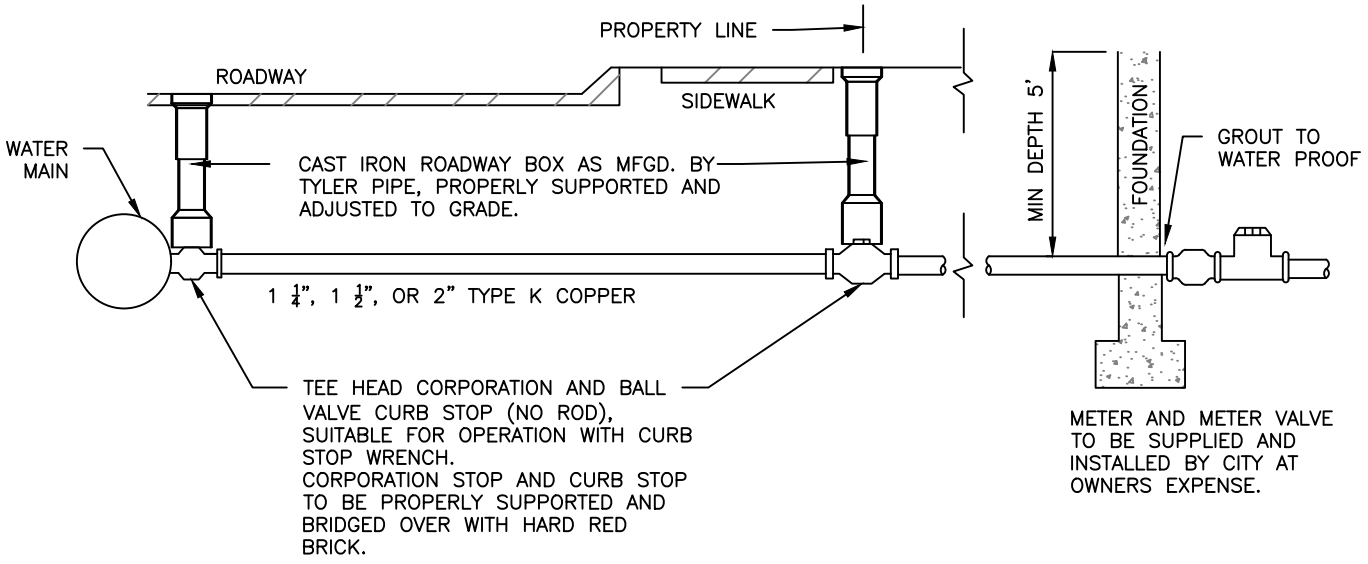
GENERAL NOTES - 1" WATER SERVICE

1. *FITTINGS AND VALVES SHALL BE MANUFACTURED BY FORD, A.Y. MCDONALD OR APPROVED EQUAL. CORPORATIONS: FORD FB1000 OR A.Y. MCDONALD 74701B-22 C.C. THREAD BY COMPRESSION; CURB STOPS: B44 OR A.Y MCDONALD 76100-22 SERIES FULL PORT (COMP. X COMP.).*
2. *ALL COMPRESSION FITTINGS USED ON POLYETHYLENE TUBING SHALL BE INSTALLED WITH SOLID, TUBULAR STAINLESS STEEL INSERT STIFFENERS.*
3. *MAINS 6 INCHES AND SMALLER IN DIAMETER: SERVICE SADDLES SHALL BE USED. DUCTILE IRON BODY SADDLES SHALL BE DOUBLE STRAP EQUAL TO: POWERSEAL 3413; SMITH-BLAIRE 331; FORD F202; JCM402; MUELLER DR2A.*
4. *EXISTING PLASTIC MAINS ALL SIZES: SERVICE SADDLES SHALL BE USED. DUCTILE IRON BODY SADDLES SHALL BE DOUBLE STRAP EQUAL TO: POWERSEAL 3417; SMITH-BLAIRE 317; FORD FSD202; JCM402; MUELLER DR2A.*
5. *BEFORE ANY EXCAVATION IS STARTED AND ANY PIPE IS INSTALLED, PERMITS SHALL BE OBTAINED THRU ONLINE PERMITTING PORTAL DPW&P ENGINEERING PERMIT SECTION. ALL PAVING SHALL CONFORM TO CITY OF WORCESTER D.P.W. STANDARDS.*
6. *SAND SHALL BE USED FOR BACKFILLING FROM A POINT 6 INCHES BELOW THE PIPE TO A POINT 12 INCHES ABOVE THE PIPE. THE REMAINING BACKFILL SHALL HAVE NO STONES GREATER THAN 3 INCHES IN THEIR LARGEST DIMENSION.*
7. *SERVICES SHALL BE FLUSHED BEFORE ACTIVATING TO AVOID METER CLOGGING.*
8. *MAIN VALVES ARE TO BE OPERATED BY THE CITY ONLY. COSTS INCURRED IN SHUTTING DOWN MAINS DUE TO NEGLIGENCE OF THE CONTRACTOR AS DETERMINED BY THE FIELD INSPECTOR SHALL BE PAID BY THE CONTRACTOR.*
9. *THE CONTRACTOR SHALL INFORM THE OWNER AND THE CITY WIRE INSPECTOR OF PROPER GROUNDING REQUIREMENTS PURSUANT TO M.G.L. CHAPTER 165, SECTION 1C.*
10. *ON NEW SERVICES, IN ACCORDANCE WITH THE MASS. DEPARTMENT OF ENVIRONMENTAL PROTECTION CODE 5 AND ITS AMENDMENTS, THE WATER SERVICE SHALL BE A MINIMUM OF 10 HORIZONTAL FEET FROM THE SEWER SERVICE.*
11. *THE CONTRACTOR SHALL FURNISH AND COMPLETELY INSTALL THE SERVICE FROM CORPORATION TO THE METER VALVES WITH NEW MATERIALS.*
12. *1" FIRE PIPES SHALL BE COPPER TUBING TYPE"K" ASTM-B88, "ANNEALED" (SOFT) AND TESTED AT 200 PSI FOR TWO HOURS PER NFPA STANDARDS.*
13. *1" DOMESTIC SERVICE PIPE CAN BE POLYETHYLENE TUBING AND SHALL MEET AWWA C901AS LATEST REVISED, HAVE A WORKING PRESSURE OF 250 PSI, AND SHALL MEET THE NOMINAL SIZE AS SHOWN. ALL POLYETHYLENE TUBING SHALL BE COPPER TUBE SIZE (CTS), MEETING ASTM SPECIFICATIONS D-1248, D-2239, AND D-2737 AND SHALL MEET PE 4710 REQUIREMENTS OR COPPER TUBING TYPE "K" ASTM-B88, "ANNEALED" (SOFT).*
14. *INSTALLATIONS SHALL HAVE BURIED DETECTABLE WATER LINE WARNING TAPE INSTALLED AT MINIMUM 12" ABOVE THE PIPE.*
15. *UPON INSTALLATION OF THE SERVICE BOX, THE CONTRACTOR SHALL OPERATE THE STOP TO THE SATISFACTION OF THE FIELD INSPECTOR PRIOR TO ACCEPTANCE OF THE JOB.*

WATER DETAIL W-8A
FEBRUARY 26, 2025
ITEM 309.3
NOT TO SCALE
SHEET 1 OF 1

DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

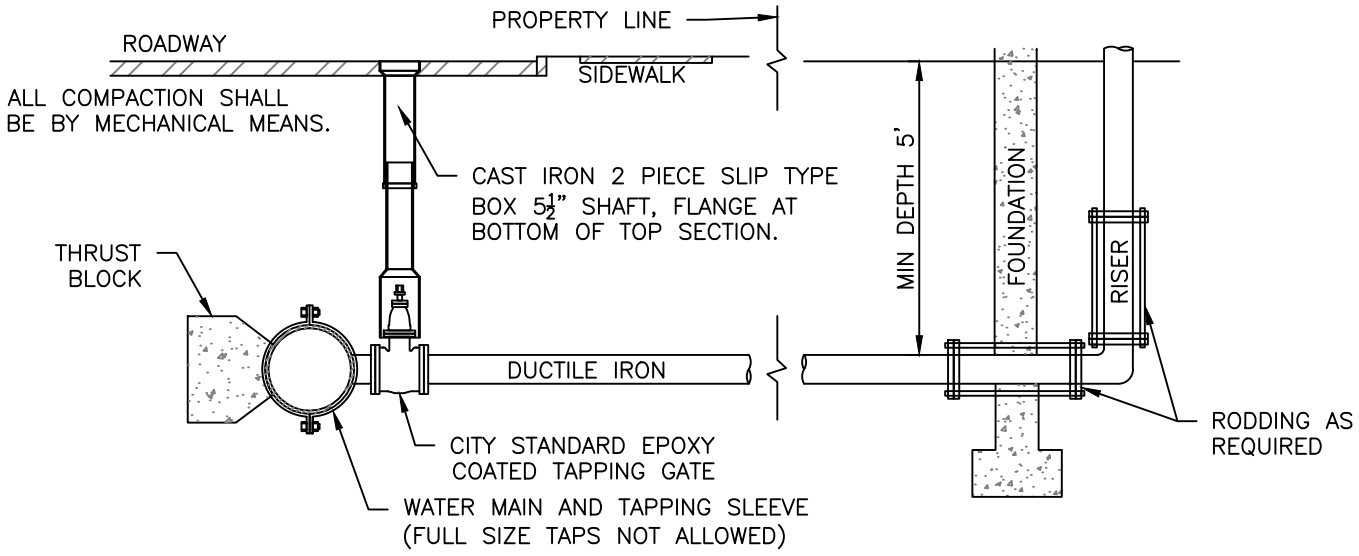
NO.	DATE	DESCRIPTION	BY
1	3/4/2025	WATER SERVICE 1"	MW



GENERAL NOTES - 1 ¼" ,1 ½" ,2" WATER SERVICE

1. *FITTINGS AND VALVES SHALL BE MANUFACTURED BY FORD, FORD, A.Y. MCDONALD OR APPROVED EQUAL. CORPORATION: FORD FB1000 OR A.Y. MCDONALD 74101BCAP-22 WITH TEE HEAD ADAPTER (CC THREAD X COMP.). BALL VALVE CURB STOP: FORD B44 OR A.Y MCDONALD 76100-22 SERIES FULL PORT (COMP. X COMP.).*
2. *MAINS 16 INCHES IN DIAMETER AND LARGER: TAPS SHALL BE BY DIRECT MEANS ONLY.*
3. *MAINS SMALLER THAN 16 INCHES IN DIAMETER: SERVICE SADDLES SHALL BE USED. DUCTILE IRON BODY SADDLES SHALL BE DOUBLE STRAP EQUAL TO: POWERSEAL 3413; SMITH-BLAIRE 331; FORD F202; JCM402; MUELLER DR2A.*
4. *EXISTING PLASTIC MAINS ALL SIZES: SERVICE SADDLES SHALL BE USED. DUCTILE IRON BODY SADDLES SHALL BE DOUBLE STRAP EQUAL TO: POWERSEAL 3417; SMITH-BLAIRE 317; FORD FSD202; JCM402; MUELLER DR2A.*
5. *SAND SHALL BE USED FOR BACKFILLING FROM A POINT 6 INCHES BELOW THE PIPE TO A POINT 12 INCHES ABOVE THE PIPE. THE REMAINING BACKFILL SHALL HAVE NO STONES GREATER THAN 3 INCHES IN THEIR LARGEST DIMENSION.*
6. *BEFORE ANY EXCAVATION IS STARTED AND ANY PIPE IS INSTALLED, PERMITS SHALL BE OBTAINED THRU ONLINE PERMITTING PORTAL DPW&P ENGINEERING PERMIT SECTION. ALL PAVING SHALL CONFORM TO CITY OF WORCESTER D.P.W. STANDARDS.*
7. *SERVICES SHALL BE FLUSHED BEFORE ACTIVATING TO AVOID METER CLOGGING.*
8. *MAIN VALVES ARE TO BE OPERATED BY THE CITY ONLY. COSTS INCURRED IN SHUTTING DOWN MAINS DUE TO NEGLIGENCE OF THE CONTRACTOR, AS DETERMINED BY THE FIELD INSPECTOR, SHALL BE PAID BY THE CONTRACTOR.*
9. *THE CONTRACTOR SHALL INFORM THE OWNER AND THE CITY WIRE INSPECTOR OF PROPER GROUNDING REQUIREMENTS PURSUANT TO M.G.L. CHAPTER 165, SECTION 1C.*
10. *ON NEW SERVICES, IN ACCORDANCE WITH THE MASS. DEPARTMENT OF ENVIRONMENTAL PROTECTION CODE 5 AND ITS AMENDMENTS, THE WATER SERVICE SHALL BE A MINIMUM OF 10 HORIZONTAL FEET FROM THE SEWER SERVICE.*
11. *THE CONTRACTOR SHALL FURNISH AND COMPLETELY INSTALL THE SERVICE FROM CORPORATION TO THE METER VALVES WITH NEW MATERIALS.*
12. *ALL 1 ¼", 1 ½" AND 2" DIAMETER WATER SERVICES SHALL BE HYDROSTATICALLY PRESSURE TESTED AND DISINFECTED IN ACCORDANCE WITH THE SPECIFICATIONS. FIRE PIPES SHALL BE TESTED AT A MINIMUM 200 PSI FOR TWO HOURS PER NFPA STANDARDS.*
13. *INSTALLATIONS SHALL HAVE BURIED DETECTABLE WATER LINE WARNING TAPE INSTALLED AT MINIMUM 12" ABOVE THE PIPE.*
14. *UPON INSTALLATION OF THE SERVICE BOX, THE CONTRACTOR SHALL OPERATE THE VALVE TO THE SATISFACTION OF THE FIELD INSPECTOR PRIOR TO ACCEPTANCE OF THE JOB.*

WATER DETAIL W-8B			
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	WATER SERVICE 1¼", 1½", 2"	MW
ITEM 309.4	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

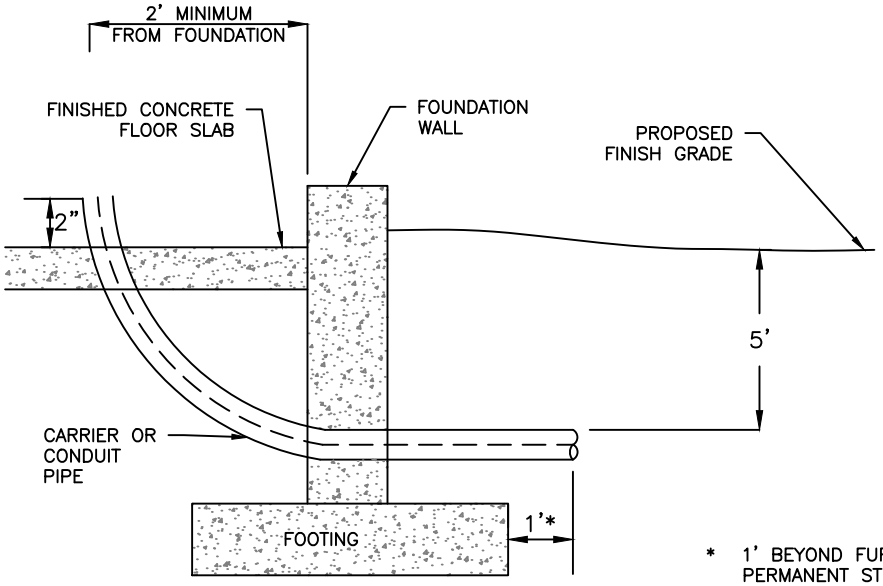


GENERAL NOTES

1. TAPPING SLEEVE SHALL BE CAST OR DUCTILE IRON MECHANICAL JOINT TYPE. TAPPING GATE TO BE CITY STANDARD EPOXY COATED. THE OPERATING NUT SHALL BE 2 INCHES SQUARE AND SHALL OPEN RIGHT.
2. IF EXCAVATED MATERIAL IS NOT SUITABLE FOR BACKFILLING, THEN THE CONTRACTOR SHALL BACKFILL WITH GRAVEL BORROW. MATERIAL USED FOR BACKFILLING SHALL CONTAIN NO STONES GREATER THAN 3 INCHES IN THEIR LARGEST DIMENSION.
3. BEFORE ANY EXCAVATION IS DONE, A STREET OPENING PERMIT SHALL BE OBTAINED FROM THE PUBLIC WORKS OFFICE AT 20 EAST WORCESTER ST. ALL PAVING SHALL CONFORM TO CITY OF WORCESTER D.P.W. STANDARDS.
4. MAIN VALVES ARE TO BE OPERATED BY THE CITY ONLY. COSTS INCURRED IN SHUTTING DOWN MAINS DUE TO NEGLIGENCE OF THE CONTRACTOR AS DETERMINED BY THE FIELD INSPECTOR SHALL BE PAID BY THE CONTRACTOR.
5. ALL TAPPING SLEEVES AND TAPPING VALVE ASSEMBLIES SHALL BE HYDROSTATICALLY PRESSURE TESTED PRIOR TO TAPPING. THE TEST SHALL BE AT 1–1/2 TIMES THE WORKING PRESSURE OF THE EXISTING MAIN OR A MINIMUM OF 150PSI AND SHALL BE MAINTAINED FOR TWO HOURS, OR AS DIRECTED BY THE FIELD ENGINEER.
6. UPON INSTALLATION OF THE GATE BOX, THE CONTRACTOR SHALL OPERATE THE TAPPING GATE TO THE SATISFACTION OF THE FIELD INSPECTOR PRIOR TO THE ACCEPTANCE OF THE JOB.

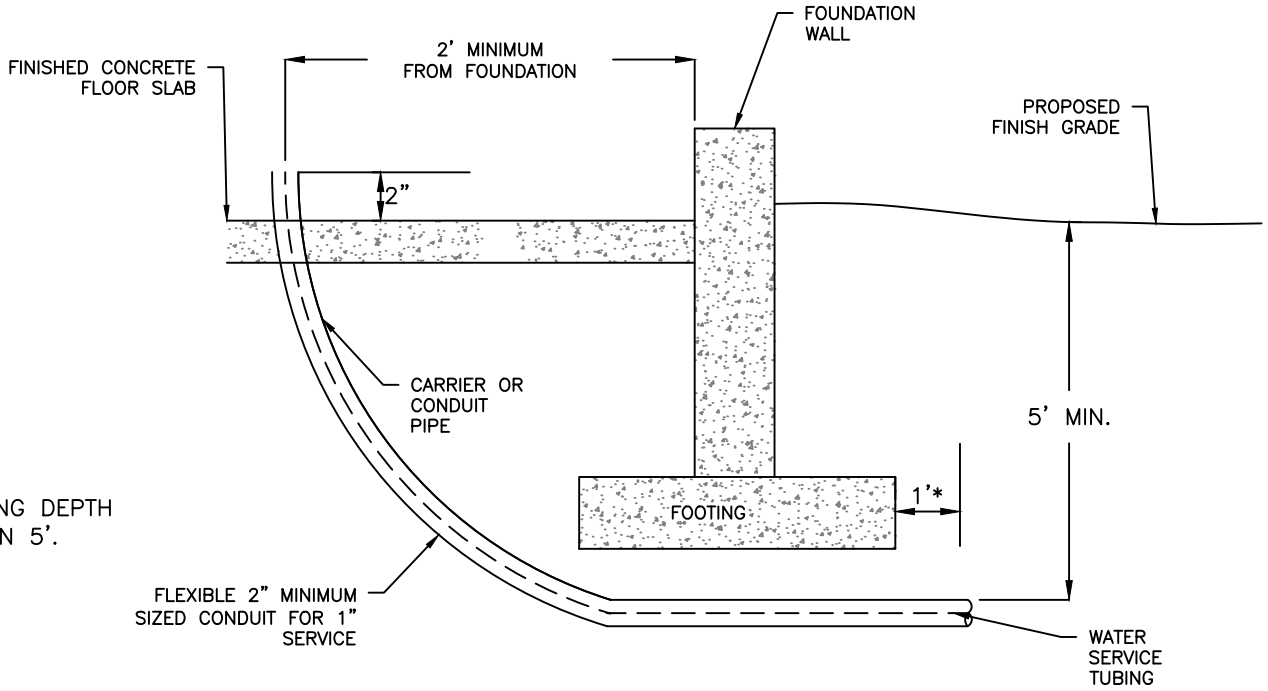
LARGE WATER SERVICE DETAIL

WATER DETAIL W-8C			
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	LARGE WATER SERVICE	MW
ITEM 309.5	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



WHEN FOOTING DEPTH
IS GREATER THAN 5'.

* 1' BEYOND FURTHEST ADJACENT PERMANENT STRUCTURE.
I.E. FOOTING, STEPS, PORCH, DECK, ETC.



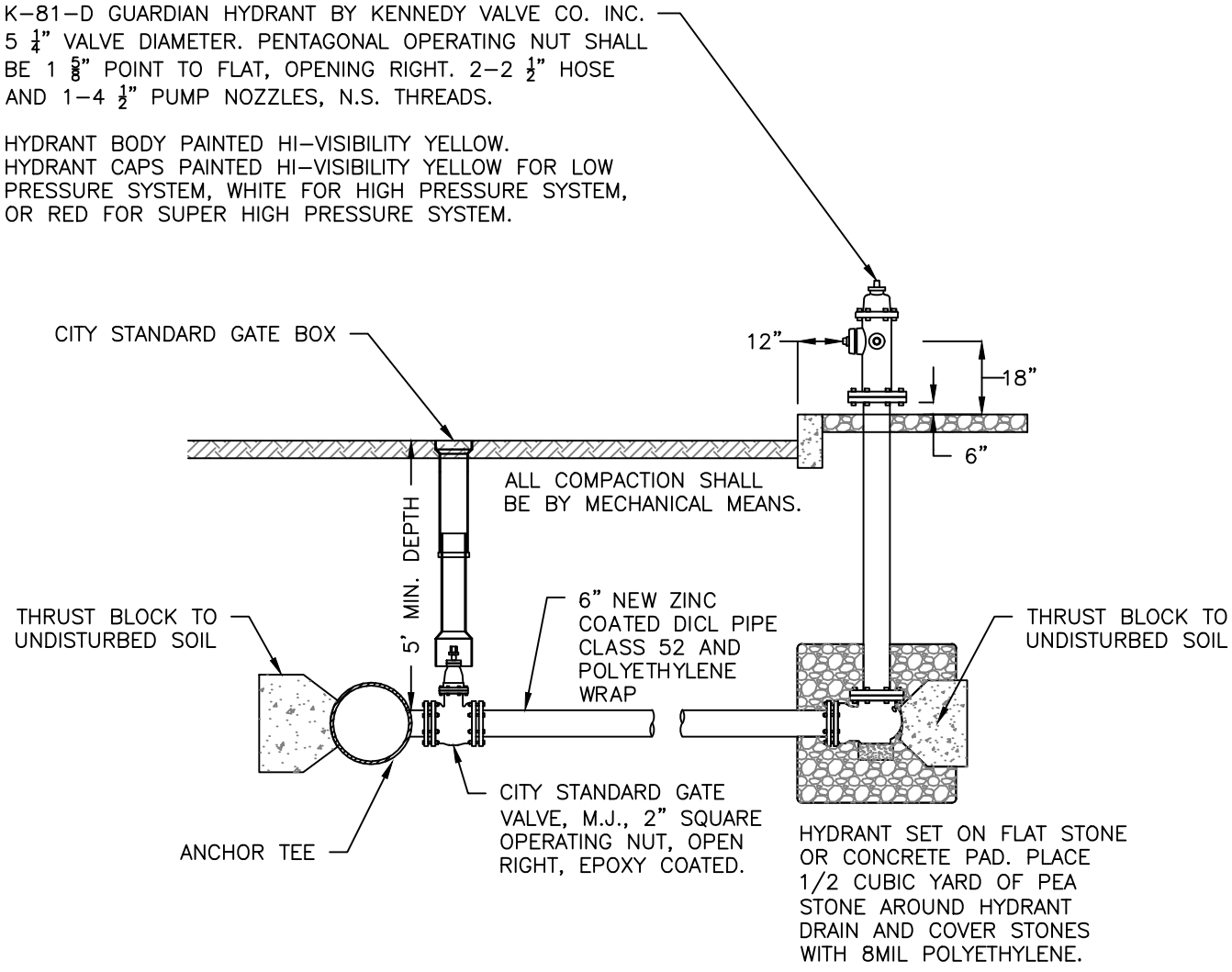
WHEN FOOTING DEPTH
IS LESS THAN 5'.

GENERAL NOTES – 1" WATER SERVICE CONDUIT

1. WHEN ANY WATER SERVICE 1 INCH OR LESS IS TO BE INSTALLED UNDER A CONCRETE FLOOR SLAB, THE PIPE SHALL BE INSTALLED INSIDE AN APPROVED CONDUIT. THIS CONDUIT SHALL BE USED AS A SLEEVE OR CARRIER PIPE TO RECEIVE THE PROPOSED WATER SERVICE TUBING. *THIS CONDUIT SHALL BE EXTENDED 1 FOOT BEYOND FURTHEST ADJECENT PERNAMENT STRUCTURE. I.E. FOOTING, STEPS, PORCH, DECK, ETC.
2. THE SIZE OF THE CONDUIT SHALL BE AT LEAST TWICE THE DIAMETER OF THE WATER SERVICE PIPE BEING INSTALLED.

WATER SERVICE ENTRANCE

WATER DETAIL W-8D			
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	WATER SERVICE ENTRANCE	MW
ITEM 309	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



HYDRANT INSTALLATION DETAIL

WATER DETAIL W-9			
FEBRUARY 26, 2025			
ITEM 310.1-310.5 - HYDRANTS			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

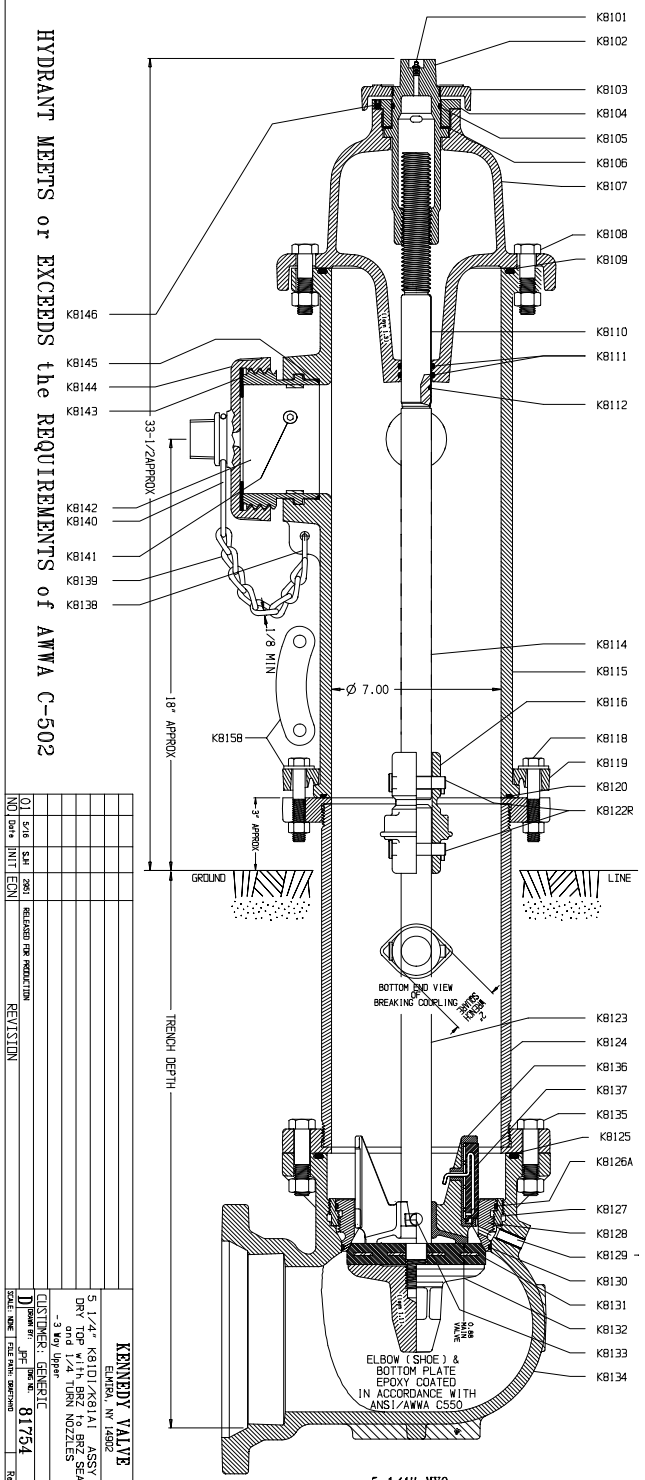
NO.	DATE	DESCRIPTION	BY
1	12/2/2025	HYDRANT DETAIL	MW

AWWA GUARDIAN HYDRANT

KENNEDY VALVE

Division of McWane, Inc

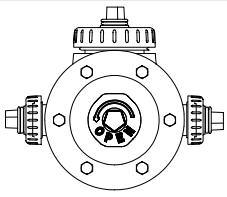
HYDRANT MEETS or EXCEEDS the REQUIREMENTS of AWWA C-502



5 1/4" MVO

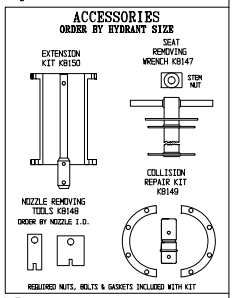
Drain holes are shown rotated 90° for clarity.

6" MECHANICAL JOINT ELBOW SHOWN IN DUCTILE IRON, ASTM A536 70-50-5. 8" MJ FLANGED & PUSH ON ALSO AVAILABLE, BUT IN GRAY IRON, ASTM A126 CLASS B MAT'L.



TWO HOSE & ONE STEAMER SHOWN,
TWO HOSE at 90 deg and OTHER CONFIGURATIONS AVAILABLE

ACCESSORIES
ORDER BY HYDRANT SIZE



REQUIRED NUTS, BOLTS & GASKETS INCLUDED WITH KIT

PARTS LIST

	DETAIL	PART	MATERIAL	ASTM SPEC (or as stated)
	K8101	ALEMITE FITTING	STAINLESS STEEL	A276 (304)
†	K8102	OPERATING STEM NUT	BRONZE	B584 C87850
	K8103	DIRT SHIELD	CAST IRON	A126 CLASS B
	K8104	STEM LOCK NUT	BRONZE	B584 C87850
†	K8105	O-RING	VITON	D2000
†	K8106	THRUST WASHER	NYLATRON GS	MIL LP-410
	K8107	HYDRANT CAP	DUCTILE IRON	A536 GRADE 70-50-5
	K8108	CAP BOLTS & NUTS	STEEL(ZINC PLATED)	A 307/SAE GRADE 2
†	K8109	CAP SEAL	RUBBER	D2000
*	K8110	STEM FERRULE	BRASS	B135 C26000
†	K8111	O-RING	BUNA-N (SYN. RUBBER)	D2000
*	K8112	O-RING	BUNA-N (SYN. RUBBER)	D2000
	K8114	UPPER STEM	COLD DRAWN STEEL	A108 C1018/C1020
	K8115	UPPER BARREL	DUCTILE IRON	A536 GRADE 70-50-5
	K8116	STEM BREAKING COUPLING	CAST IRON	A126 CLASS B
	K8118	BOLTS & NUTS	STEEL (ZINC PLATED)	A 307/SAE GRADE 2
	K8119	BREAKING RING	DUCTILE IRON	A536 GRADE 70-50-5
	K8120	O-RING	BUNA-N (SYN. RUBBER)	D2000
	K8122R	COUPLING PINS	STAINLESS STEEL	302HQ
	K8123	LOWER STEM	COLD DRAWN STEEL	A108 C1018/C1020
	K8124	LOWER BARREL	DUCTILE IRON	ANSI/AWWA C151/A21.51
†	K8125	ELBOW SEAL	RUBBER	D2000
†	K8126A	O-RING	BUNA-N (SYN. RUBBER)	D2000
*	K8127	SEAT RING INSERT	BRONZE	B806 C95400 or B584 C90833
†	K8128	SEAT RING	BRONZE	B584 C90833 or C87850
	K8129	DRAIN TUBE	BRASS	B135 C23000
†	K8130	O-RING	BUNA-N (SYN. RUBBER)	D2000
†	K8131	MAIN VALVE	E.P.D.M. w\ STEEL INSERT	D2000
	K8132	BOTTOM PLATE	CAST IRON	A126 CLASS B
	K8133	DRAIN VALVE PIN	STAINLESS STEEL	410/416
	K8134	ELBOW	DUCTILE IRON	A536 GRADE 70-50-5
	K8135	ELBOW BOLTS AND NUTS	18-8 STAINLESS STEEL	F593/F594
†	K8136	DRAIN VALVE	ALUMINUM BRONZE	B806 C95400/C95500
	K8137	DRAIN VALVE FACING w/INSERT	EPDM, SBR, or BUNA-N w/SST	D2000/A276 (304)
	K8138	NOZZLE CHAIN "S" HOOK	ZINC PLATED STEEL	A108
*	K8139	NOZZLE CAP CHAIN W/3 BANDS	ZINC PLATED STEEL	A108
#	K8140	HOSE NOZZLE	BRONZE	B806 C95400 or B584 C90833
†	K8141	NOZZLE RETAINING SCREW	STAINLESS STEEL	A276 (304)
#	K8142	NOZZLE	BRONZE	B806 C95400 or B584 C90833
#	K8143	NOZZLE CAP GASKET	NEOPRENE	D 2000
#	K8144	NOZZLE CAP	CAST IRON	A126 CLASS B
† #	K8145	O-RING	BUNA-N (SYN. RUBBER)	D2000
	K8146	ALLEN HEAD SET SCREW	STAINLESS STEEL	A276 (410)
†	K8147	SEAT REMOVAL WRENCH		
	K8148	NOZZLE REMOVAL TOOLS		
†	K8149	COLLISION REPAIR KIT		
	K8150	GRADE EXTENSION KIT		
	K8158	BREAKER RING STRAP	STEEL	

* Denotes that part is available only as part of an assembly.
\# Must specify type of Nozzle, Hose or Steamer.
† Recommended spare parts.

NOZZLE ARRANGEMENTS
2 HOSE & 1 STEAMER
2 HOSE at 90°
2 STEAMERS at 90°
4 HOSE at 90°

KENNEDY
K81-DI
MARKING
FRONT HALF UPPER
OF "DUAL RATED"
HYDRANTS
NOT ALL HYDRANTS AVAILABLE
UL LISTED/FM APPROVED
CONSULT FACTORY

KENNEDY
ELMIRA, NY
AWWA
K81-AI
MARKING
FRONT HALF UPPER
OF AWWA ONLY
HYDRANTS

OPEN DIRECTION
ON DIRT SHIELD

20 16
CURRENT YEAR
ON FRONT

5 1/4
SIZE

KENNEDY
ELMIRA, NY
AWWA
350 CWP
MARKING
BACK HALF ALL UPPERS

The GUARDIAN Hydrant meets or exceeds all requirements of AWWA C-502.

SPECIFICATIONS

CUSTOMER: GENERIC	
Spec: -----	
No TURNS\DIRECTIO OPEN: 15 1\2-OPEN LEFT	
CAP & OPERATING NUT SHAPE - SIZE: 1-1/2" PENTAGON	
HOSE NOZZLE THDS: TWO - 2 1/2" NST (Ref NFPA No 1963)	
STEAMER NOZZLE THDS:	4-1/2" NST (Ref NFPA No 1963)
TRENCH DEPTH:	PER ORDER
SIZE & TYPE of PIPE CONN. to MAIN:	PER ORDER

PAINT: PER ORDER	

OTHER: -----	

--	

NO	Date	INIT	ECN	REVISION
01	5/16	SJH	2951	RELEASED FOR PRODUCTION

KENNEDY VALVE
ELMIRA, NY 14902

5 1/4" K81D(A)(I) ASSY DWG
DRY TOP with BRZ SEAT
and 1/4 TURN NOZZLES
-3 Way Upper

CUSTOMER: GENERIC

DRAWN BY:	DWG NO.	Revision
DJ	81754	01

SCALE: NONE | FILE Path: SWORKING

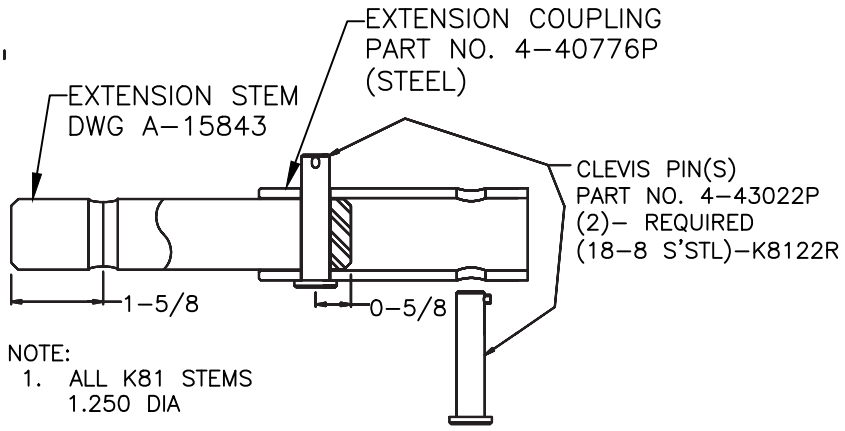
HYDRANT

FEBRUARY 26, 2025			
ITEM 310.1-310.5 - HYDRANTS			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

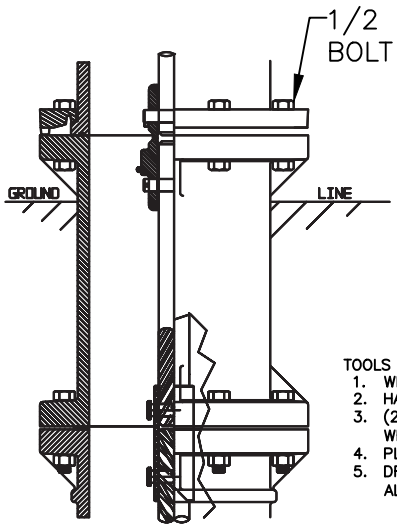
NO.	DATE	DESCRIPTION	BY
1	3/3/25	HYDRANT ITEMS	JN

EXTENSION STEM INSTALLATION



NOTE:
1. ALL K81 STEMS 1.250 DIA

K81 SPOOL INSTALLATION



TOOLS REQUIRED:
1. WIRE SCRATCH BRUSH
2. HAMMER
3. (2)–8" ADJUSTABLE WRENCH(S)
4. PLIERS
5. DRIFTER (FOR HOLE ALIGNMENT)

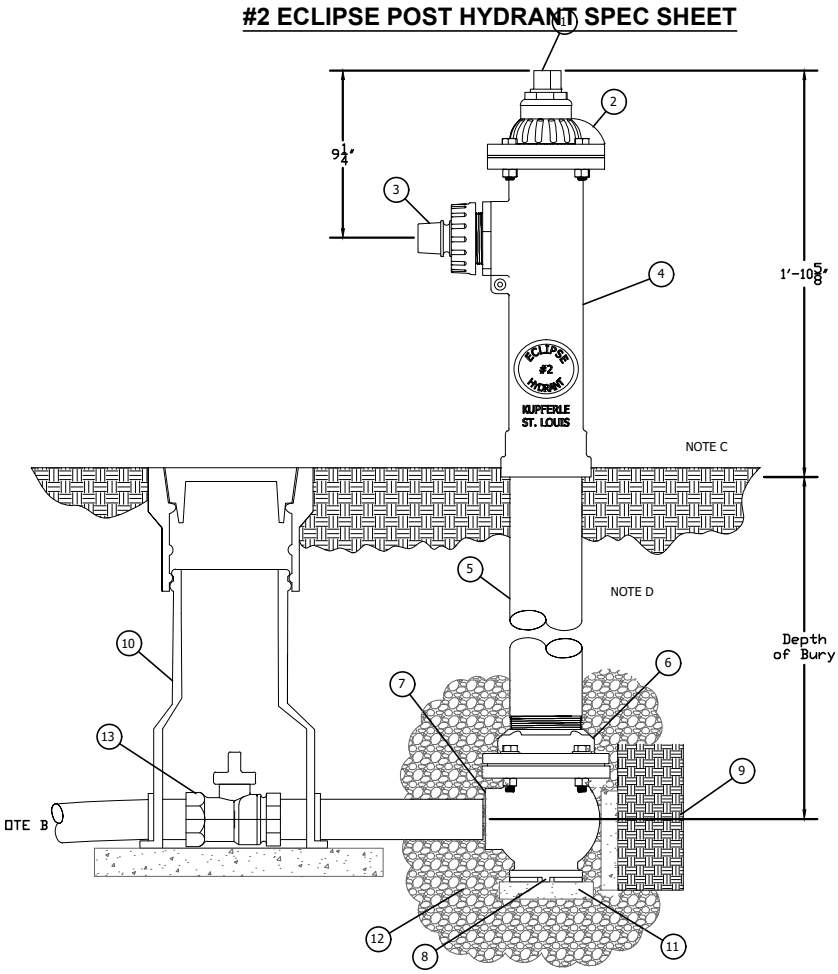
NOTE: IT IS PREFERABLE TO BE ABLE TO TURN THE WATER PRESSURE ON AND OFF. IF THE WATER PRESSURE IS LOW, IT IS POSSIBLE THAT THE HYDRANT WILL BE OPENED WHEN REMOVING THE UPPER.

1. MAKE CERTAIN THAT THE HYDRANT IS CLOSED. THE WATER MAY REMAIN ON, BUT SEE ABOVE NOTE
2. REMOVE THE EIGHT 1/2–UNC BOLTS & NUTS THAT RETAIN THE BREAKING RINGS.
3. TURN THE OPERATING NUT IN THE OPENING DIRECTION UNTIL THE THREADED STEM DISENGAGES FROM THE OPERATING NUT. (THIS WILL LIFT THE UPPER AWAY FROM THE FLANGE).
4. LIFT THE COMPLETE HYDRANT UPPER STAND–PIPE ASSEMBLY AND DONE FROM THE STEM LIST THIS ASSEMBLY STRAIGHT UP ABOUT 12" TO AVOID DAMAGING THE O–RINGS THAT SEAL THE STEM AND REMOVE THE COMPLETE UPPER ASSEMBLY
5. DISENGAGE THE LOWER STEM FROM THE UPPER STEM. REMOVE THE LOWER CLEVIS PIN THAT RETAINS THE LOWER STEM TO THE BREAKING COUPLING.
6. WIRE BRUSH THE EXPOSED FLANGE OF THE LOWER STAND–PIPE UNTIL ALL DIRT AND BUILT UP RUST IS REMOVED.
7. WIRE BRUSH THE END OF THE LOWER STEM AND ATTACH THE EXTENSION STEM COUPLING TO THE LOWER STEM EXACTLY AS ILLUSTRATED.
8. ATTACH THE UPPER STEM TO THE EXTENSION STEM IN EXACTLY THE SAME WAY THAT IT WAS PREVIOUSLY ATTACHED TO THE LOWER STEM.
9. PLACE THE GASKET FOR THE EXTENSION SPOOL ON THE EXPOSED FLANGE OF THE LOWER STAND–PIPE. RETAIN THE GASKET WITH GREASE TO KEEP IT FROM SHIFTING.
10. PLACE THE EXTENSION SPOOL ON THE LOWER STAND–PIPE AND ALIGN THE BOLT HOLES.
11. INSERT THE BOLTS PROVIDED IN THE HOLES. START THE NUTS PROVIDED ON THE BOLTS. TIGHTEN THE BOLTS WRIST TIGHT ONLY THEN TIGHTEN THEM SECURELY (70 FT–LB), PROCEEDING IN A SIDE TO SIDE PATTERN THAT ASSURES THAT THE PRESSURE ON THE GASKET IS UNIFORM.
12. CAREFULLY LIFT THE COMPLETE UPPER ASSEMBLY UP ABOVE THE UPPER STEM AND LOWER IT ONTO THE UPPER STEM, TAKING CARE NOT TO CUT THE O–RINGS IN THE DOME.
13. TURN THE OPERATING NUT IN THE CLOSED DIRECTION UNTIL THE BOTTOM OF THE STAND PIPE JUST TOUCHED THE FLANGE.
14. ALIGN THE HYDRANTS AND REPLACE THE BREAKING RINGS IN THE ORIGINAL POSITION. 2-10
15. REPLACE THE BOLTS IN THE BREAKING RINGS IN THE ORIGINAL POSITION.
16. START THE NUTS ON THE BOLTS AND TIGHTEN THE BOLTS PER STEP 11 EXCEPT THAT THE TORQUE SHOULD BE 40 FT–LB.

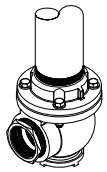
K81-D HYDRANT EXTENSION KIT K8150 INSTALLATION

FEBRUARY 26, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/3/25	HYDRANT ITEMS	JN
ITEM 310.1-310.5 - HYDRANTS		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

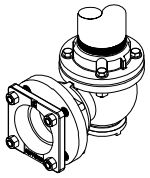
#2 ECLIPSE POST HYDRANT SPEC SHEET



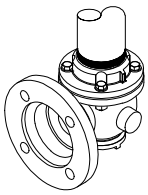
1 #2 STANDARD INSTALL VIEW
Scale: 3"=1'



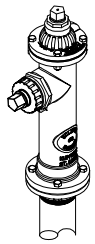
A 2" FIP INLET
Scale: 1"=1'



D 3" MJ INLET
Scale: 1"=1'



E 4" MJ INLET
Scale: 1"=1'



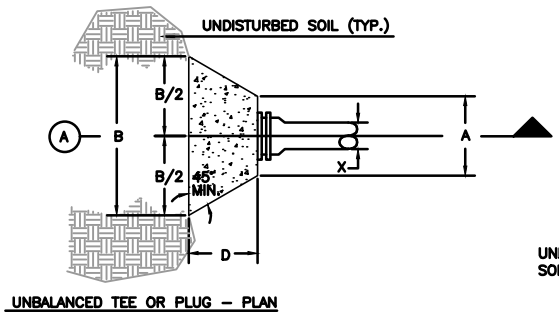
F 1 NOZZLE BOLTED FLANGE TOP STOCK
Scale: 3/4"=1'

ITEM	DESCRIPTION	NOTES
1	OPERATING SCREW	
2	TOP CAP	
3	SIDE CAP	
4	TOP STOCK	
5	3-1/2" FBE COATED STEEL PIPE	
6	COUPLING	
7	INLET VALVE BODY	
8	DRAIN HOLE	
9	UNDISTURBED EARTH	BY OTHERS
10	VALVE BOX	BY OTHERS
11	THRUST BLOCKS	BY OTHERS
12	CRUSHED ROCK	BY OTHERS
13	HYDRANT SHUT-OFF VALVE	BY OTHERS

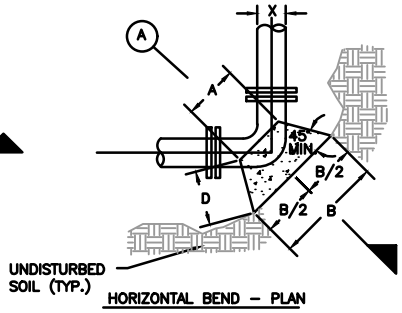
#2 ECLIPSE POST HYDRANT SHALL BE SELF-DRAINING, NON-FREEZING, COMPRESSION TYPE WITH 2-3/16" MAIN VALVE OPENING. INLET CONNECTION SHALL BE 2" FIP STANDARD. OUTLET SHALL BE 2-1/2" NST STANDARD. STANDARD DEPTH OF BURY IS 3'.
ALL WATER FLOW SHALL PASS THROUGH A 3-1/2" FBE COATED STEEL PIPE AND CAST IRON TOP STOCK WATER WAY.
ALL WORKING PARTS SHALL BE SERVICEABLE FROM ABOVE GROUND WITH NO DIGGING OR REPLACEMENT NEEDED.
HYDRANT SHALL BE SET IN 4 CUBIC FEET OF CRUSHED STONE TO ALLOW FOR PROPER DRAINAGE OF HYDRANT. RECOMMENDATION OF THE AWWA SHOULD BE FOLLOWED WHEN INSTALLING THE HYDRANT.

SINGLE PORT BLOW OFF
#2 ECLIPSE POST HYDRANT SPEC SHEET

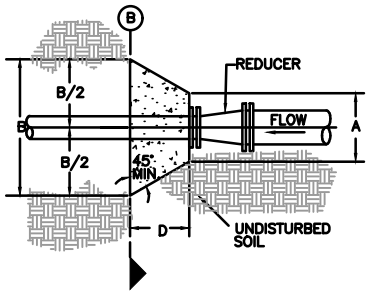
WATER DETAIL W-13B			
FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/5/25	HYDRANT ITEMS	JN
ITEM 310.1-310.5 - HYDRANTS	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



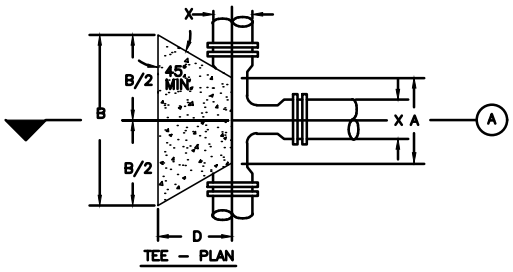
UNBALANCED TEE OR PLUG – PLAN



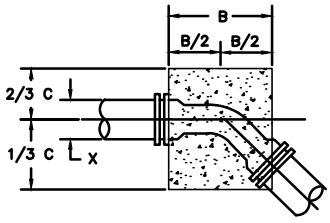
HORIZONTAL BEND – PLAN



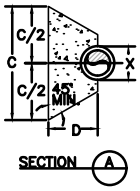
REDUCER – PLAN



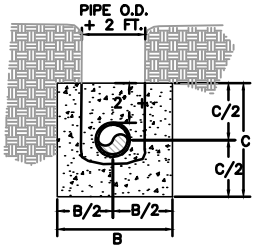
TEE – PLAN



VERTICAL BEND – ELEVATION



SECTION A



SECTION B

Line Pressure = 150 PSI Soil Pressure = 2000 PSF 90 DEGREE BEND					
Pipe Size	A	B	C	D	VOL. CONC.
4"	0'–10"	1'–11"	1'–11"	1'–6"	4± CF
6"	0'–10"	1'–11"	1'–11"	1'–6"	4± CF
8"	0'–10"	2'–7"	2'–7"	1'–6"	7± CF
12"	0'–10"	3'–10"	3'–10"	1'–6"	14± CF

Line Pressure = 150 PSI Soil Pressure = 2000 PSF 22–1/2 DEGREE BEND					
Pipe Size	A	B	C	D	VOL. CONC.
4"	0'–10"	1'–0"	1'–0"	1'–0"	1± CF
6"	0'–10"	1'–0"	1'–0"	1'–0"	1± CF
8"	0'–10"	1'–4"	1'–4"	1'–0"	1.5± CF
12"	0'–10"	2'–0"	2'–0"	1'–0"	3± CF

Line Pressure = 150 PSI Soil Pressure = 2000 PSF TEE & PLUG					
Pipe Size	A	B	C	D	VOL. CONC.
4"	0'–10"	1'–8"	1'–8"	1'–3"	3± CF
6"	0'–10"	1'–8"	1'–8"	1'–3"	3± CF
8"	0'–10"	2'–2"	2'–2"	1'–3"	4± CF
12"	0'–10"	3'–3"	3'–3"	1'–3"	8± CF

45 DEGREE BEND					
4"	0'–10"	1'–6"	1'–6"	1'–0"	2± CF
6"	0'–10"	1'–6"	1'–6"	1'–0"	2± CF
8"	0'–10"	1'–11"	1'–11"	1'–0"	3± CF
12"	0'–10"	2'–10"	2'–10"	1'–0"	5± CF

11–1/4 DEGREE BEND					
4"	0'–10"	0'–10"	0'–10"	1'–0"	0.7± CF
6"	0'–10"	0'–10"	0'–10"	1'–0"	0.7± CF
8"	0'–10"	1'–0"	1'–0"	1'–0"	1± CF
12"	0'–10"	1'–6"	1'–6"	1'–0"	2± CF

NOTES :

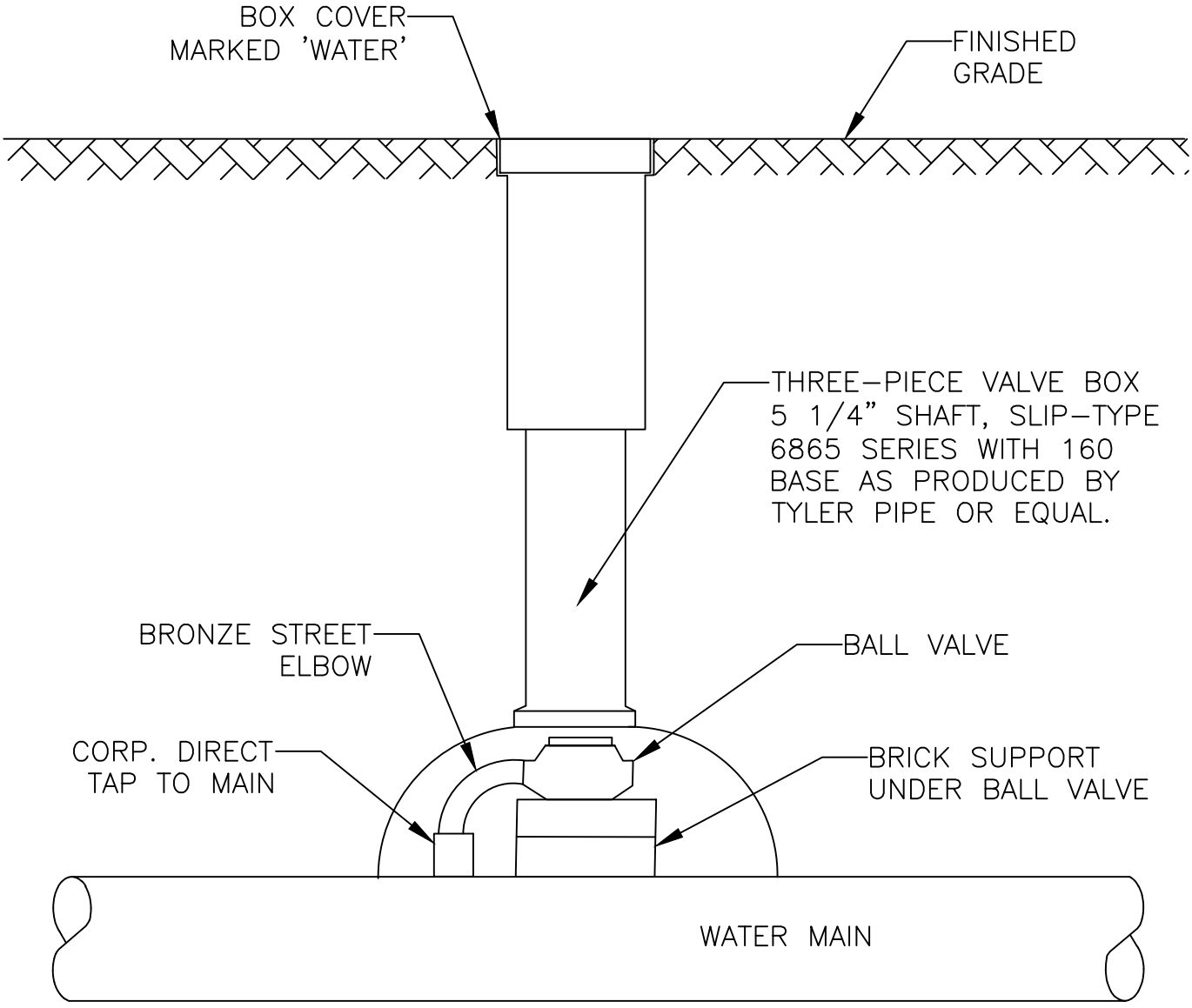
1. BLOCKING SHALL BE 3000 PSI CONCRETE.
2. 50lb FELT PAPER TO BE PLACED BETWEEN CONCRETE AND ALL PIPE SURFACES.
3. THE WATER LINE MUST BE LOWERED IN ORDER TO HAVE 4'–6" OF COVER AT THE BEND, TEE, REDUCER OR PLUG AT ALL LOCATIONS WHERE THESE FITTINGS ARE UTILIZED.

THRUST BLOCK DETAILS

WATER DETAIL W-12
MARCH 5, 2025
ITEM 313.1-313.2
NOT TO SCALE
SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/5/25	THRUST BLOCK	JN

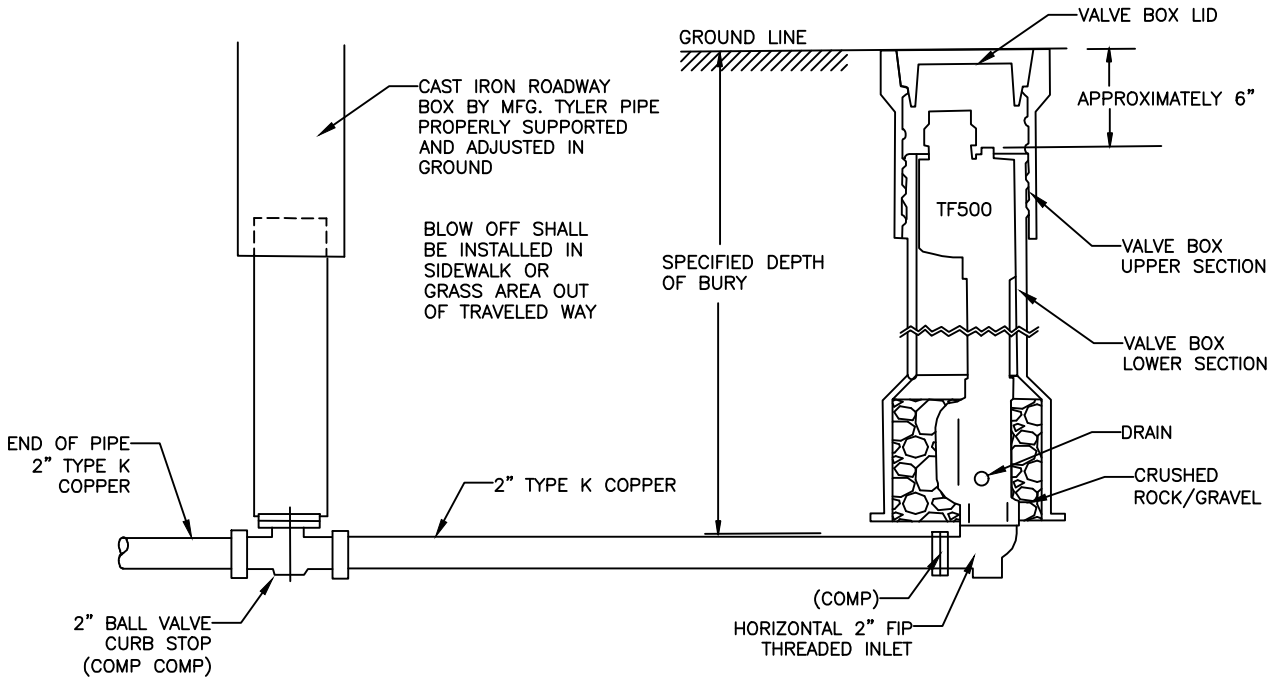


CONFIRM SIZE WITH CITY OF WORCESTER
WATER OPERATIONS ENGINEER

1"-2" MANUAL AIR RELEASE

DECEMBER 2, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604		
ITEM 314.1 - 1"-2": AIR RELEASE			
NOT TO SCALE			
SHEET 1 OF 1			

NO.	DATE	DESCRIPTION	BY
1	12/2/2025	1"–2" AIR RELEASE	MW



INSTALLATIONS NOTES

INSURE THAT THE HYDRANT IS FREE TO MOVE VERTICALLY WITH THE VALVE BOX. IN ORDER TO PREVENT THE TRANSMISSION OF TRAFFIC LOADS TO THE HYDRANT, IT SHOULD NOT BE JAMMED OR WEDGED AGAINST THE VALVE BOX ID.

THE NORMAL POSITION OF THE TOP OF THE OPENING NUT IS ABOUT 6" BELOW THE TOP OF THE VALVE BOX, BUT YOU CAN FREELY ADJUST THIS POSITION TO SUIT YOUR CIRCUMSTANCES. JUST KEEP IN MIND THAT MAINTENANCE PROCEDURES ARE BEST PERFORMED WHEN THE BOLTS ATTACHING THE TOP CAP ARE WITHIN AN EASY REACH

FOLLOW THE SUGGESTIONS OF THE AWWA FOR HYDRANT INSTALLATION. IN PARTICULAR, SURROUND THE DRAIN PORT WITH A SUFFICIENT AMOUNT OF CRUSHED ROCK/GRAVEL TO PROVIDE AN ADEQUATE DRAIN FIELD.

SAMPLE TF500 SPECIFICATIONS

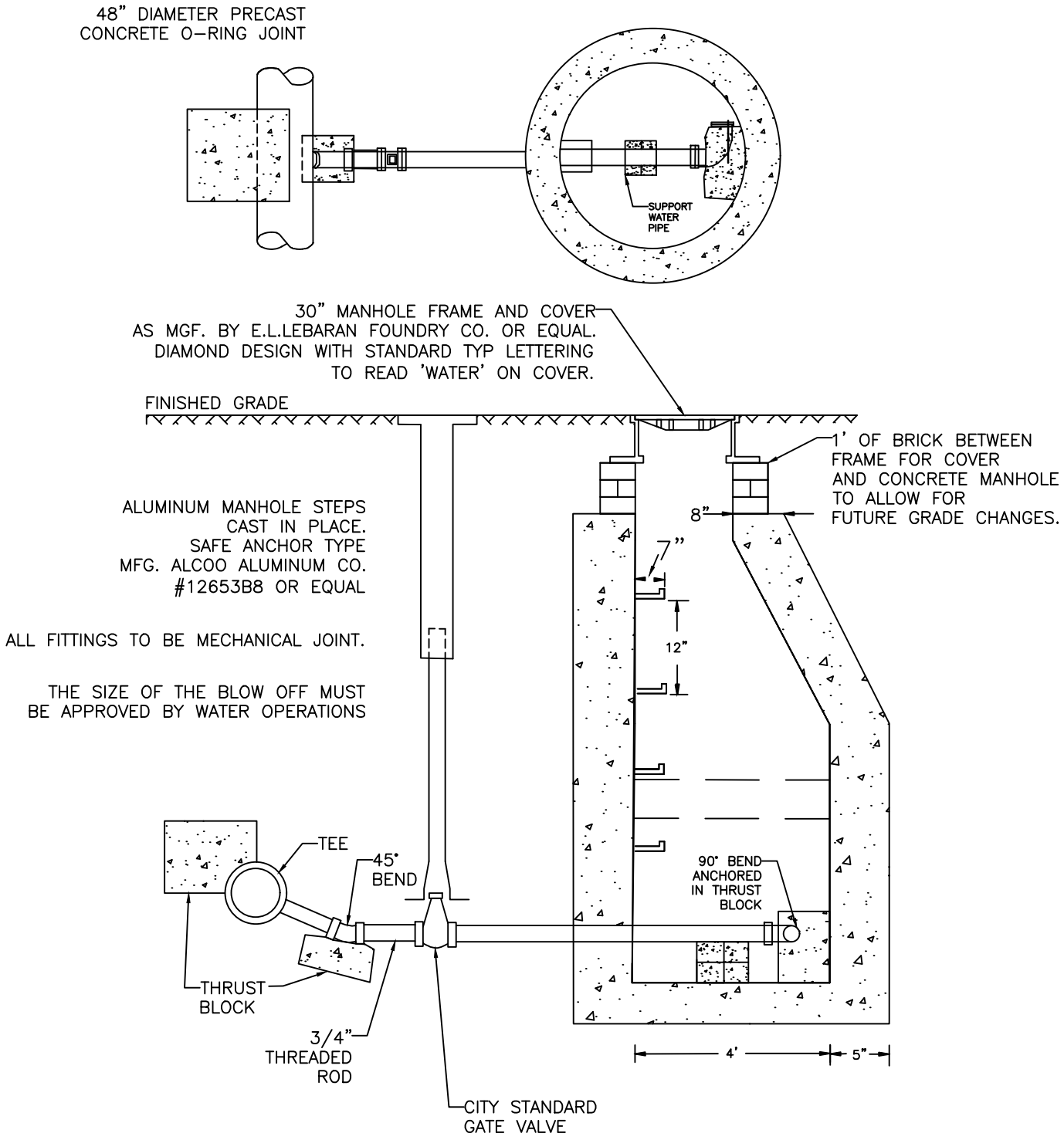
HYDRANT SHALL BE _____' BURY, WITH (2" VERTICAL FIP / 2" HORIZONTAL FIP / 2" MJ) INLET AND 2" NPT NOZZLE OUTLET. HYDRANT SHALL BE NON–FREEZING AND SELF–DRAINING. HYDRANT SHALL BE OPERATED BY TURNING A TOP–MOUNTED 9 /16" SQUARE OPERATING NUT COUNTERCLOCKWISE TO OPEN, CLOCKWISE TO CLOSE. HYDRANT MUST SEAL THE DRAIN OUTLET IN ALL POSITIONS FROM
1 /4 – OPEN TO FULLY–OPEN. ALL INTERNAL WORKING PARTS, THE INLET, AND THE OUTLET SHALL BE LOW–LEAD BRASS. ALL WORKING PARTS SHALL BE SERVICEABLE FROM ABOVE WITH NO DIGGING REQUIRED. ALL WEAR PARTS (O–RINGS AND VALVE SEAT) SHALL BE OF COMMONLY–AVAILABLE DIMENSIONS AND MATERIALS, AND NONE MAY BE OF VENDOR UNIQUE DESIGN. HYDRANT SHALL BE THE TRUFLO MODEL TF500 AS MANUFACTURED BY THE KUPFERLE FOUNDRY CO., ST LOUIS MO 63102 OR EQUAL

BLOW OFF / FLUSHING HYDRANT FOR 2" TYPE K COPPER / END OF PIPE

WATER DETAIL W-13C			
MARCH 11, 2025			
ITEM 314.2 -1" BLOW OFF			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

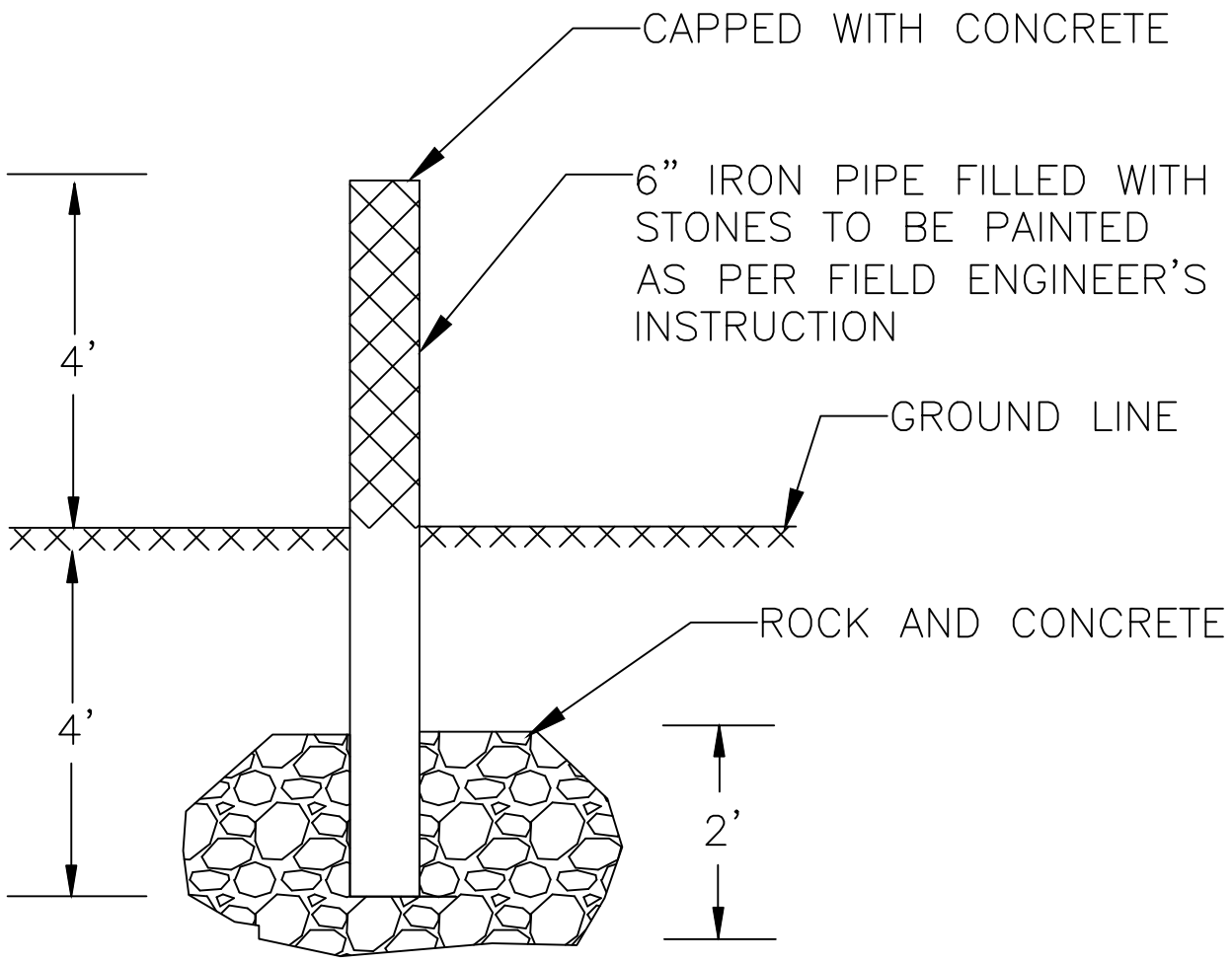
NO.	DATE	DESCRIPTION	BY
1	3/5/25	BLOW OFF / FLUSHING HYDRANT FOR 2" TYPE K COPPER / END OF PIPE	JN



BLOW OFF MANHOLE

WATER DETAIL W-13			
MARCH 10, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**		
ITEM 314.4 - BLOW OFF MANHOLE	**Engineering Division**		
NOT TO SCALE	20 East Worcester St, Worcester MA 01604		
SHEET 1 OF 1			

NO.	DATE	DESCRIPTION	BY
1	3/10/25	BLOW OFF MANHOLE	JN

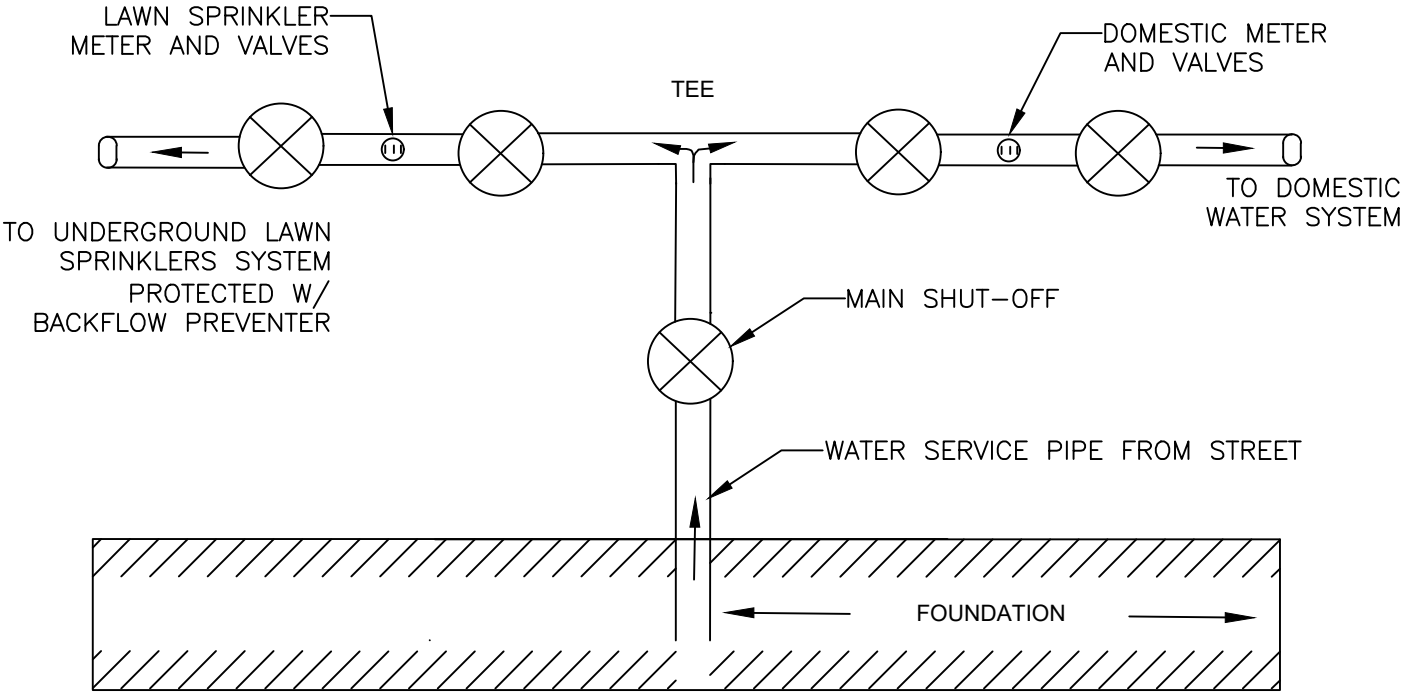


INDICATOR POST

WATER DETAIL W-16			
MARCH 7, 2025			
ITEM 315.1 - INDICATOR POST			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/7/25	INDICATOR POST	JN



IMPORTANT:

1. CONSULT LOCAL CODES FOR APPROPRIATE MANDATORY BACKFLOW PREVENTION DEVICE TO BE USED IN CONJUNCTION WITH LAWN SPRINKLER SYSTEM
2. CONSULT LOCAL CODES FOR APPROPRIATE CONTAINMENT BACKFLOW PREVENTION DEVICE TO BE USED ON DOMESTIC WATER SYSTEM

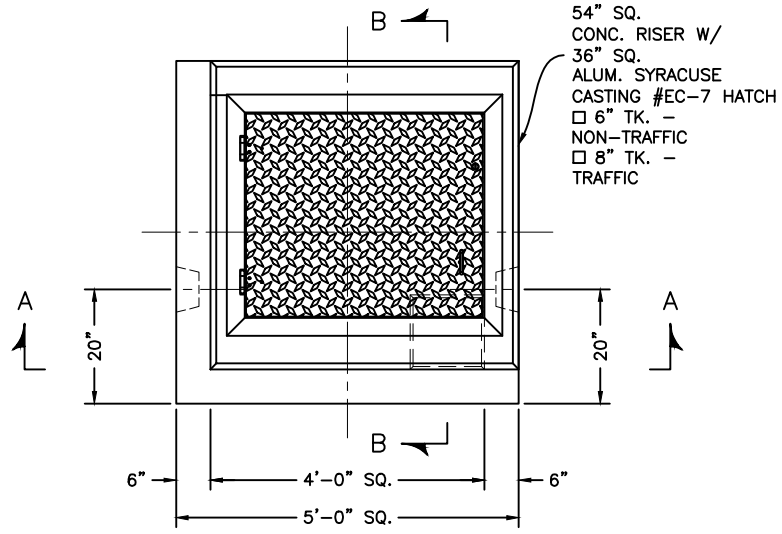
NOTES:

1. BOTH WATER METERS INSTALLED BY WATER OPERATIONS AT THE OWNERS EXPENSE
2. METERS WILL BE MAINTAINED BY WATER OPERATIONS
3. LAWN SPRINKLERS METERS SHALL BE BILLED WATER ONLY

TYPICAL LAWN SPRINKLER SYSTEM METER INSTALLATION

MARCH 7, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/7/25	TYPICAL LAWN SPRINKLER METER INSTALLATION	JN
ITEM 324 - TYPICAL LAWN SPRINKLER METER INSTALLATION	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

(1½" – 2" WMP)



TOP VIEW

NOTE:
TRAFFIC LOADED ALUMINUM HATCHES ARE NOT DESIGNED FOR PLACEMENT IN DELIBERATE TRAFFIC AREAS. IF REQUIRED – UPGRADE TO GALVANIZED STEEL.

☐ A: SPECIFICATIONS:

CONCRETE:	4,000 P.S.I. @ 28 DAYS
ENTRAINED AIR:	5%–9%
STEEL:	A.S.T.M. A496–A615 GRADE 60–60 KSI.
DESIGN LOADING:	A.A.S.H.T.O. HS–20–44 WITH 30% IMPACT AND EQUIVALENT SOIL PRESSURE OF 130 (PSF). FLOTATION FORCES NOT ACCOUNTED FOR. 6" ROOF & BASE.

☐ B: SPECIFICATIONS:

CONCRETE:	4,000 P.S.I. @ 28 DAYS
ENTRAINED AIR:	5%–9%
STEEL:	A.S.T.M. A496–A615 GRADE 60–60 KSI.
DESIGN LOADING:	A–0.3/300KSI/WALKWAYS FLOTATION FORCES NOT ACCOUNTED FOR. 6" ROOF & BASE.
WEIGHT:	TOP SECTION: 4,970 LBS. BOTTOM SECTION: 7,904 LBS. TOTAL: 12,874 LBS.

☐ HOLES – CONTRACTOR TO GROUT

☐ WATERTIGHT BOOT SEAL

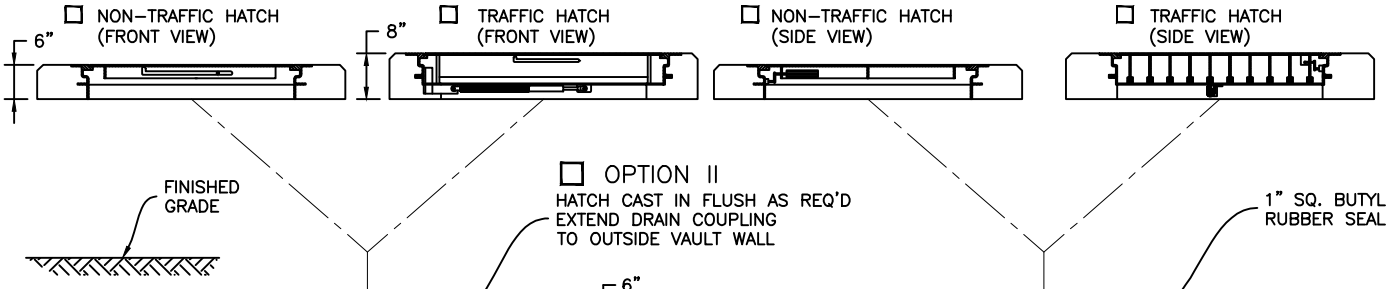
☐ LINK SEAL WITH STEEL SLEEVE

☐ LADDER ONLY

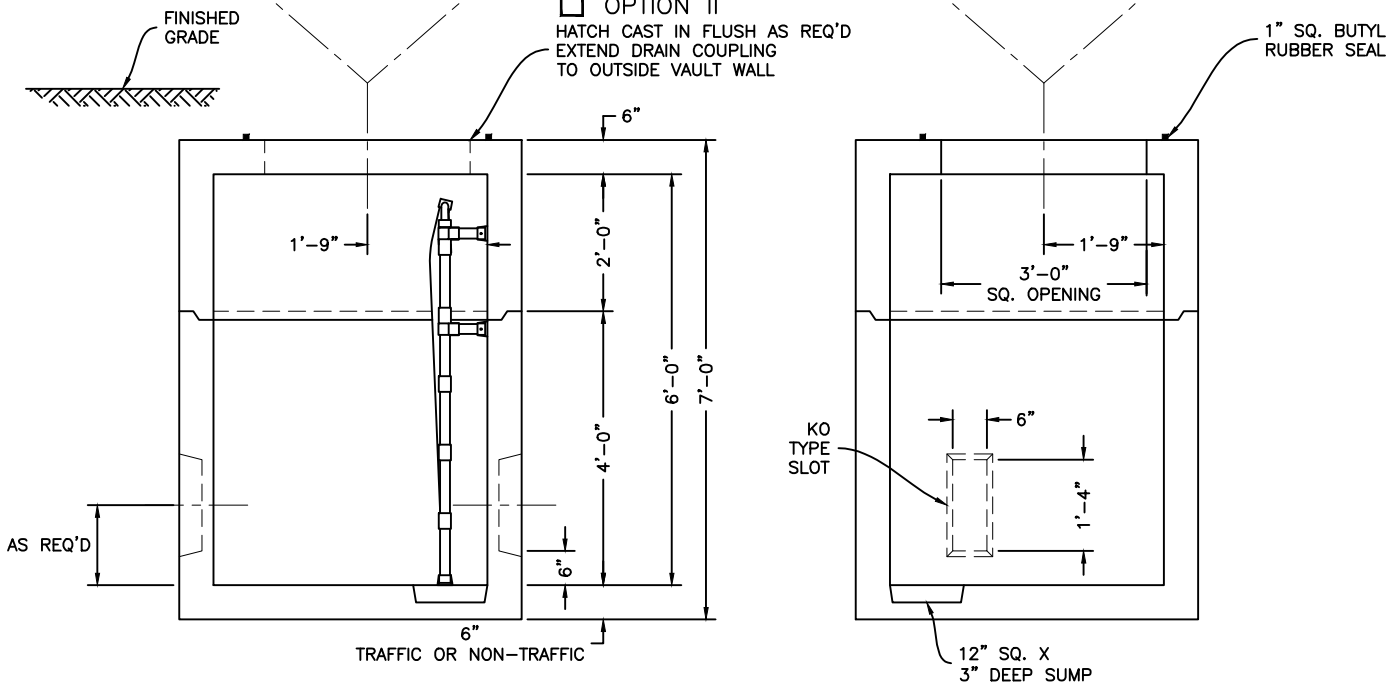
☐ LADDER WITH INTEGRAL LADDER UP POST

☐ LADDER WITH SEPARATE LADDER UP POST

☐ OPTION I



☐ OPTION II



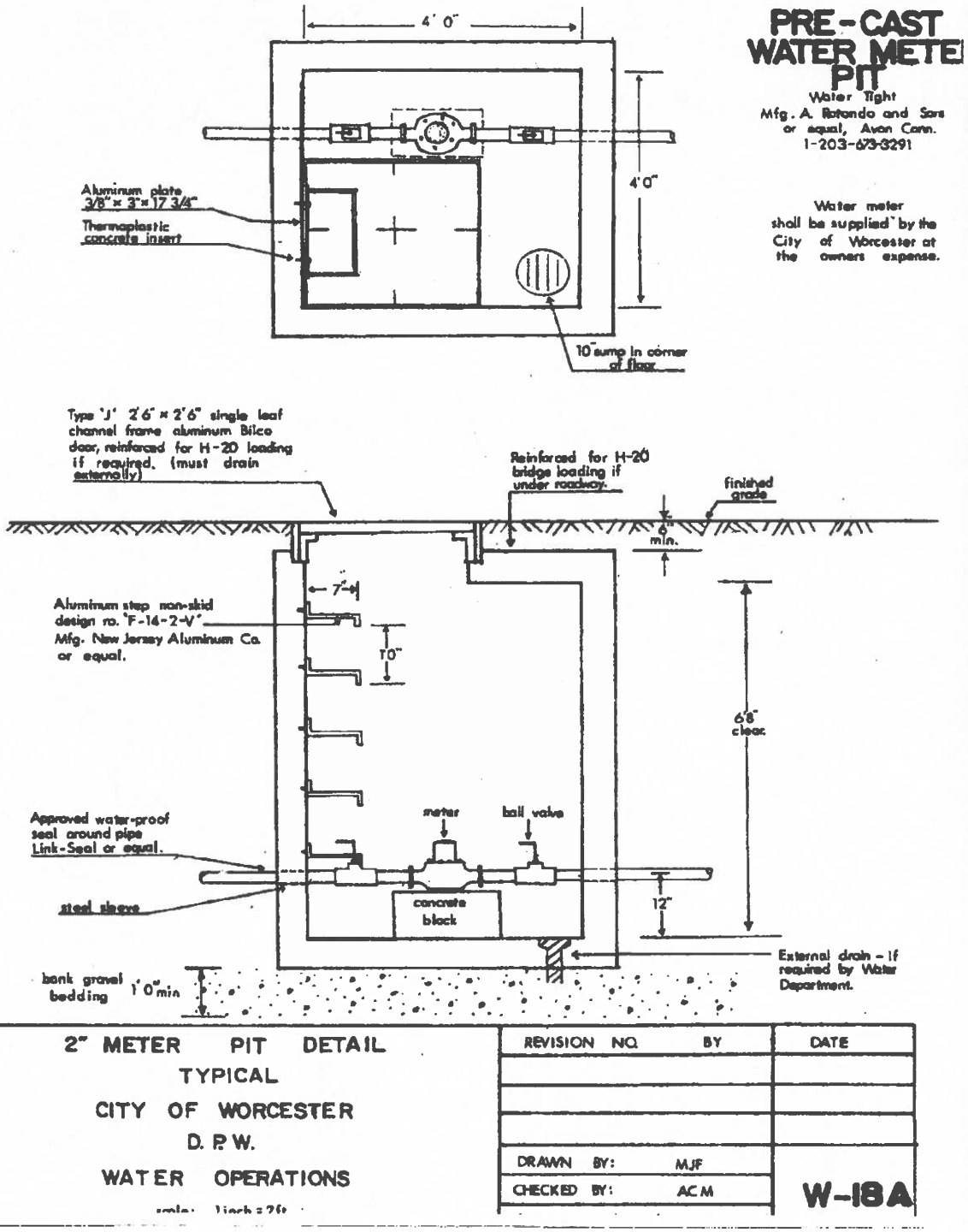
SECTION A–A

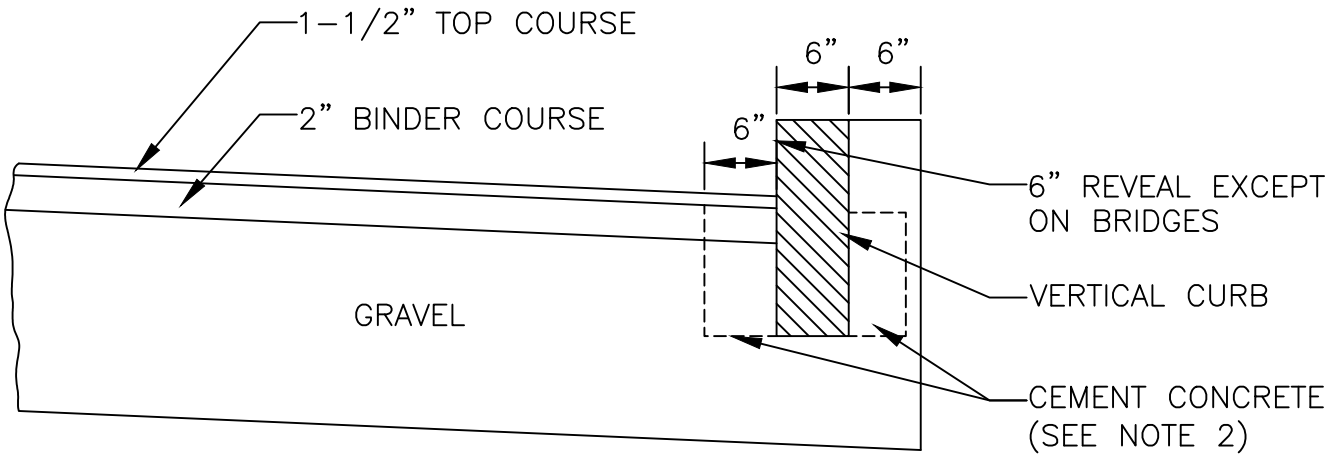
SECTION B–B

WATER DETAIL W-18A
MARCH 21, 2025
2" METER PIT DETAIL TYPICAL
NOT TO SCALE
SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	03/25	2" METER PIT DETAIL TYPICAL	MCR


PRE-CAST WATER METER PIT
Water Tight
Mfg. A. Rotondo and Sons or equal, Avon Conn. 1-203-673-3291
Water meter shall be supplied by the City of Worcester at the owners expense.
4' 0"
4'0"
Aluminum plate 3/8" x 3" x 17 3/4"
Thermoplastic concrete insert
10" sump in corner of floor
Type 'J' 2'6" x 2'6" single leaf channel frame aluminum Bilco door, reinforced for H-20 loading if required. (must drain externally)
Reinforced for H-20 bridge loading if under roadway.
finished grade
6" min.
7"
Aluminum step non-skid design no. "F-14-2-V" Mfg. New Jersey Aluminum Co. or equal.
10"
6'8" clear
meter
ball valve
Approved water-proof seal around pipe Link-Seal or equal.
steel sleeve
concrete block
12"
External drain - if required by Water Department.
bank gravel bedding
1'0" min
2" METER PIT DETAIL
TYPICAL
CITY OF WORCESTER
D. P. W.
WATER OPERATIONS
REVISION NO.
BY
DATE
DRAWN BY: MJF
CHECKED BY: ACM
W-18A



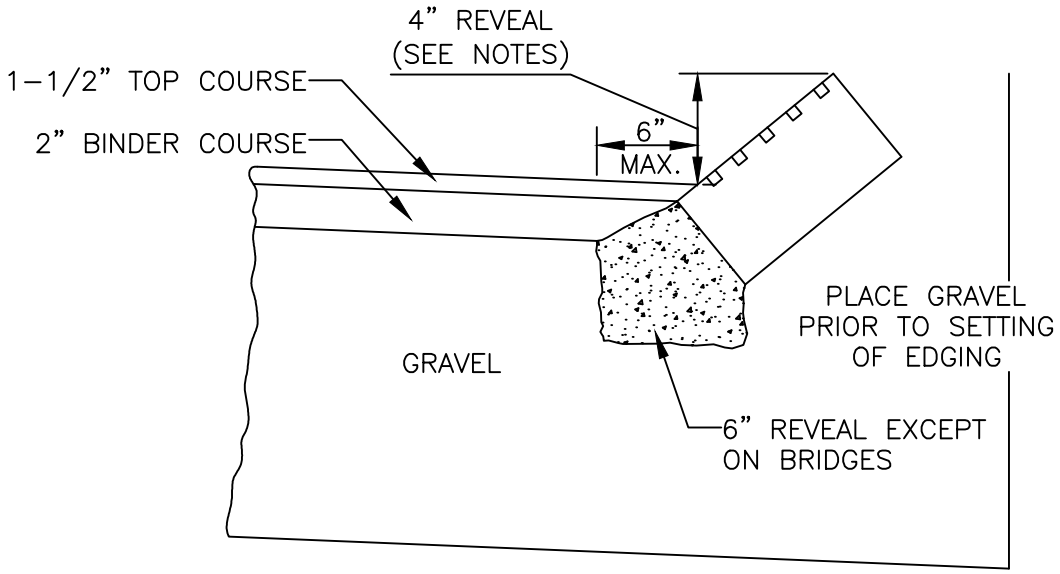
NOTES:

1. CUT NEAT LINE 6" FROM CURB LINE AND REMOVE BINDER, BASE AND STONE, REPLACE WITH CEMENT CONCRETE.

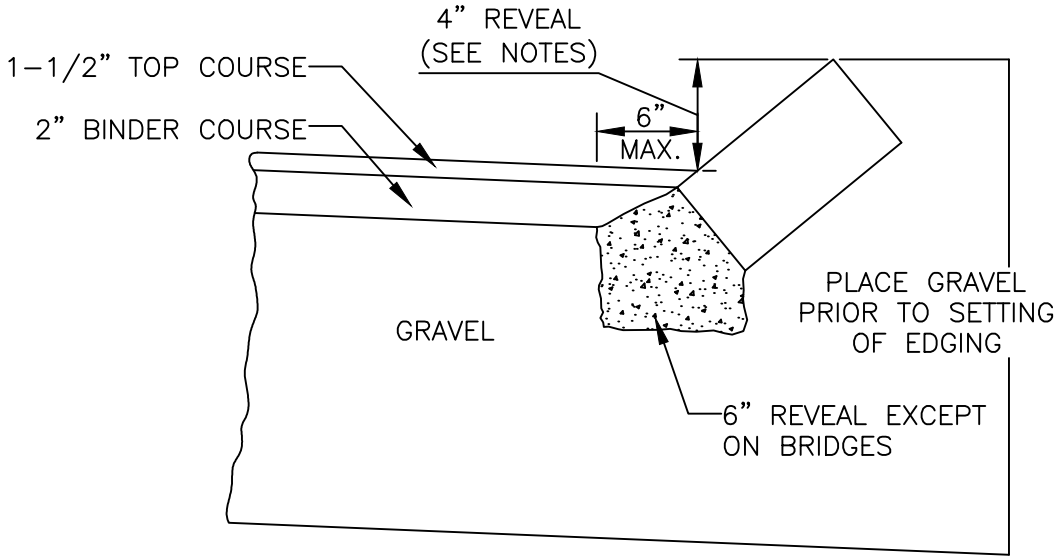
2. ANY CLASS CEMENT CONCRETE THAT IS ACCEPTABLE TO THE DEPARTMENT UNDER SECTION M4 OF THE 1973 STANDARD SPECIFICATIONS. ALL TEST REQUIREMENTS ARE WAIVED. BITUMINOUS CONCRETE SHALL NOT BE USED AS A SUBSTITUTE.

3. PAYMENT FOR CLASS B CONCRETE WILL BE PAID FOR UNDER ITEM 446.1.

MARCH 21, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	METHOD OF SETTING VERTICAL CURB	MCR
METHOD OF SETTING VERTICAL CURB		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



PRE–CAST EDGING



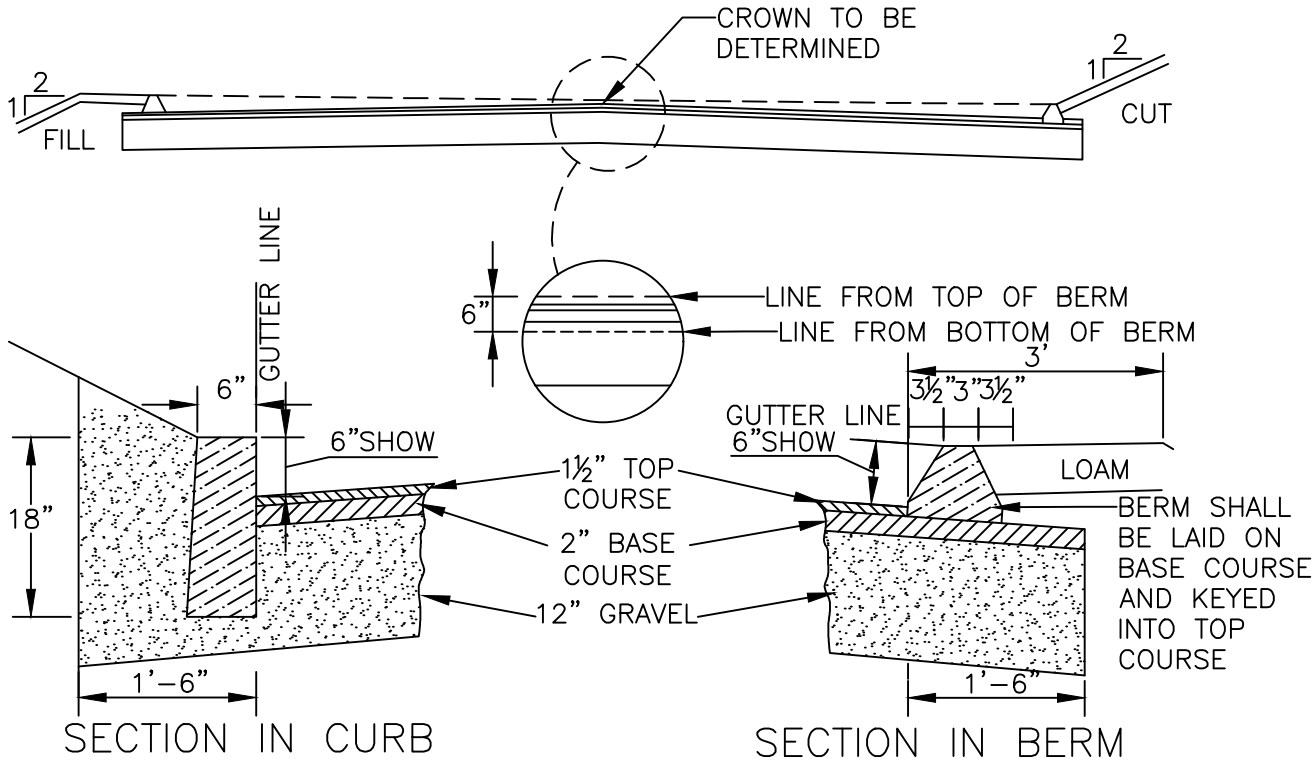
SLOPED GRANITE EDGING

NOTES:

1. ANY CLASS CEMENT CONCRETE THAT IS ACCEPTABLE TO THE DEPARTMENT UNDER SECTION M4 OF THE 1973 STANDARD SPECIFICATIONS. ALL TEST REQUIREMENTS ARE WAIVED. BITUMINOUS CONCRETE SHALL NOT BE USED AS A SUBSTITUTE.
2. PAYMENT FOR CEMENT CONCRETE WILL BE INCLUDED IN THE PRICE PER LINEAL FOOT OF PRE-CAST OR GRANITE EDGING.
3. FOR DETAILS OF PRE-CAST EDGING, SEE 106-40.
4. THE REVEAL SHALL BE 4" UNDER ALL CONDITIONS.

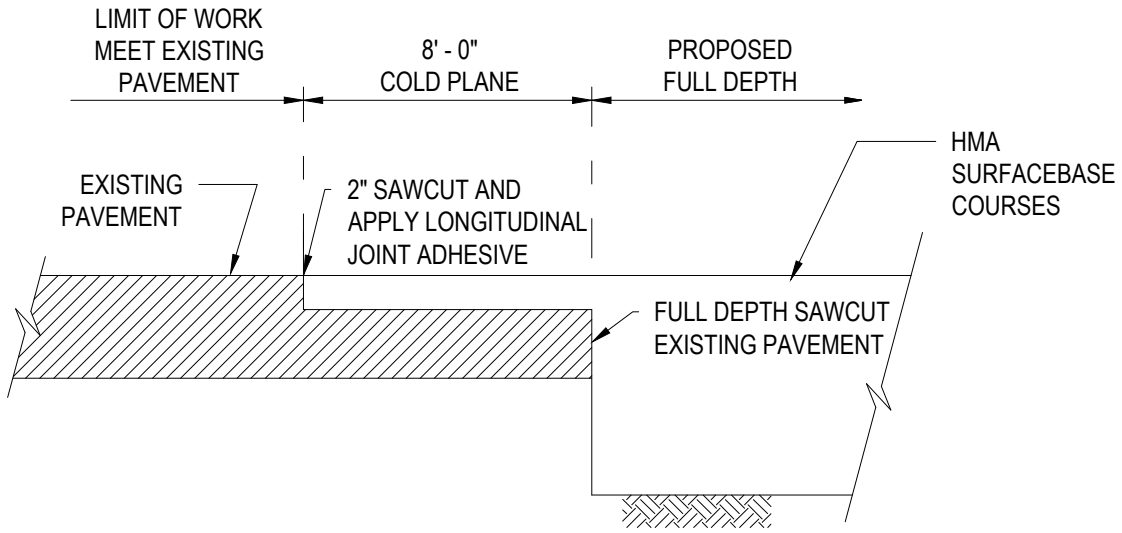
METHOD OF SETTING PRE-CAST CONCRETE EDGING & GRANITE EDGING

MARCH 11, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/11/25	Precast Concrete Edging & Granite Edging	NW
PRECAST CONCRETE EDGING & GRANITE EDGING					
NOT TO SCALE					
SHEET 1 OF 1					
		NO.	DATE	DESCRIPTION	BY



TYPICAL SECTION OF ROAD WITH BERM OR CURB

MARCH 11, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/11/25	Typ. Section of Road w/ Berm or Curb	NW
TYPICAL SECTION OF ROAD WITH BERM OR CURB		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



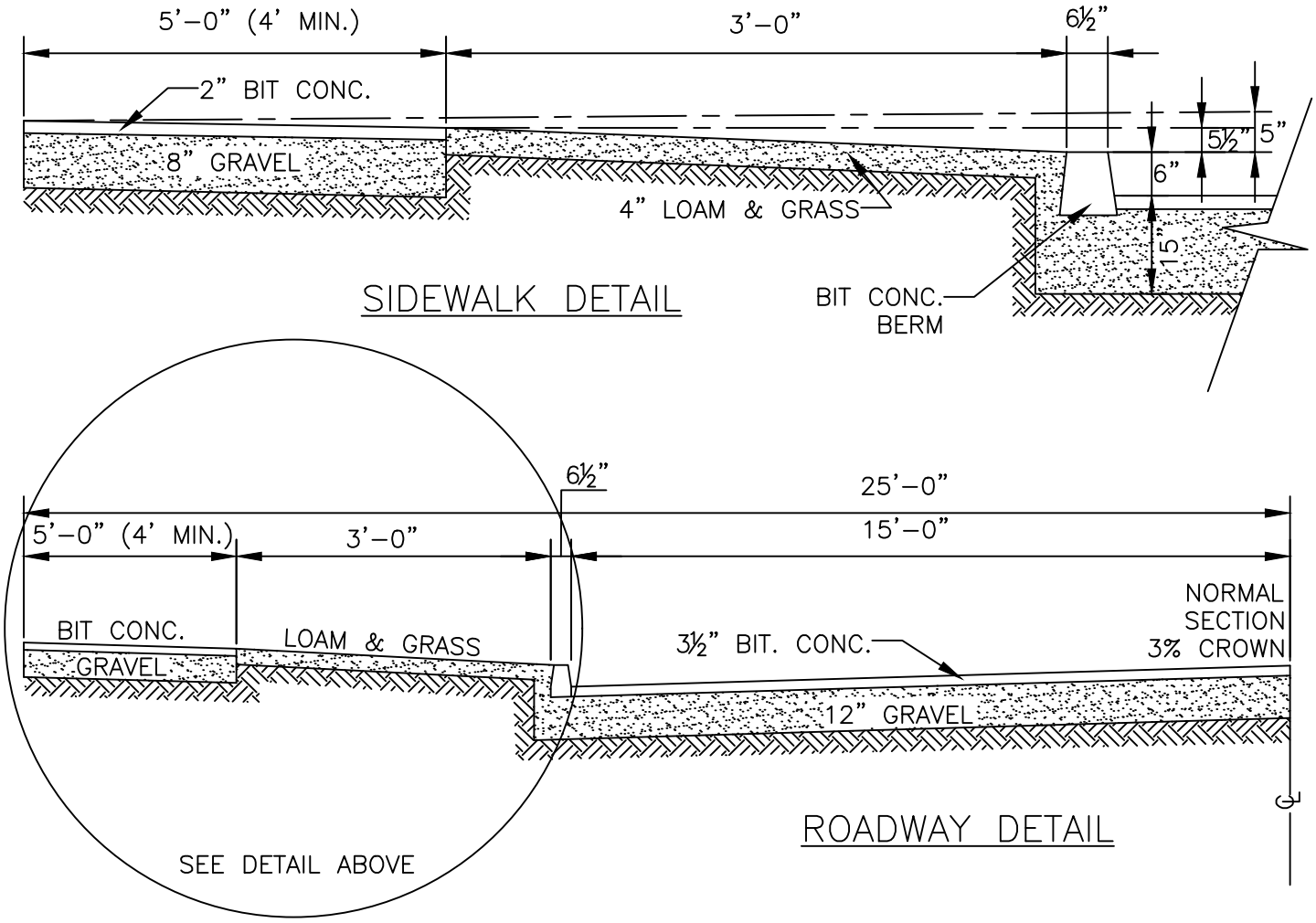
NOTES:

1. CLEAN ALL COLD PLANED SURFACES BEFORE APPLYING JOINT ADHESIVE, TACK COAT AND FINAL PAVEMENT.
2. APPLY TACK COAT TO COLD PLANED SURFACES PRIOR TO BEING OVERLAID AT THE RATE OF 0.10 GALLONS PER SQUARE YARD.
3. TEMPORARY PAVEMENT SHALL BE PLACED ALONG ANY LIP CREATED BY PAVEMENT REMOVAL. TEMPORARY PAVEMENT SHALL BE PLACED AT A SLOPE OF LESS THAN 1V:3H.

PAVEMENT TRANSITION

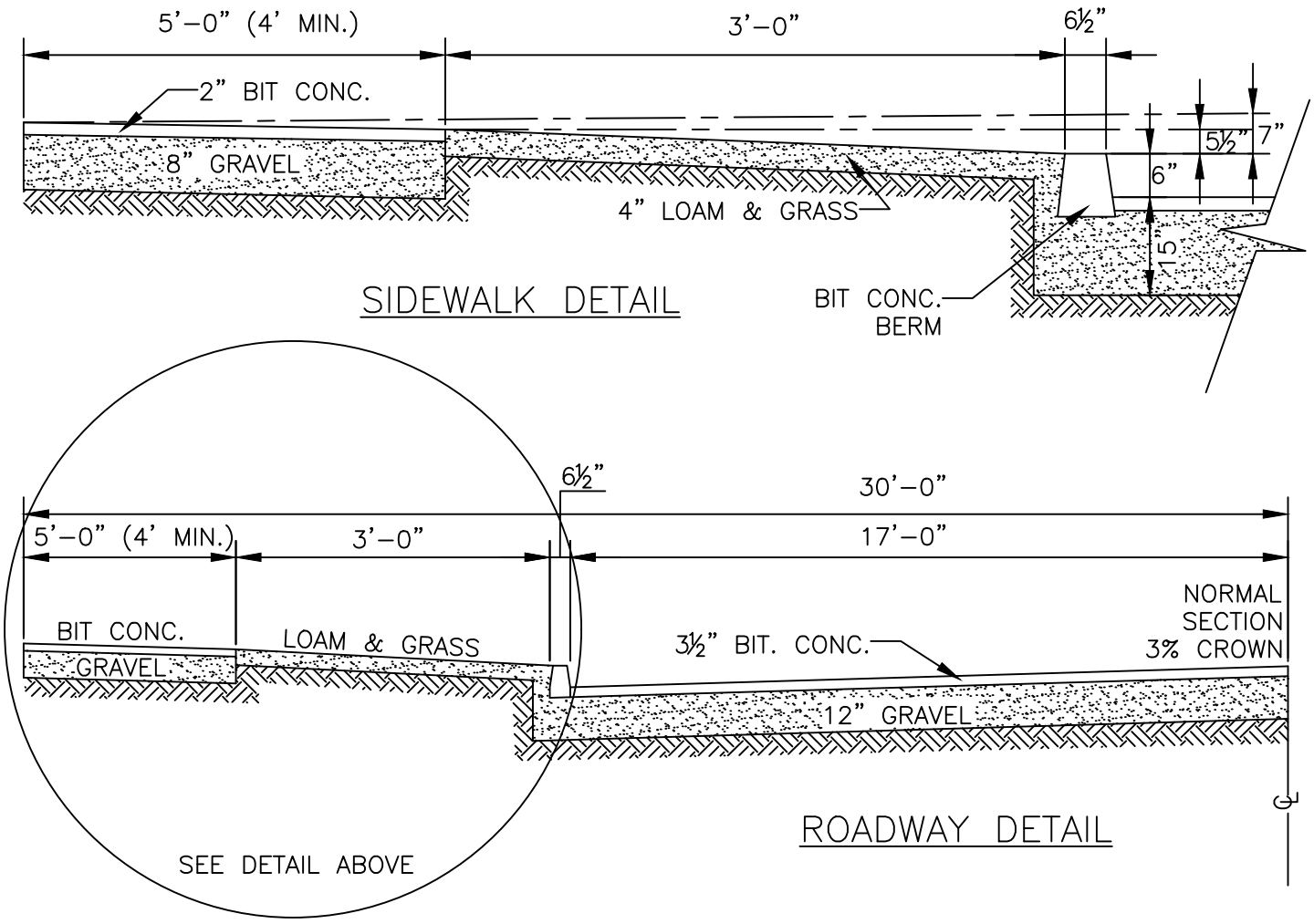
CITY OF WORCESTER STANDARD DETAILS

SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	-	-



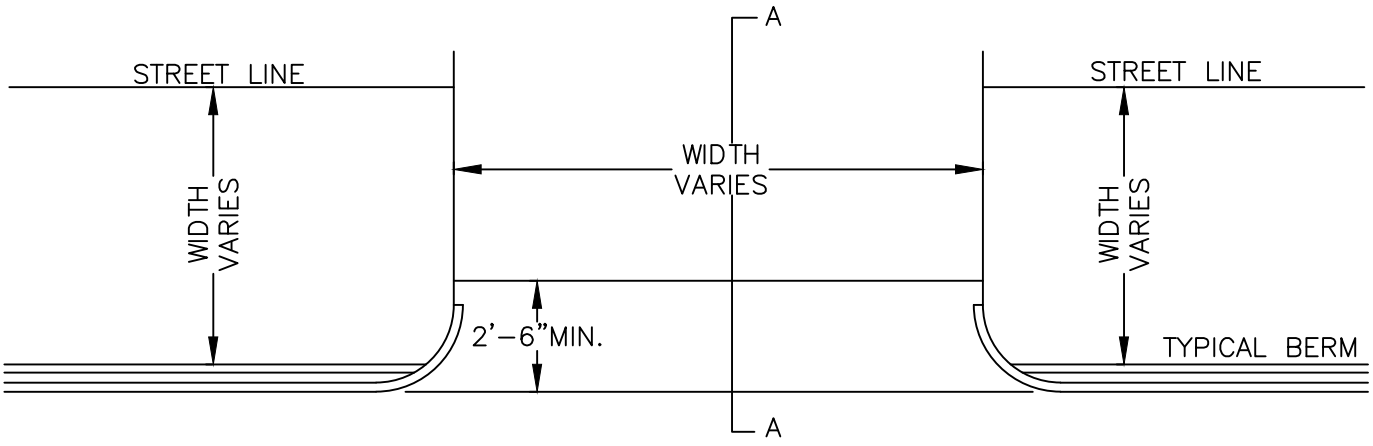
TYPICAL HALF SECTION THROUGH 50' WIDE LOCATION WITH 30' WIDE PAVEMENT

MARCH 11, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/11/25	Half Section–50' Wide ROW, 30' Wide Pavement	NW
TYPICAL HALF SECTION THRU 50-FT WIDE LOCATION	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

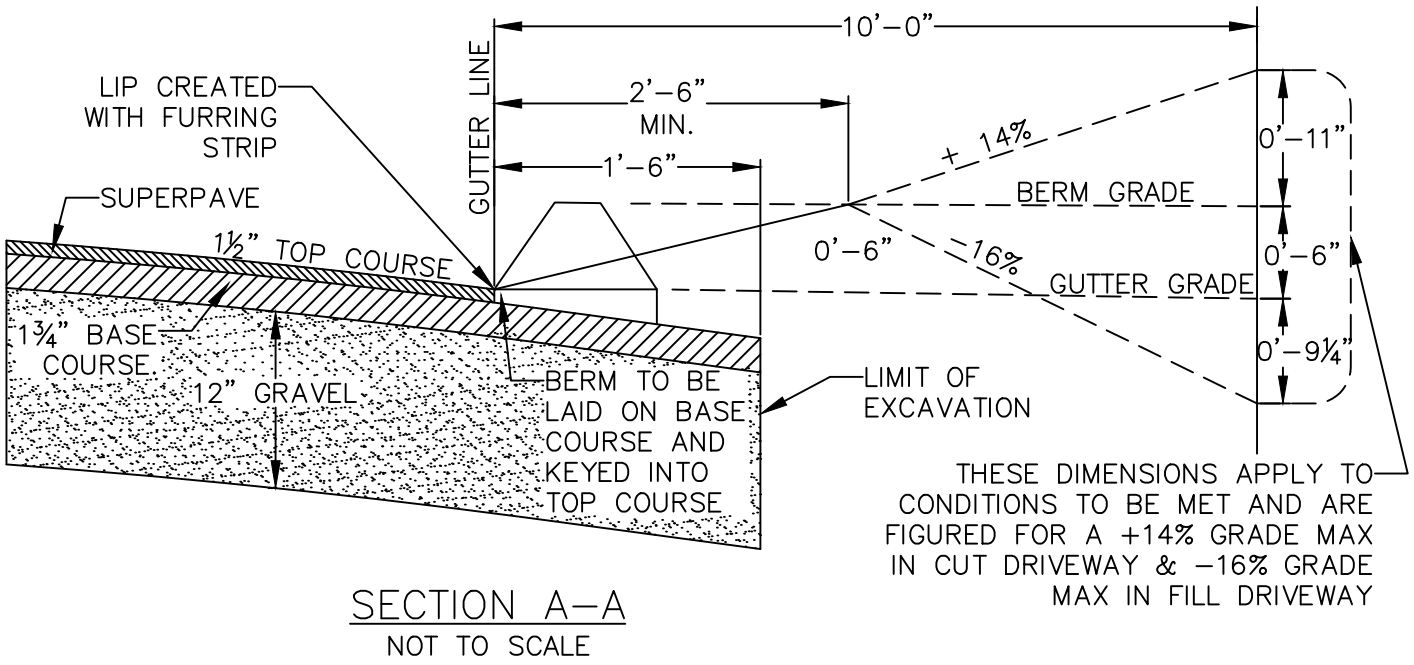


TYPICAL HALF SECTION THROUGH 60' WIDE LOCATION WITH 34' WIDE PAVEMENT

MARCH 11, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS** **Engineering Division** 20 East Worcester St, Worcester MA 01604	1	3/11/25	Half Section–60' Wide ROW, 34' Wide Pavement	NW
TYPICAL HALF SECTION THRU 60-FT WIDE LOCATION					
NOT TO SCALE					
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



PLAN



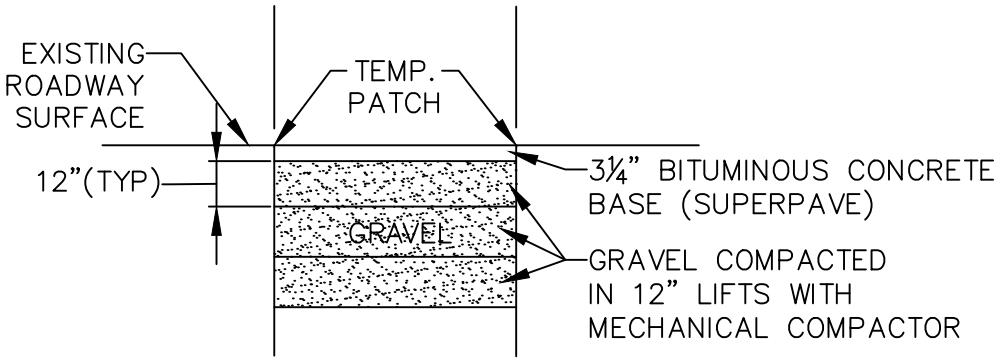
SECTION A–A
NOT TO SCALE

TYPICAL DRIVEWAY

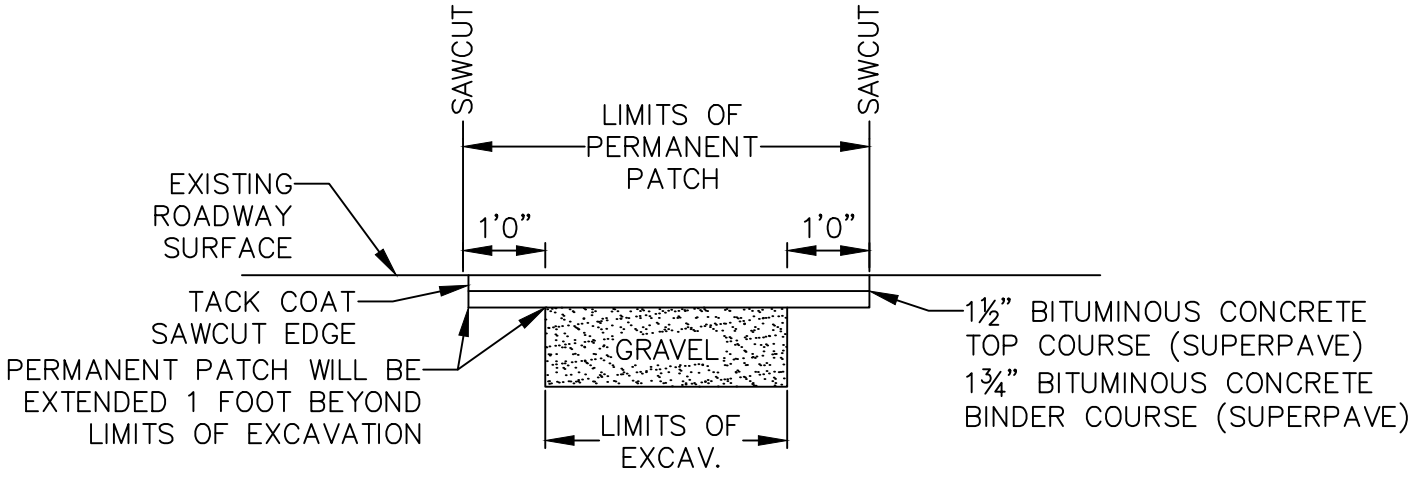
JANUARY 2016			
TYPICAL DRIVEWAY			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY



TEMPORARY PATCH

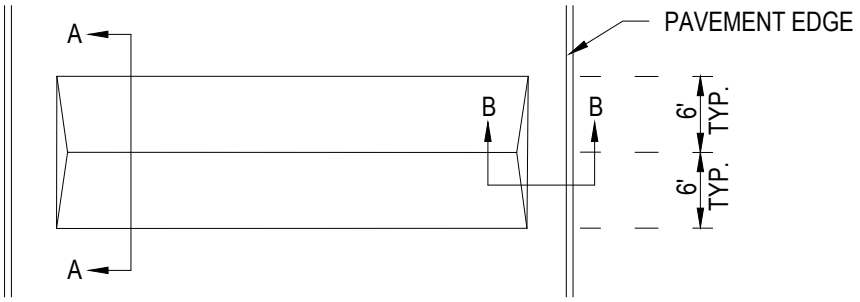


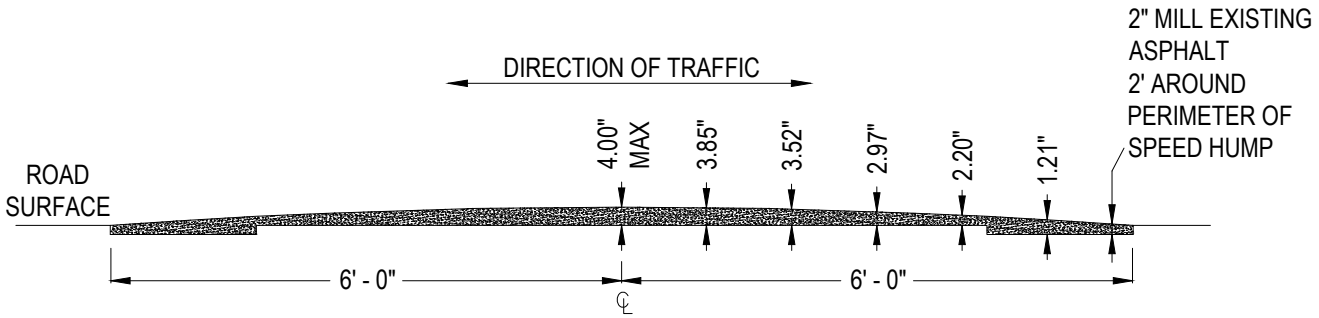
NOTE:
PERMANENT PATCH FOR ROADS HAVING A PAVING BLOCK OR CONCRETE BASE SHALL INCLUDE A LAYER OF CONCRETE EQUAL TO THE DEPTH OF THE EXISTING CONCRETE OR PAVING BLOCK. IN SUCH CASES THE DEPTH OF THE GRAVEL BACKFILL SHALL NOT BE LESS THAN 12 INCHES.

PERMANENT PATCH

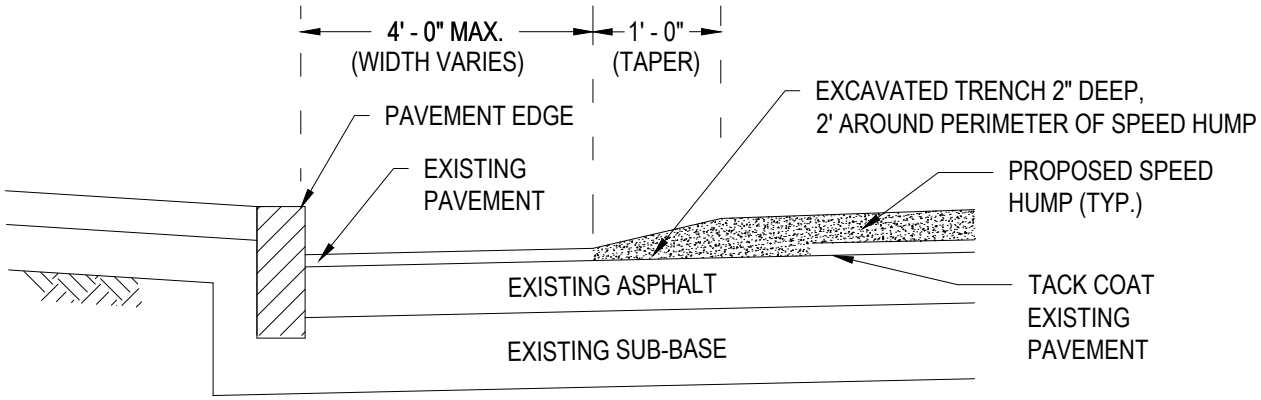
TYPICAL TEMPORARY/PERMANENT PATCH DETAIL FOR ROADWAY

JANUARY 2016		**DEPARTMENT OF PUBLIC WORKS AND PARKS**					
TYPICAL TEMPORARY/PERMANENT PATCH DETAIL FOR ROADWAY		**Engineering Division**					
NOT TO SCALE		20 East Worcester St, Worcester MA 01604					
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY	





SECTION A-A

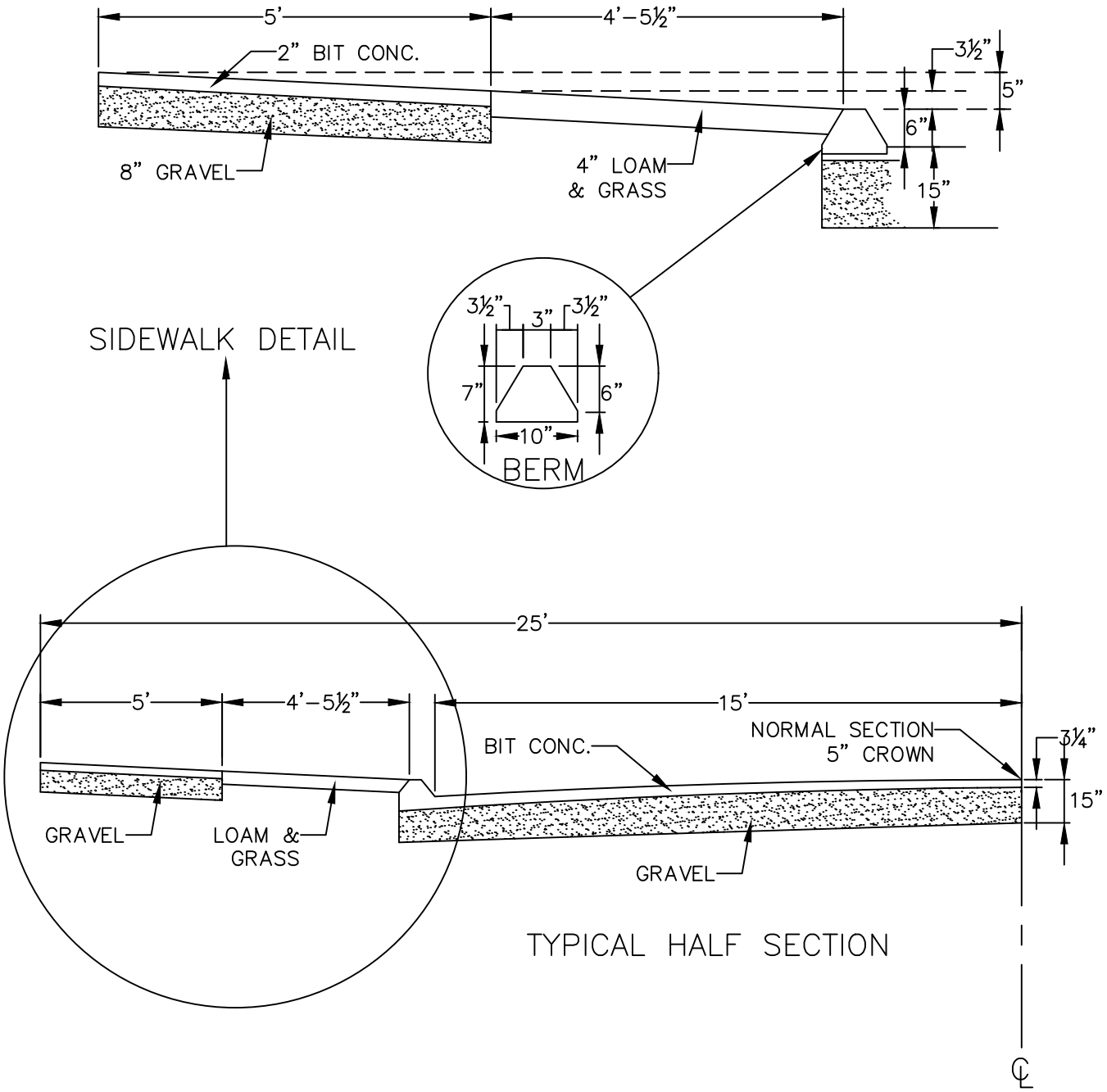


SECTION B-B

PARABOLIC CROWN SPEED HUMP

CITY OF WORCESTER STANDARD DETAILS

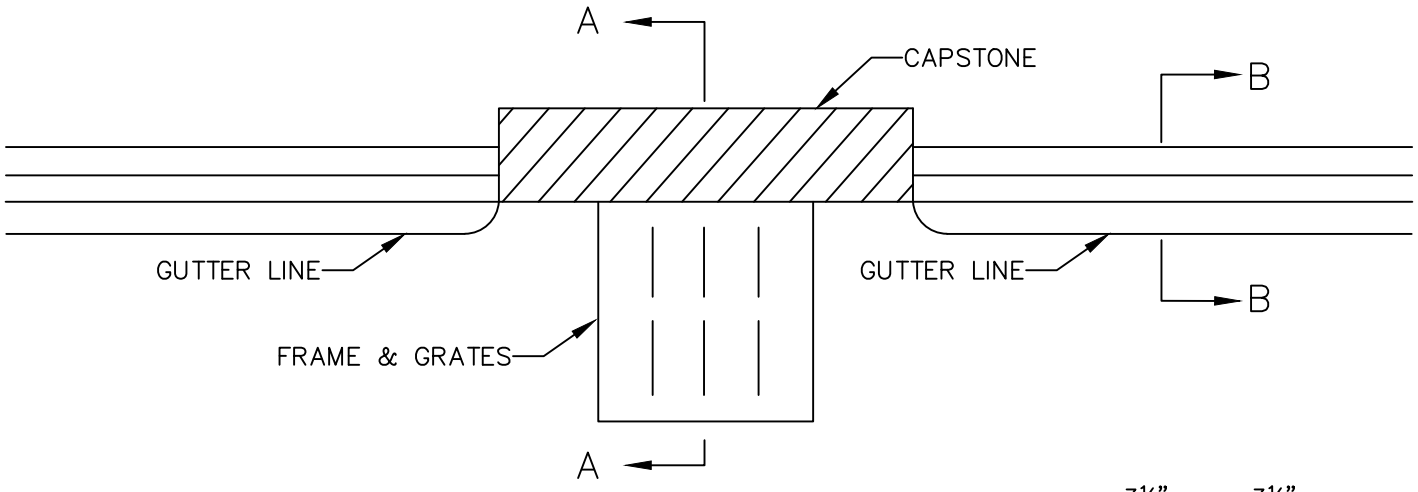
SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 437	-



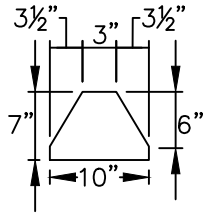
TYPICAL HALF SECTION THROUGH BITUMINOUS CONCRETE & BERM 30' ROADWAY

JANUARY 2016		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	
TYPICALE HALF SECTION THROUGH BIT. CONC. & BERM - 30' ROADWAY		**Engineering Division**	
NOT TO SCALE		20 East Worcester St, Worcester MA 01604	
SHEET 1 OF 1			

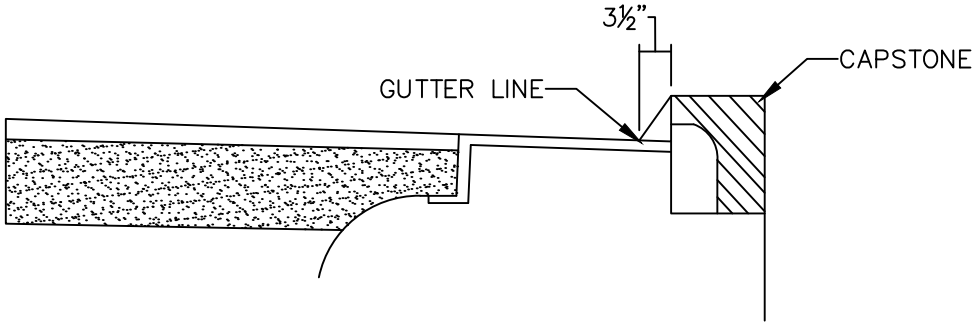
NO.	DATE	DESCRIPTION	BY



PLAN VIEW



SECTION B–B



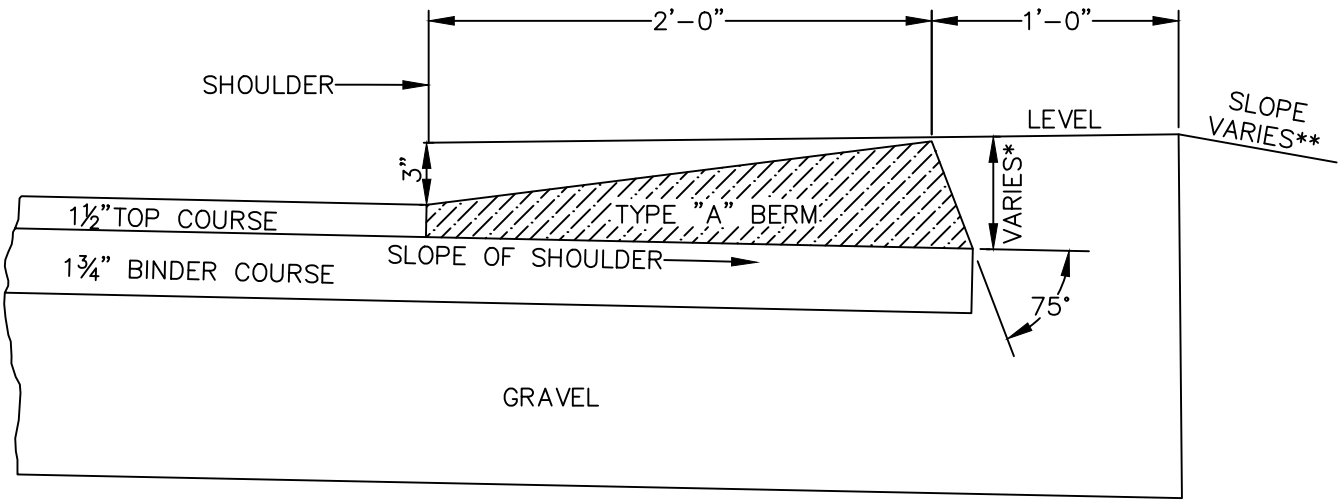
SECTION A–A

TYPICAL SECTION THROUGH CATCH BASIN & BERM

JANUARY 2016			
TYPICAL TEMPORARY/PERMANENT PATCH DETAIL FOR ROADWAY			
NOT TO SCALE			
SHEET 1 OF 1			

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY

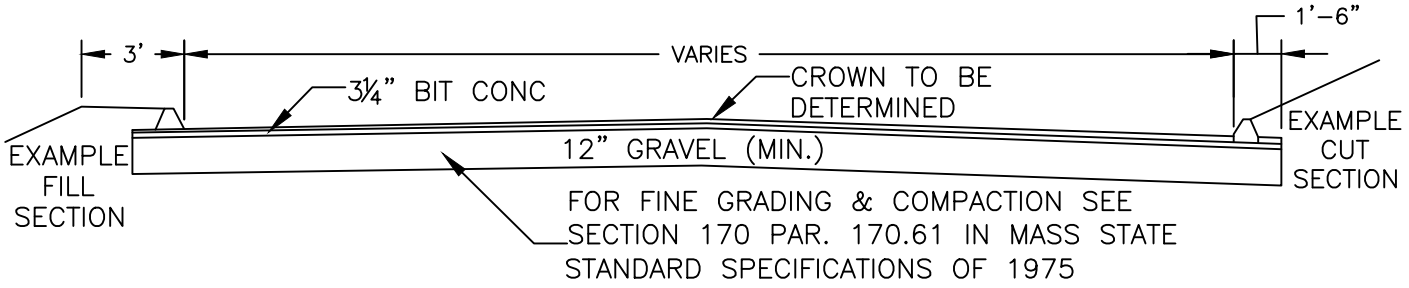


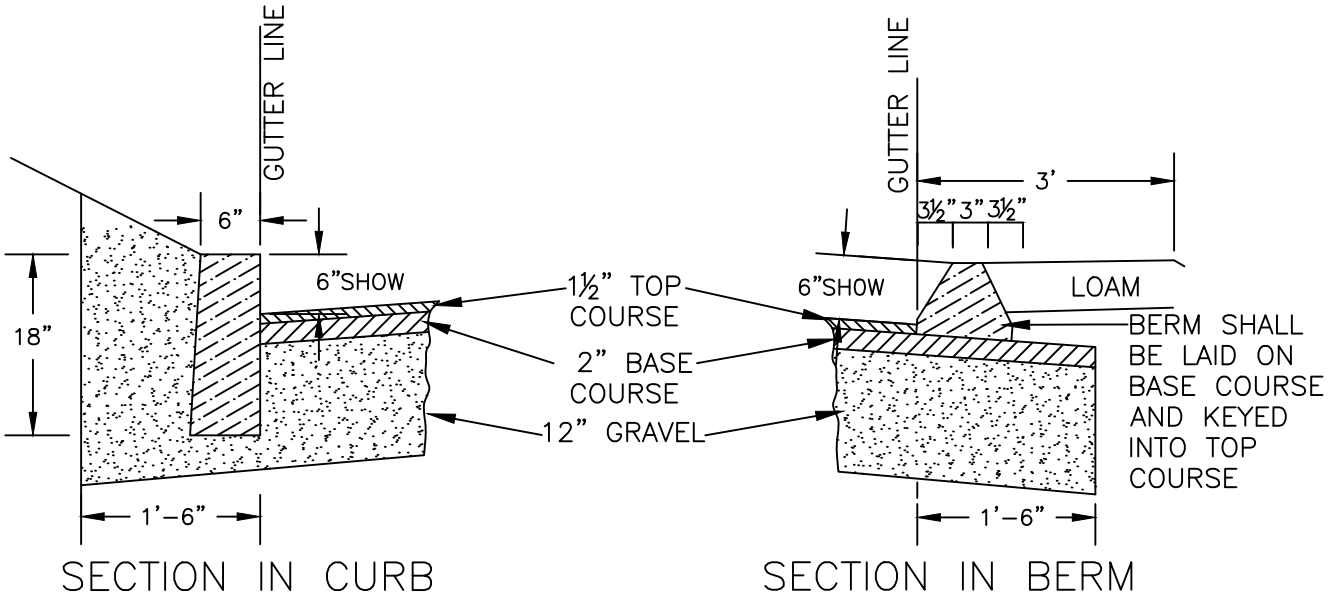
*THIS DIMENSION VARIES WITH THE THICKNESS OF THE TOP COURSE AND SLOPE OF SHOULDER

**SEE TYPICAL SECTIONS FOR PROJECT

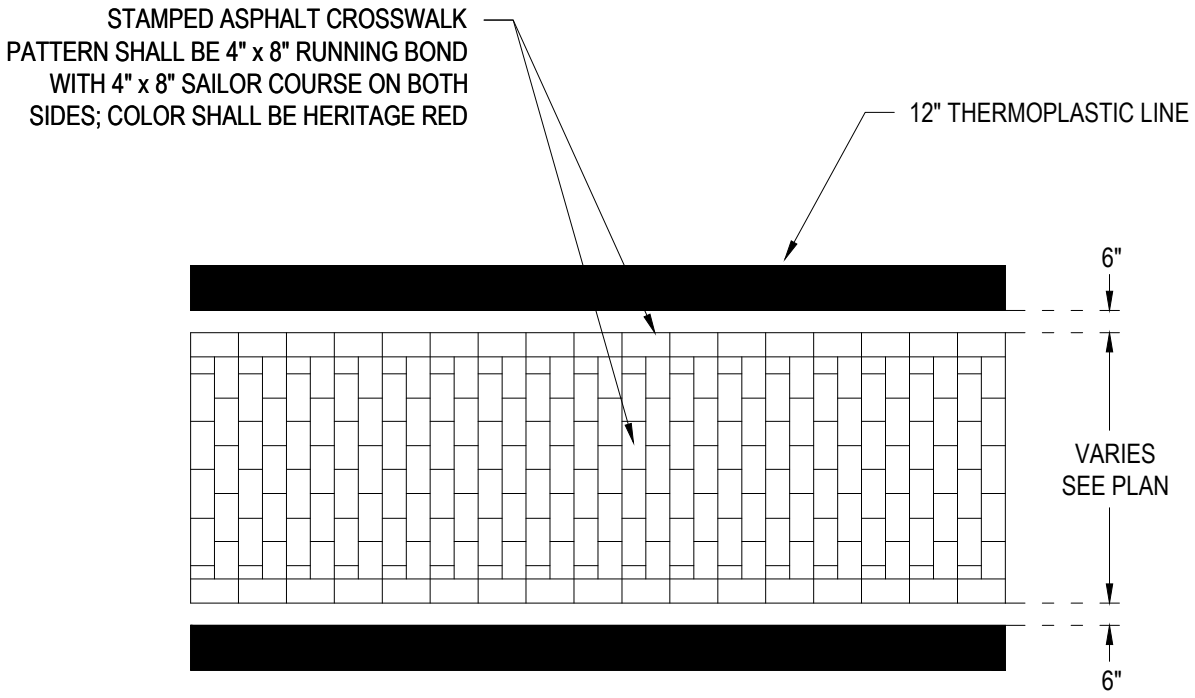
BITMUMINOUS CONCRETE BERM - TYPE "A"

JANUARY 2016		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
BITUMINOUS CONCRETE BERM - TYPE "A"		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY





MARCH 19, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	01	03/19/2025	TYPICAL SECTION WITH BERM	TK
ITEM-438		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



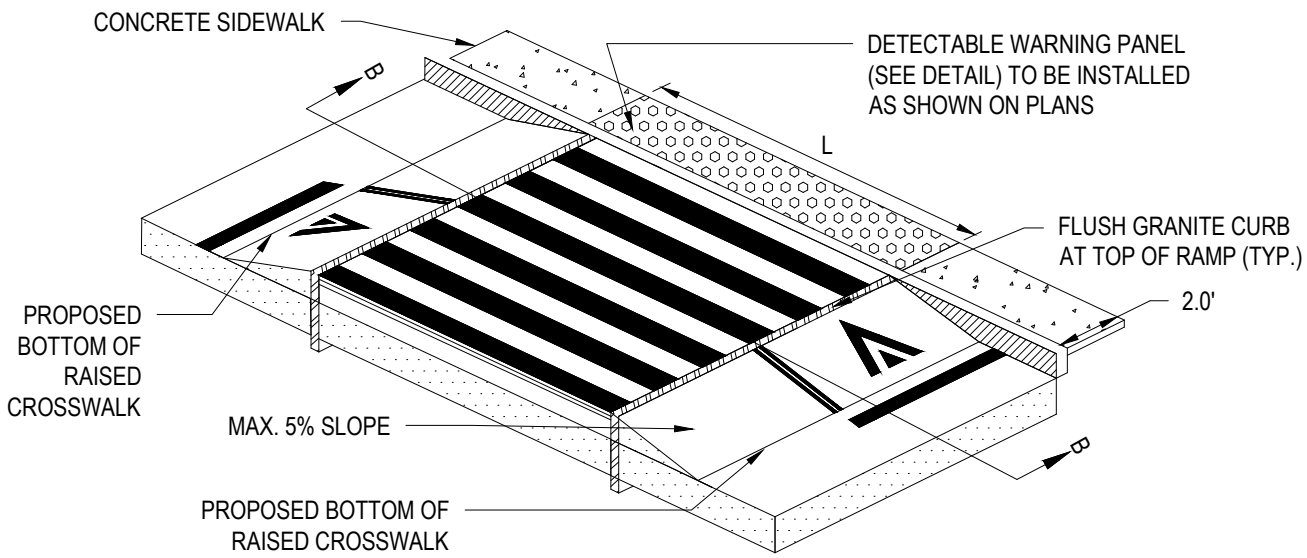
NOTES:

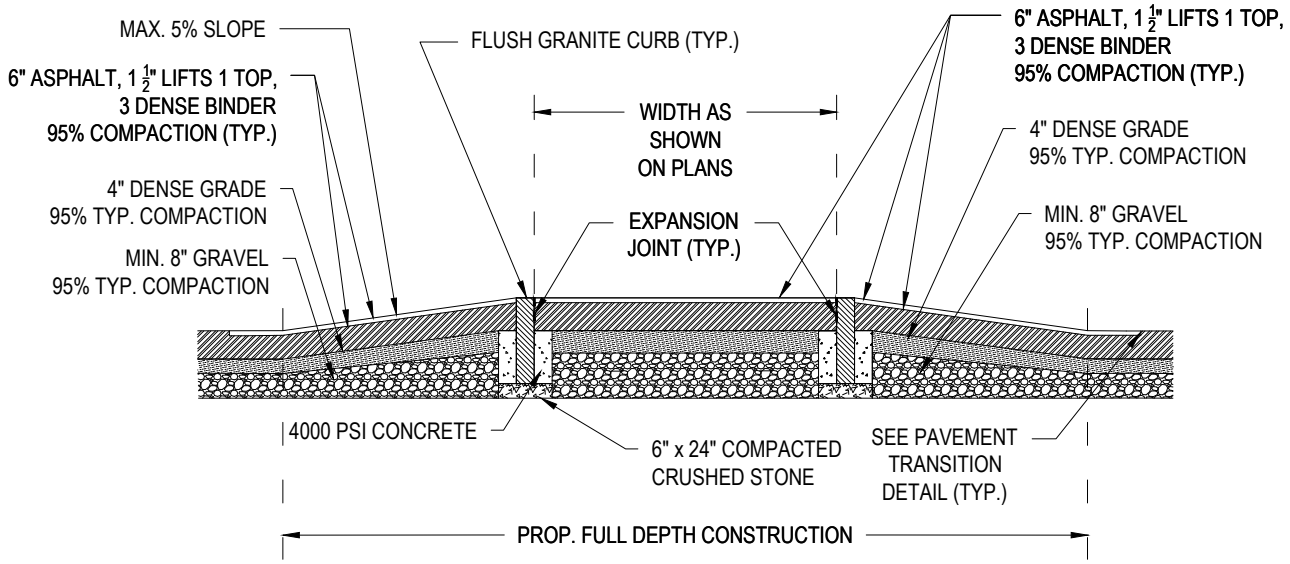
PAVEMENT MARKINGS SYMBOLS SHALL BE CONSISTED OF PREFORMED THERMOPLASTIC.

STAMPED ASPHALT CROSSWALK WITH THERMOPLASTIC PAVEMENT

CITY OF WORCESTER STANDARD DETAILS

SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 440	-





SECTION B-B

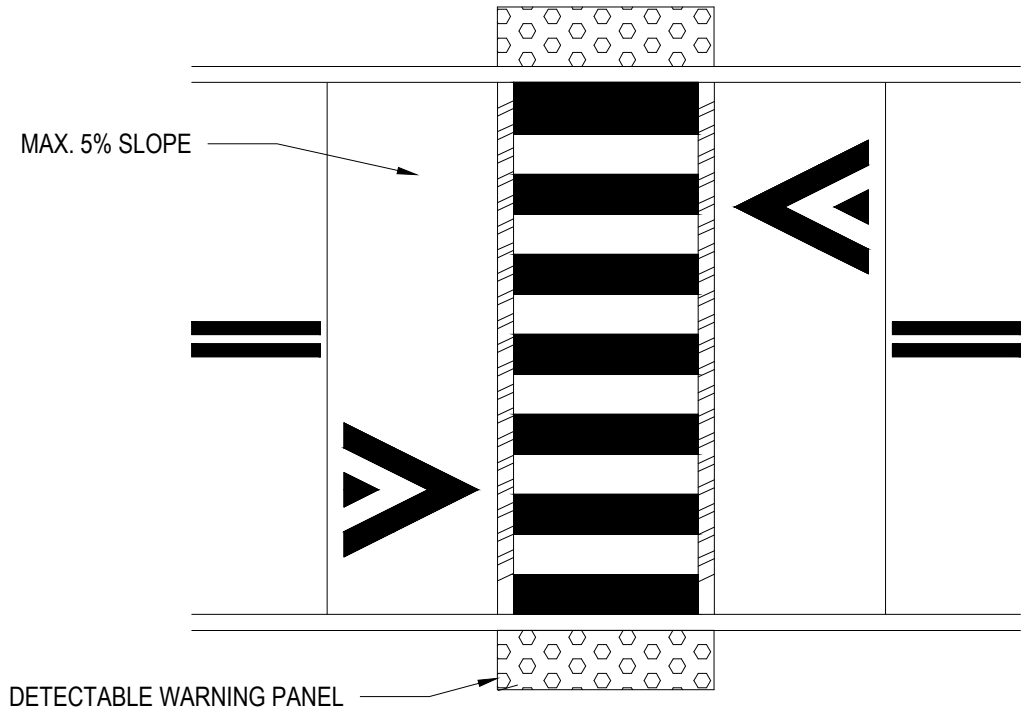
NOTE:

1. SEE SPECIFICATION FOR ADDITIONAL RAISED INTERSECTION CONSTRUCTION REQUIREMENTS

RAISED CROSSWALK ISOMETRIC PLAN

CITY OF WORCESTER STANDARD DETAILS

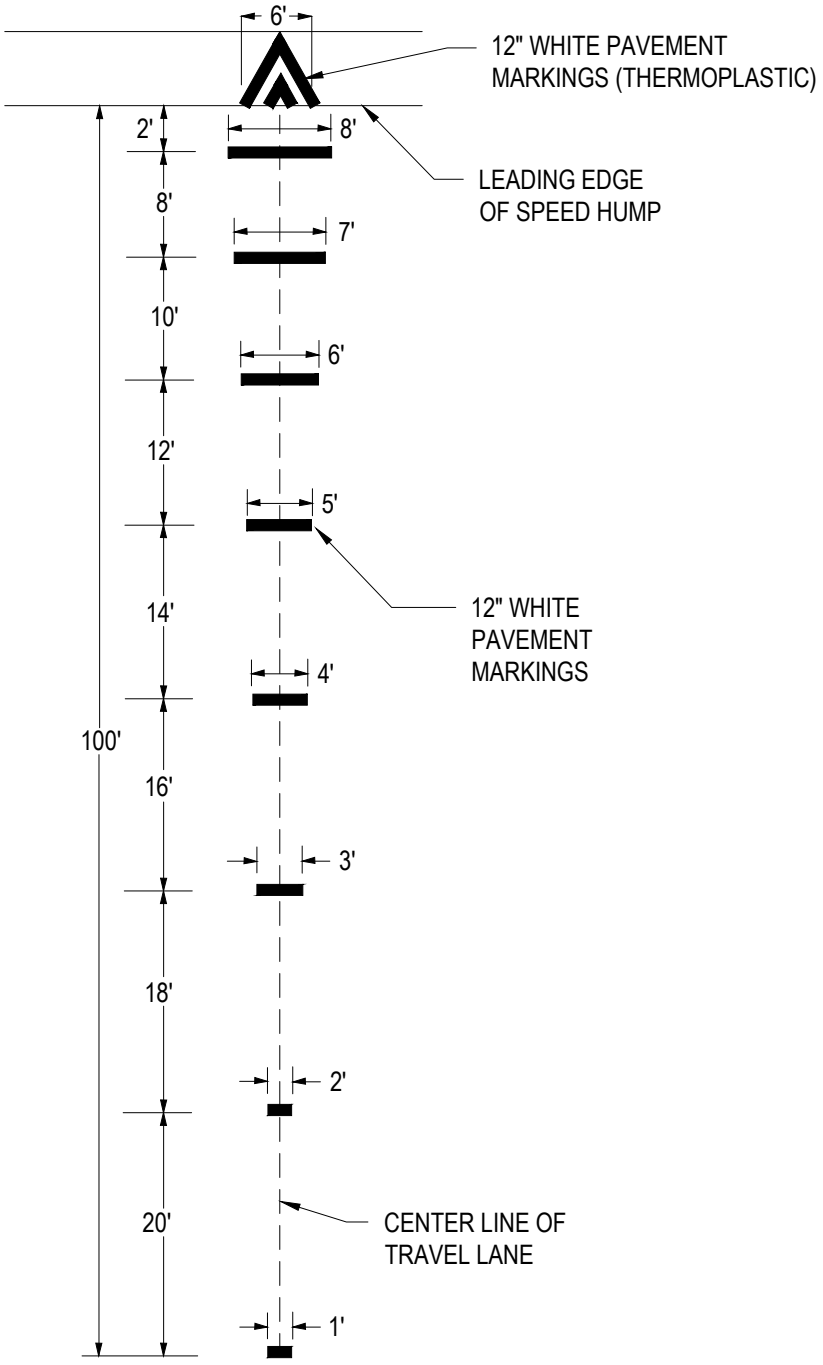
SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM-437	-



RAISED CROSSWALK PLAN VIEW

CITY OF WORCESTER STANDARD DETAILS

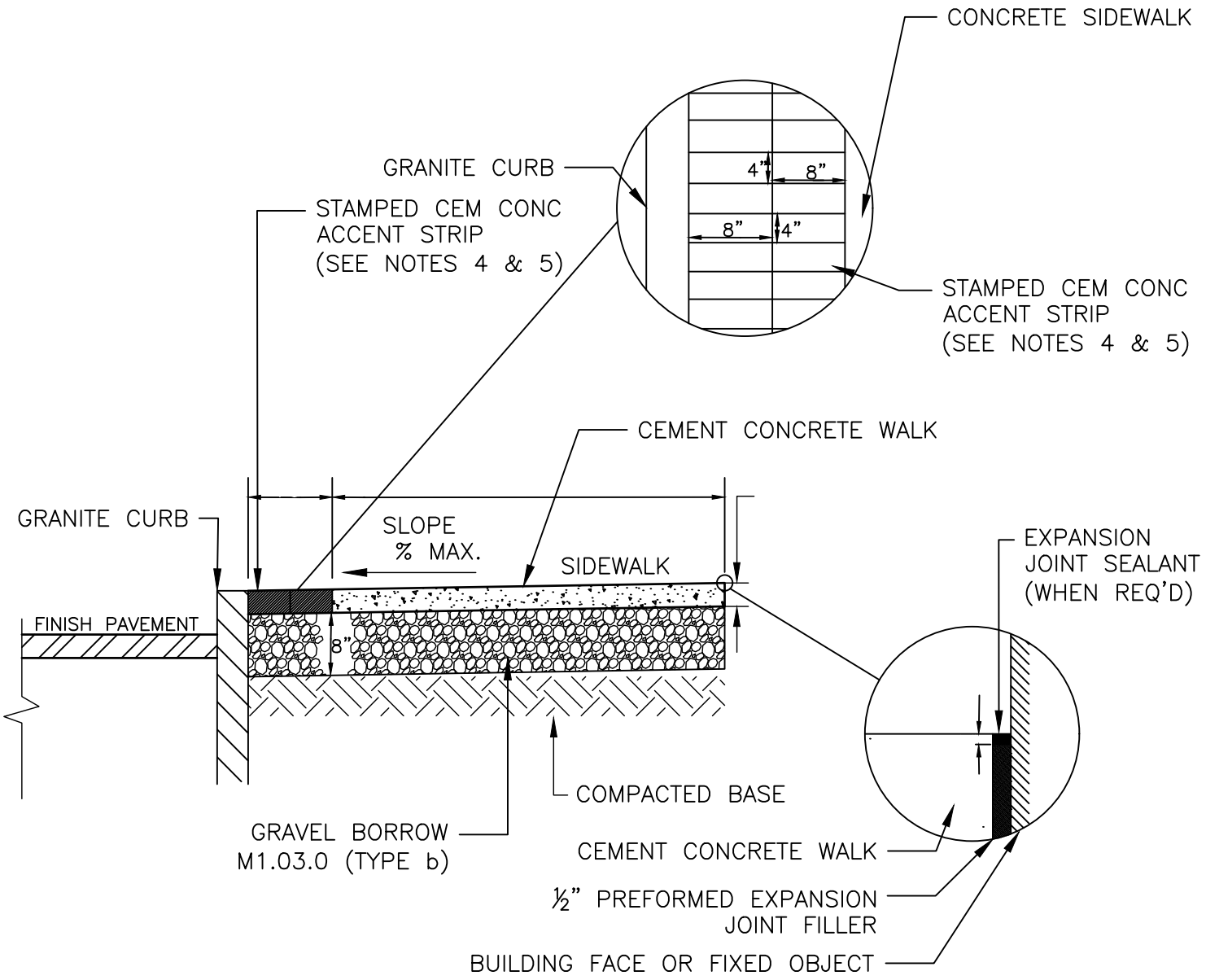
SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 437	-



ADVANCE WARNING MARKINGS FOR RAISED ELEMENTS

CITY OF WORCESTER STANDARD DETAILS

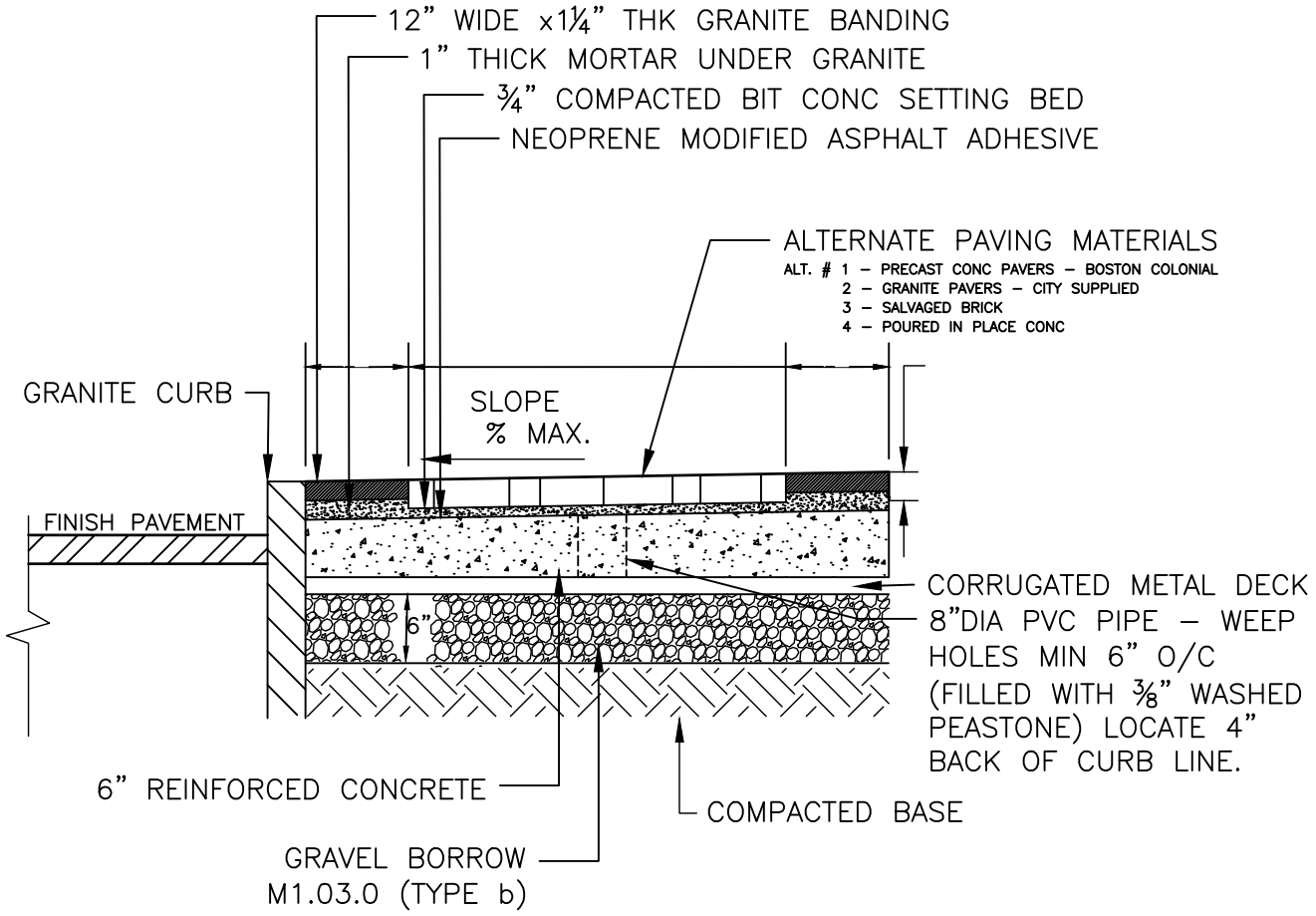
SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 437	-



NOTES:

1. PROVIDE EXPANSION JOINTS AT MIN 30' O.C. WITH PREMOULDED JOINT FILLER
2. PROVIDE TOOLED DUMMY JOINTS PER DETAIL
3. PROVIDE BROOM FINISH IN DIRECTION PERPENDICULAR TO CURB
4. ACCENT STRIP SHALL BE CEM CONC COLORED TRHOUGHOUT STAMPED/IMPRINTED WITH A BRICK PATTERN.
5. ACCENT STRIP SHALL BE FORMED AGAINST GRANITE CURB/CURB INLET AND SHALL BE PLACED PRIOR TO CEM CONC WALK SURFACE OR SIDEWALK.

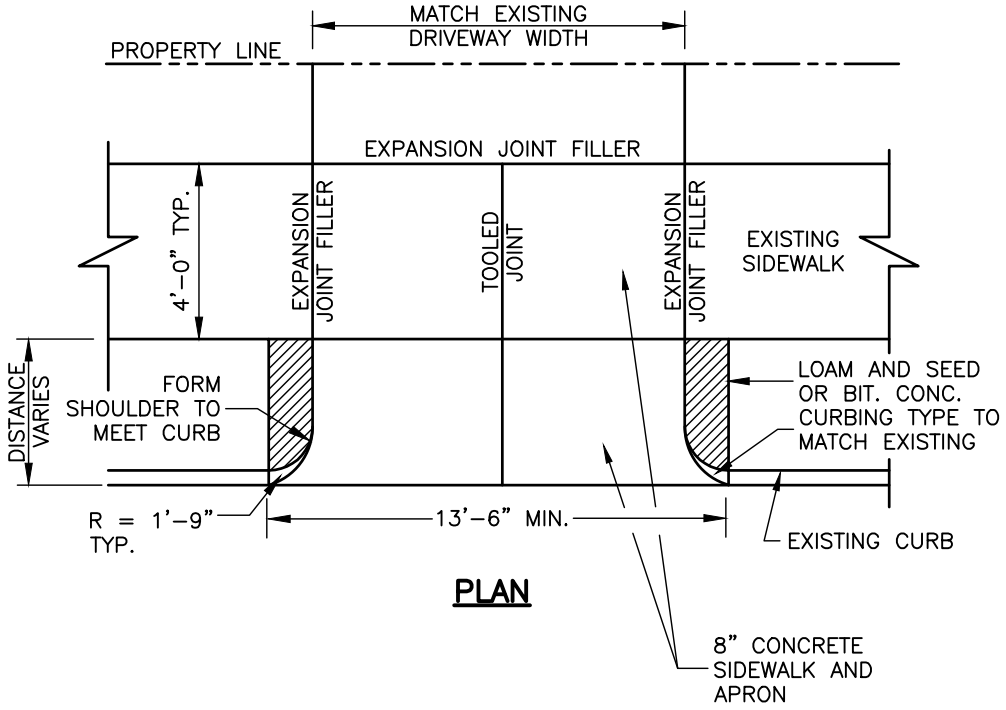
MARCH 21, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	CEMENT CONCRETE SIDEWALK WITH ACCENT STRIP	MCR
CEMENT CONCRETE SIDEWALK WITH ACCENT STRIP		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



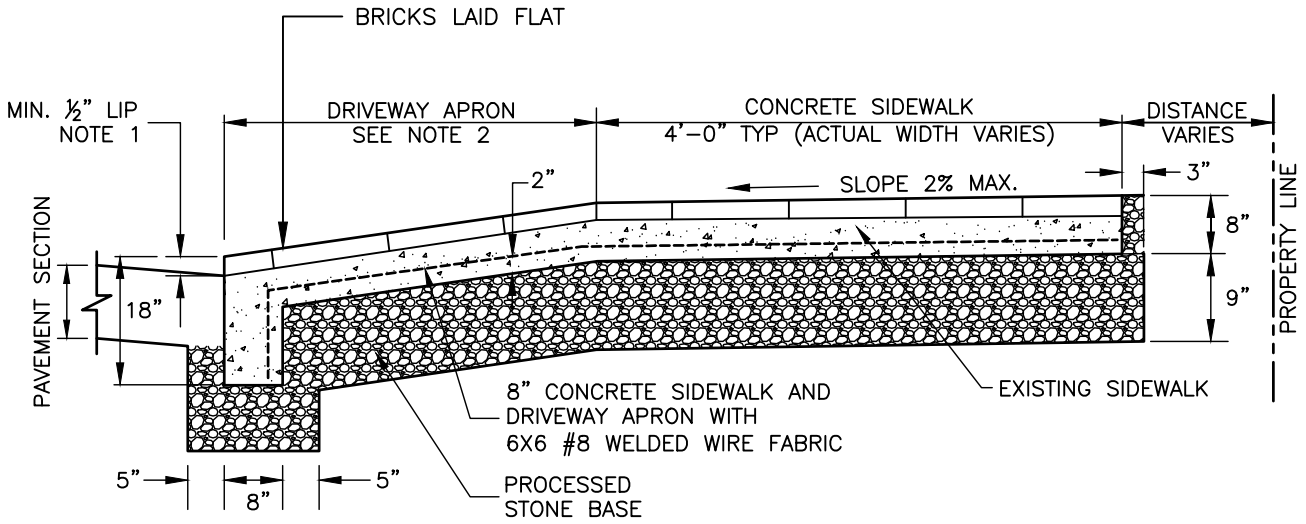
NOTES:

1. TO ESTABLISH FINISH GRADE – CONTRACTOR SHALL HOLD ALL EXISTING GRADES AT BUILIDING LINE. CONTRACTOR SHALL MAINTAIN A MINIMUM SLOPE OF ¼" INCH PER FOOT (BUILDING LINE TO GRANITE CURB). CONTRACTOR SHALL VERIFY EXISTING GRADES IN THE FIELD AND REPORT ANY DISCREPANCIES.

MARCH 21, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	TYPICAL SIDEWALK DETAIL FOR BRICK PAVERS	MCR
TYPICAL SIDEWALK DETAIL FOR BRICK PAVERS	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



PLAN

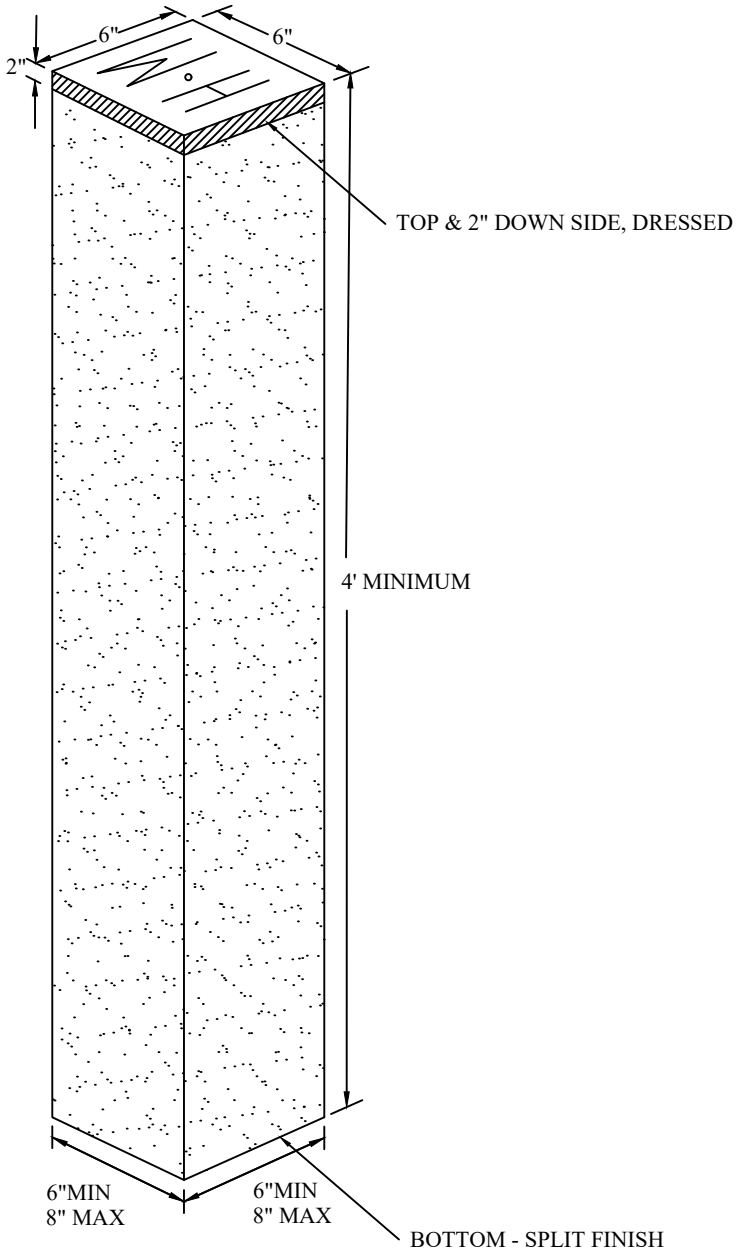


SECTION

NOTES:

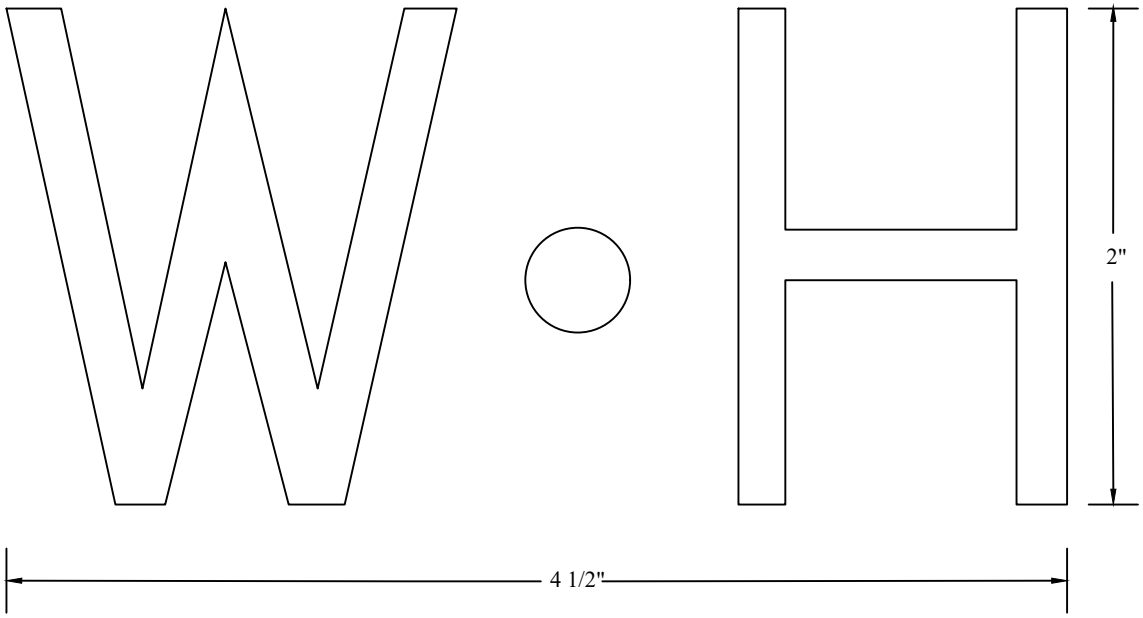
1. PROVIDE MIN. ½" LIP OR GREATER, IF REQUIRED BY MUNICIPALITY OR CT DOT.
2. THE SPECIFICATION AND REGULATIONS OF THE LOCAL MUNICIPALITY HAVING CONTROL OVER THE DRIVEWAY APRON AND SIDEWALK SHALL SUPERSEDE THIS DETAIL.

MARCH 21, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	TYPICAL DRIVEWAY/SIDEWALK FOR NEW & EXISTING BRICK	MCR
TYPICAL DRIVEWAY/SIDEWALK FOR NEW & EXISTING BRICK	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



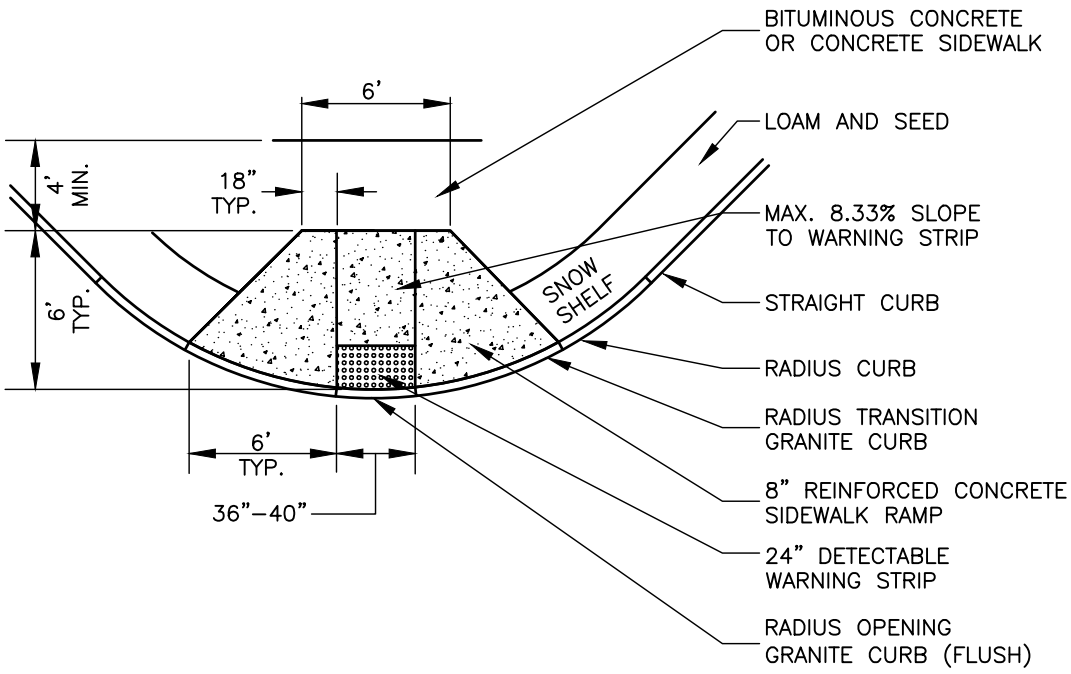
MARCH 21, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	WORCESTER HIGHWAY MONUMENT	MCR
WORCESTER STANDARD HIGHWAY - MONUMENT		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

MATERIAL.....GRANITE
MINIMUM SECTION.....6 INCHES SQUARE
MAXIMUM SECTION.....8 INCHES SQUARE
MINIMUM LENGTH.....4 FEET
DRESSED AT TOP.....6" SQUARE & 2" DOWN SIDE
BOTTOM FINISH.....SPLIT
HOLE DRILLED & "W H" INSCRIBED ON TOP FACE

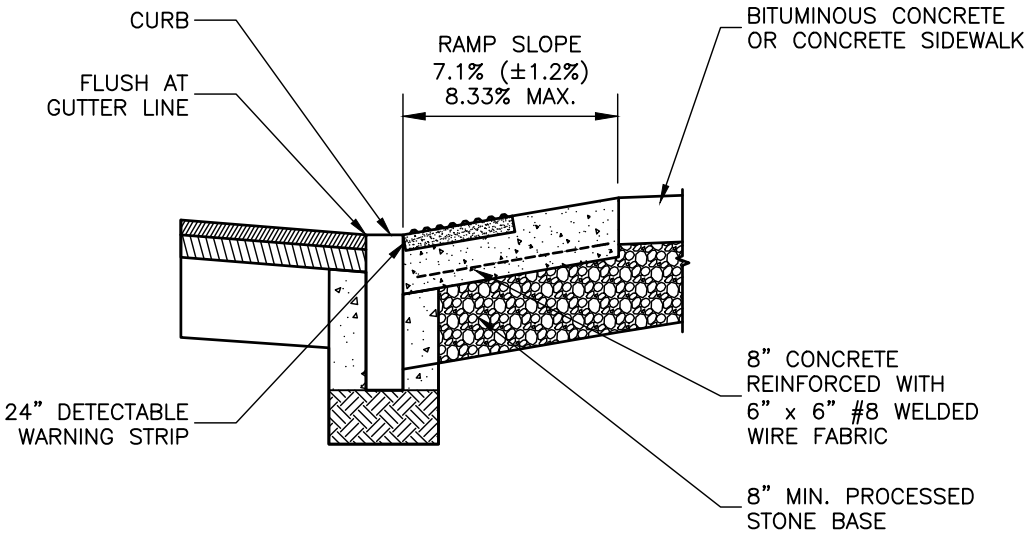


NOTE:
1. USE "V" CUT AT LEAST 1/4" DEPTH.
2. DRILL HOLE AT LEAST 1/2" DEEP AND 1/2" DIAMETER.

MARCH 21, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	WORCESTER HIGHWAY MONUMNENT INSCRIPTION	MCR
WORCESTER STANDARD HIGHWAY - MONUMENT		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



PLAN

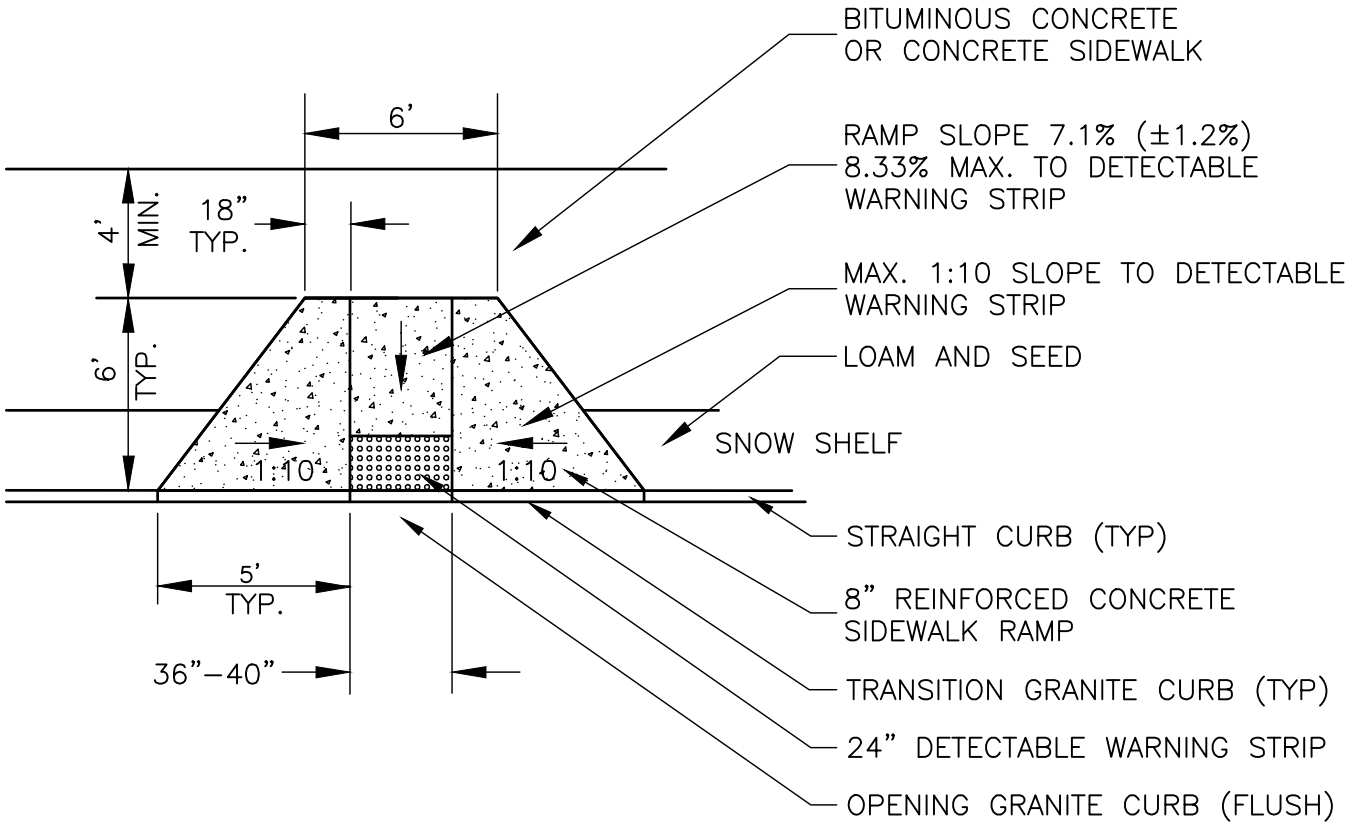


SECTION

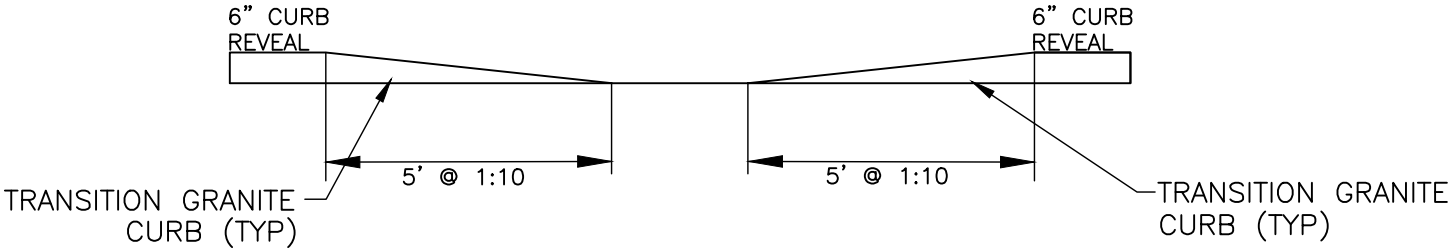
NOTES:

1. RADIUS TRANSITION CURB TO BE ONE CONTINUOUS 6' LENGTH.
2. RADIUS OPENING TO ALSO BE ONE CONTINUOUS LENGTH.
3. SEE SIDEWALK RAMP SECTION DETAIL FOR ADDITIONAL INFORMATION.

MARCH 21, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	WHEELCHAIR RAMP DETAIL	MCR
WHEELCHAIR RAMP DETAIL		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



PLAN

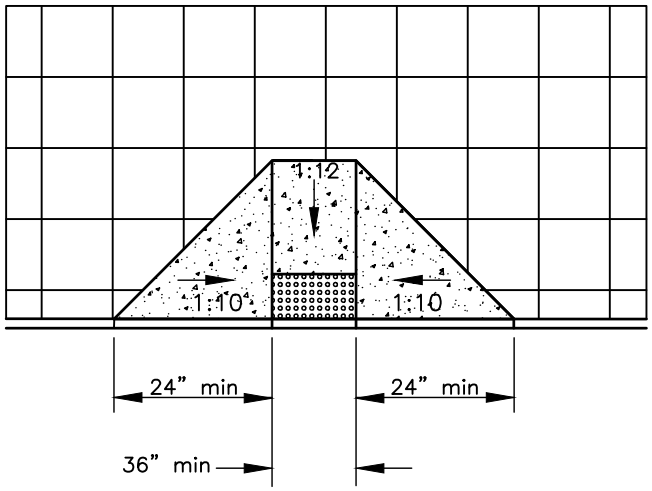


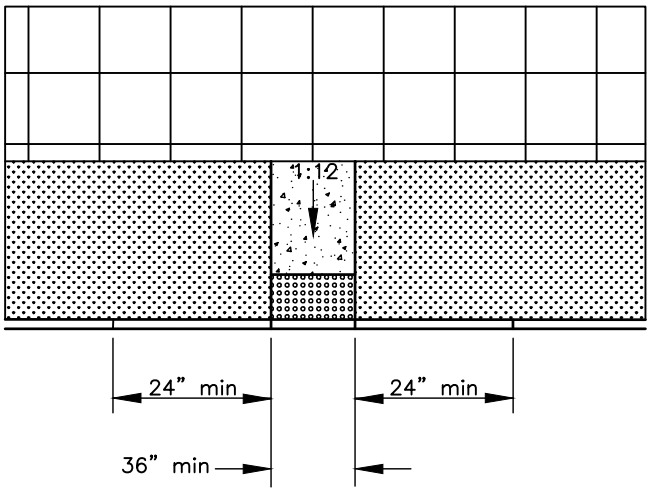
SECTION

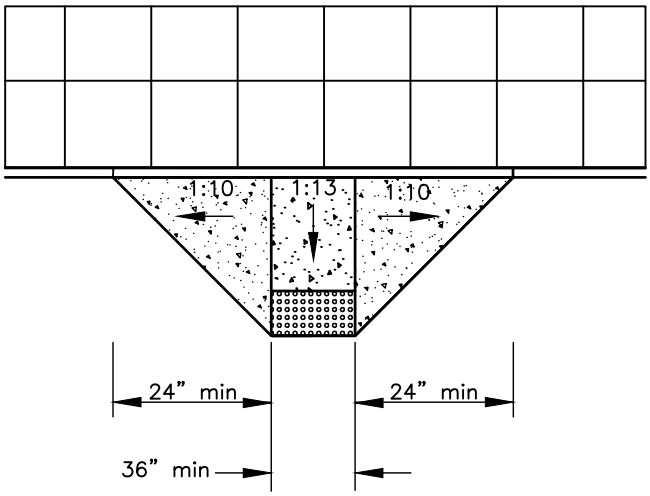
NOTES:

1. TRANSITION GRANITE CURB TO BE ONE CONTINUOUS 5' LENGTH.
2. OPENING GRANITE CURB TO ALSO BE ONE CONTINUOUS LENGTH.
3. SEE SIDEWALK RAMP SECTION DETAIL FOR ADDITIIONAL INFORMATION.

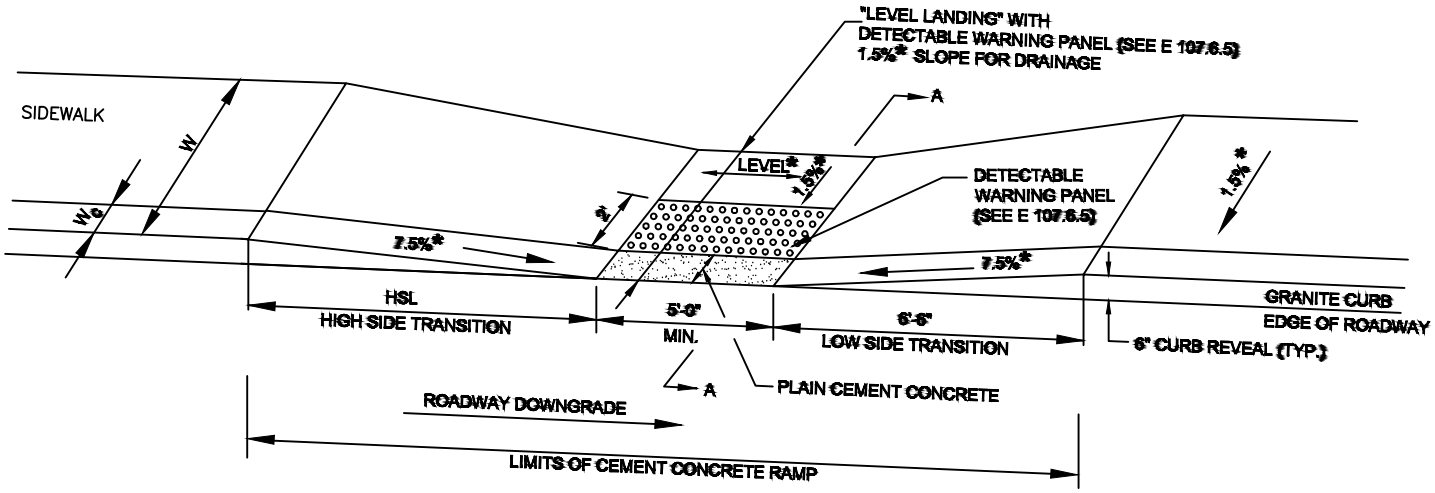
MARCH 21, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	WHEELCHAIR RAMP DETAIL	MCR
WHEELCHAIR RAMP DETAIL		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY







MARCH 21, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	CEMENT CONCRETE SIDEWALK WITH ACCENT STRIP	MCR
CEMENT CONCRETE SIDEWALK WITH ACCENT STRIP	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



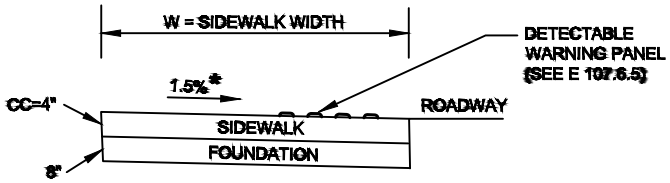
LEGEND

HSL = HIGH SIDE TRANSITION LENGTH (SEE E 107.9.0)
W = SIDEWALK WIDTH
W_C = CURB WIDTH
CC = CEMENT CONCRETE
* = TOLERANCE FOR CONSTRUCTION ±0.5%

USABLE SIDEWALK WIDTH PER AAB = W-Wc
USABLE SIDEWALK WIDTH PER AAB IS NOT TO BE LESS THAN 4'0"
SEE E 107.6.5 FOR DETAILS OF DETECTABLE WARNING PANEL

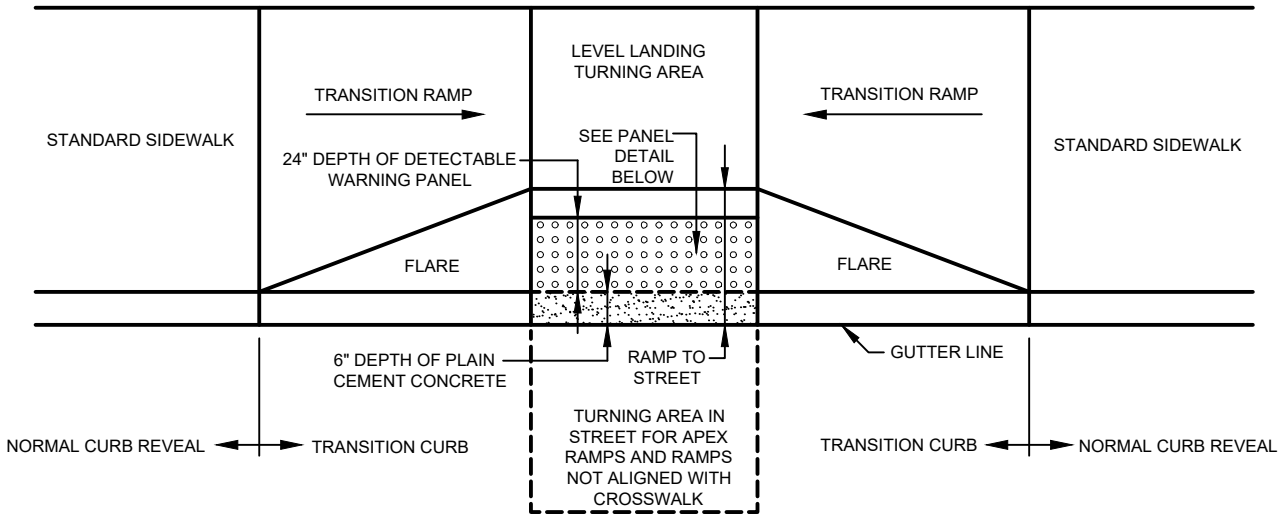
NOTE:

ROADWAY, GUTTER, AND FIRST 6" OF SIDEWALK TO BE ADJUSTED FOR FIELD CONDITIONS

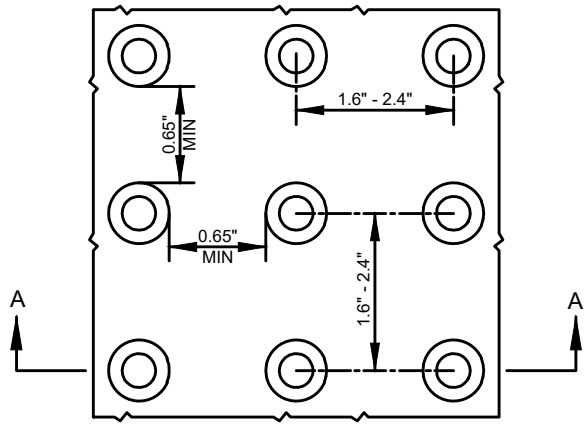


SECTION A-A

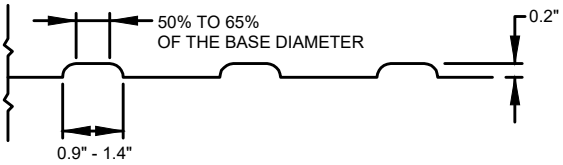
MARCH 21, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	03/25	WHEELCHAIR RAMP ON NARROW SIDEWALK	MCR
WHEELCHAIR RAMP ON NARROW SIDEWALK	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



TYPICAL INSTALLATION



DETAIL OF DETECTABLE WARNING PANEL

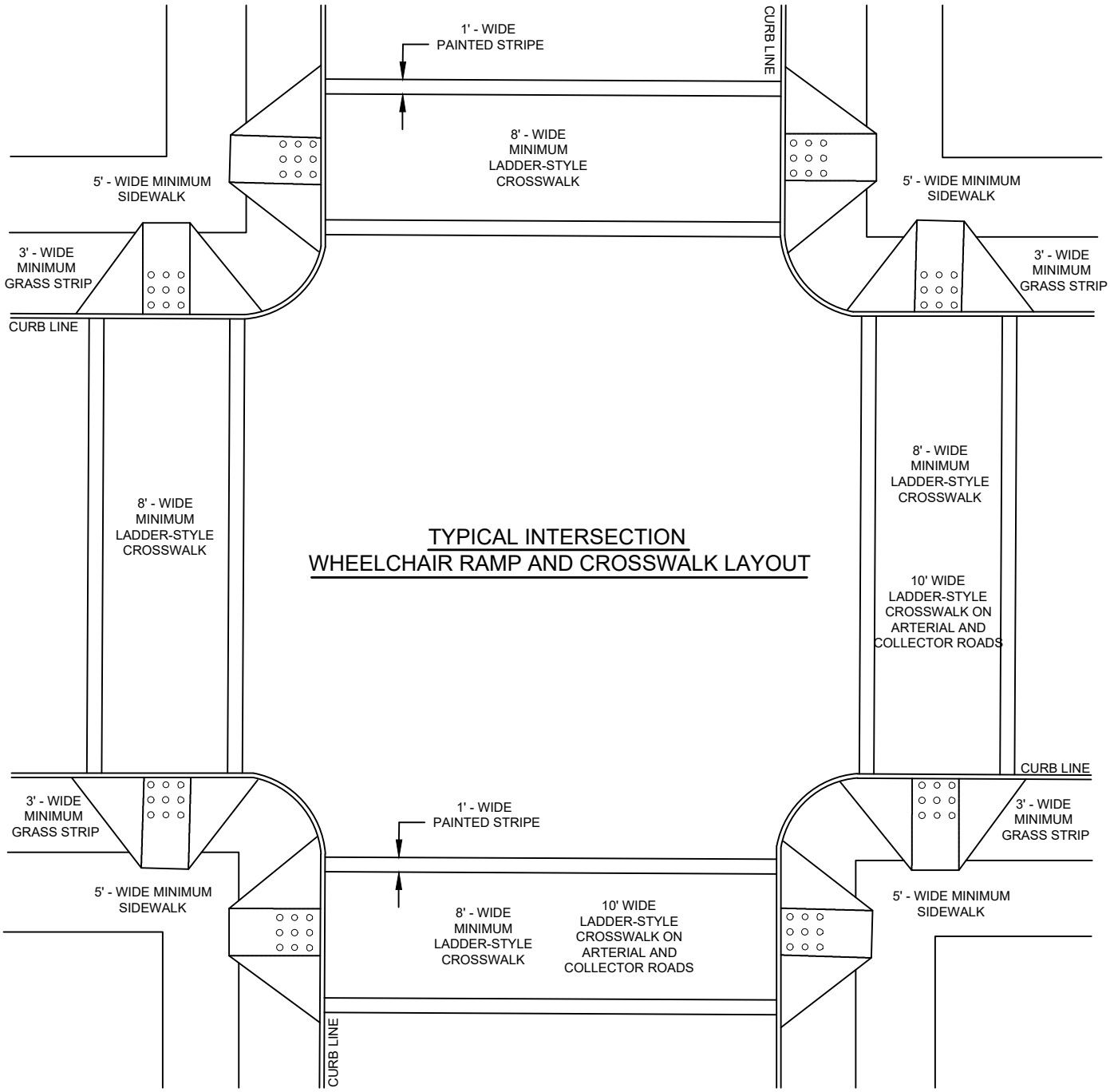


SECTION A-A

NOTE:

PANELS MAY BE CONCRETE PRECAST OR CAST IN PLACE OR OTHER SUITABLE MATERIAL PERMANENTLY APPLIED TO THE RAMP. DETECTABLE WARNING SURFACES SHALL CONTRAST VISUALLY WITH ADJACENT WALKING SURFACES EITHER LIGHT-ON-DARK, OR DARK-ON-LIGHT.

FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	2/26/25	Detectable Warning Panels Wheelchair Ramps	NW
ITEM #'s 452, 453, 454, & 454.1	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

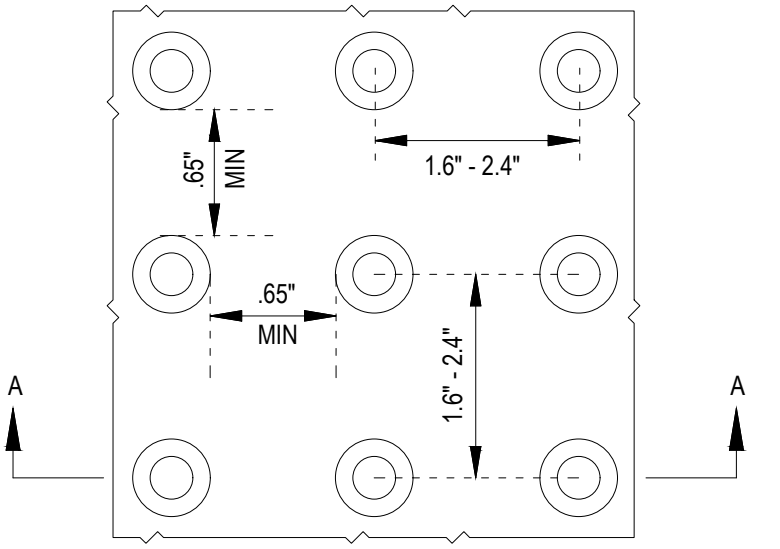


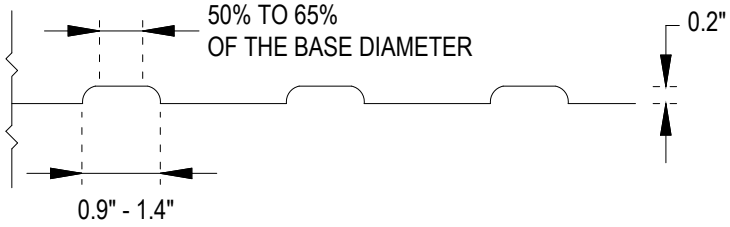
TYPICAL INTERSECTION
WHEELCHAIR RAMP AND CROSSWALK LAYOUT

NOTES:

1. LEVEL LANDINGS CAN OVERLAP.
2. ALL RAMPS BY REGULATION MUST BE PERPENDICULAR TO THE CURB AT THE GUTTER.
3. RAMPS SHOULD BE BOTH ALIGNED TOWARD THE RECEIVING RAMP AND WITHIN THE GENERALLY PREFERRED PEDESTRIAN PHASE OF TRAFFIC. APEX STYLE RAMPS SHALL BE AVOIDED IF FEASIBLE.
4. IF ISLANDS ARE NECESSARY, ISLAND AREAS SUBJECT TO TRAVEL SHOULD BE TREATED AS PLAZAS "NOT MORE THAN 2% SLOPE IN ANY DIRECTION". PLEASE REFER TO MASSDOT CONSTRUCTION DETAIL - E 107.1.0.
5. IF THE SIDEWALK IS GREATER THAN 8 FEET IN TOTAL WIDTH, THEN A 3-FOOT WIDE MINIMUM GRASS STRIP MAY BE INSTALLED AT THE ENGINEER'S DISCRETION.
6. PLEASE REFERENCE THE PUBLIC RIGHT-OF-WAY ACCESSIBILITY GUIDELINES (PROWAG) FOR PROPER DESIGN AND INSTALLATION OF WHEELCHAIR RAMPS.
7. IF A CROSSWALK IS LOCATED ON ARTERIAL OR COLLECTOR ROADS, THE CROSSWALK SHALL BE 10 FEET WIDE ON CENTER.

MARCH 3, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/3/25	Wheelchair Ramp Location Within Intersection	NW
ITEM #454 - WHEELCHAIR RAMPS		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY





NOTES:

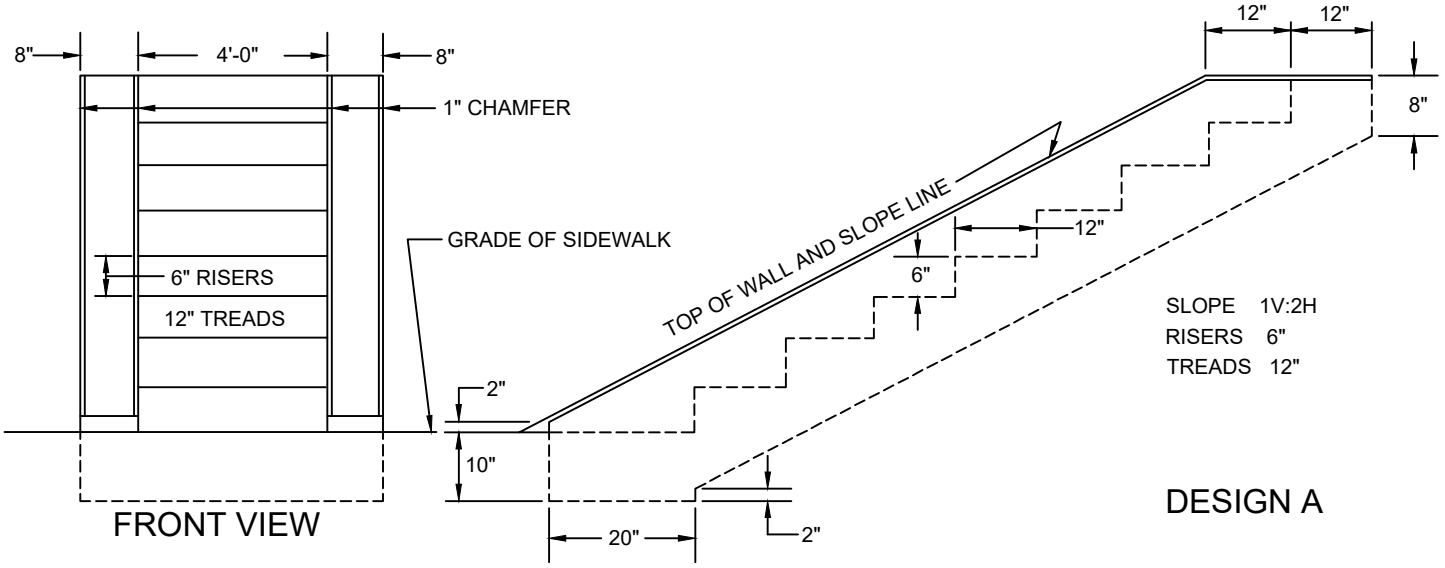
PANELS SHALL BE A HOMOGENOUS GLASS AND CARBON REINFORCED COMPOSITE WHICH IS COLORFAST AND UV STABLE. TRUNCATED DOMES SHALL BE FIBERGLASS REINFORCED FOR ENHANCED DURABILITY. YELLOW COLOR OF THE TWS PANEL SHALL BE UNIFORM THROUGHOUT AND SHALL NOT RELY ON ANY TYPE OF PAINT COATING TO ACHIEVE COLOR STABILITY.

PANELS SHALL BE EQUIPPED WITH ½' x 1½" HEAVY DUTY STEEL BOLTS (FASTENERS) PROTRUDING ½" FROM PANEL BODY. THE BOLTS (FASTENERS) ARE SECURED INTO CORROSION RESIDENT CONCRETE INSERTS TO ENSURE THAT THE BOLTS (FASTENERS) ARE SECURELY EMBEDDED 2" INTO THE CONCRETE. BOLTS (FASTENERS) SHALL BE COVERED WITH A STRUCTURAL WATER TIGHT CAP. THE TWS UNIT SHALL BE FIRMLY PRESSED INTO PLACE IN THE FRESHLY POURED CONCRETE. THE TWS UNITS SHALL BE ABLE TO BE REPLACED BY REMOVING THE BOLTS AND INSERTING A NEW INTERCHANGEABLE TWS UNIT IN THE EXISTING RECESS.

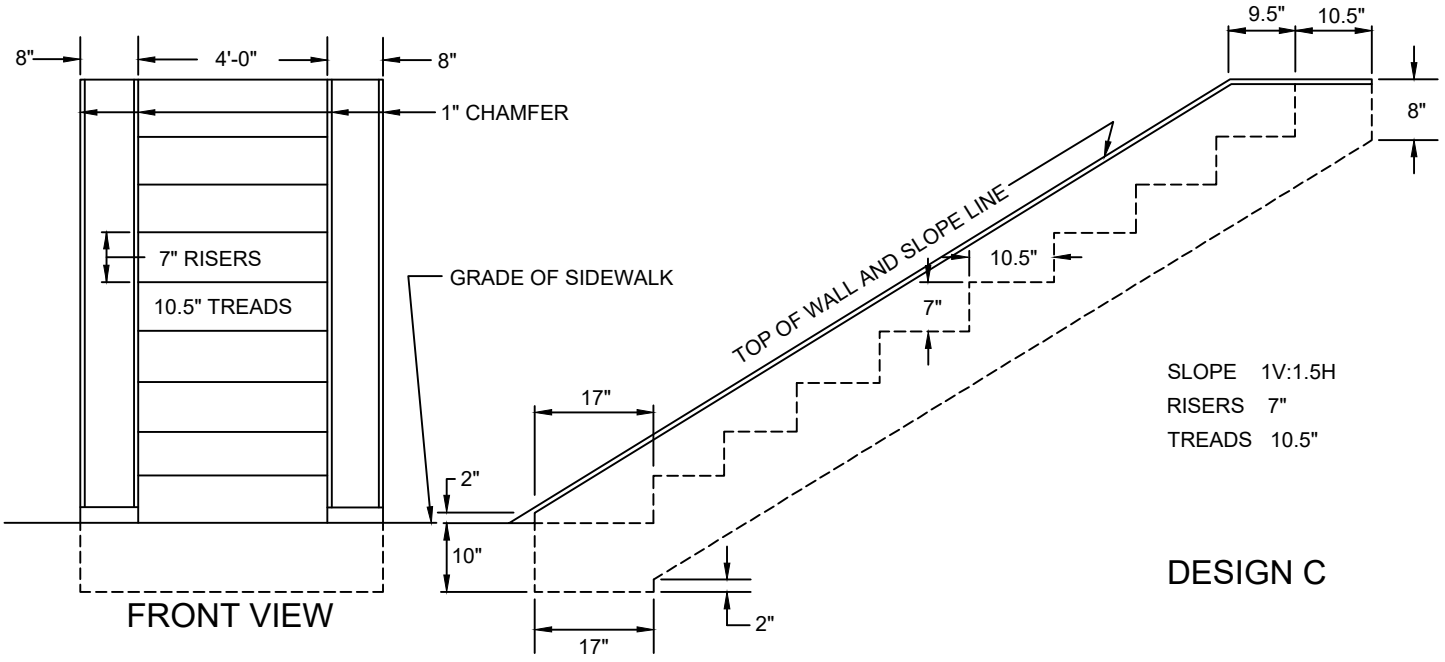
DETECTABLE WARNING PANEL

CITY OF WORCESTER STANDARD DETAILS

SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 454	-



PLEASE NOTE: MASSDOT DESIGN B HAS BEEN DISCONTINUED.



NOTES:

1. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM EXCEPT RISERS AND TREADS WHICH HAVE 0.25" (1/4") TOLERANCE.
2. FOR REINFORCING STEEL AND CONCRETE QUANTITIES SEE SHEET 2 OF 2, AND REFERENCE MASSDOT CONSTRUCTION STANDARD DETAIL DRAWING E 304.2.0.

MARCH 4, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/25	Typical Design for Cement Concrete Steps	NW
ITEM #456 - CONCRETE STEPS	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 2		NO.	DATE	DESCRIPTION	BY

MARCH 6, 2025

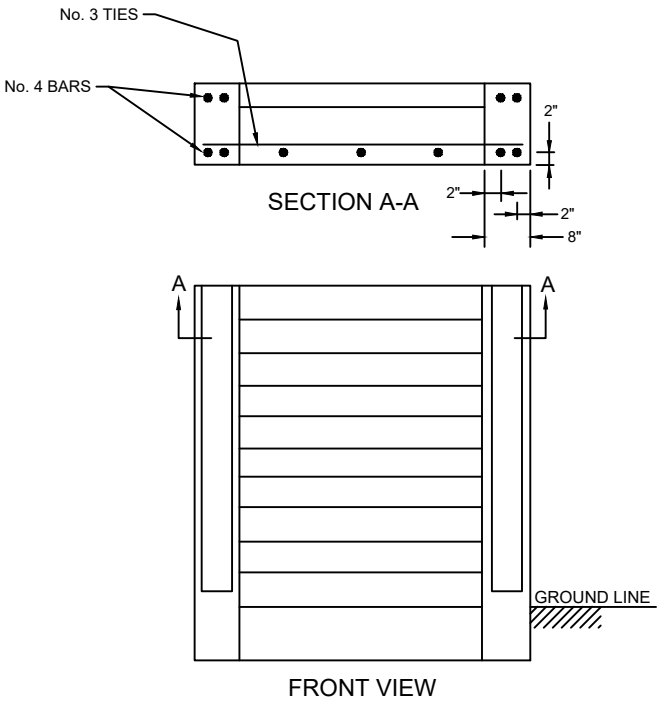
ITEM #456 - CONCRETE STEPS

NOT TO SCALE

SHEET 2 OF 2

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

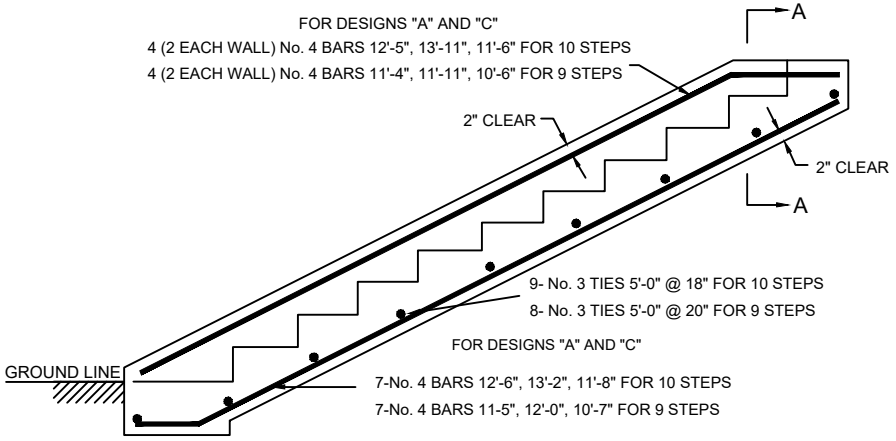
NO.	DATE	DESCRIPTION	BY
1	3/6/25	Typical Design for Cement Concrete Steps	NW



FRONT VIEW

NOTES:

1. FOR DESCRIPTIONS, MATERIALS, AND CONSTRUCTION METHODS SEE MASSDOT STANDARD SPECIFICATIONS.
2. PAYMENT WILL BE BASED ON THE QUANTITIES SHOWN IN THE ACCOMPANYING TABLES.
3. RAILING AS REQUIRED BY AAB AND STATE BUILDING CODE.

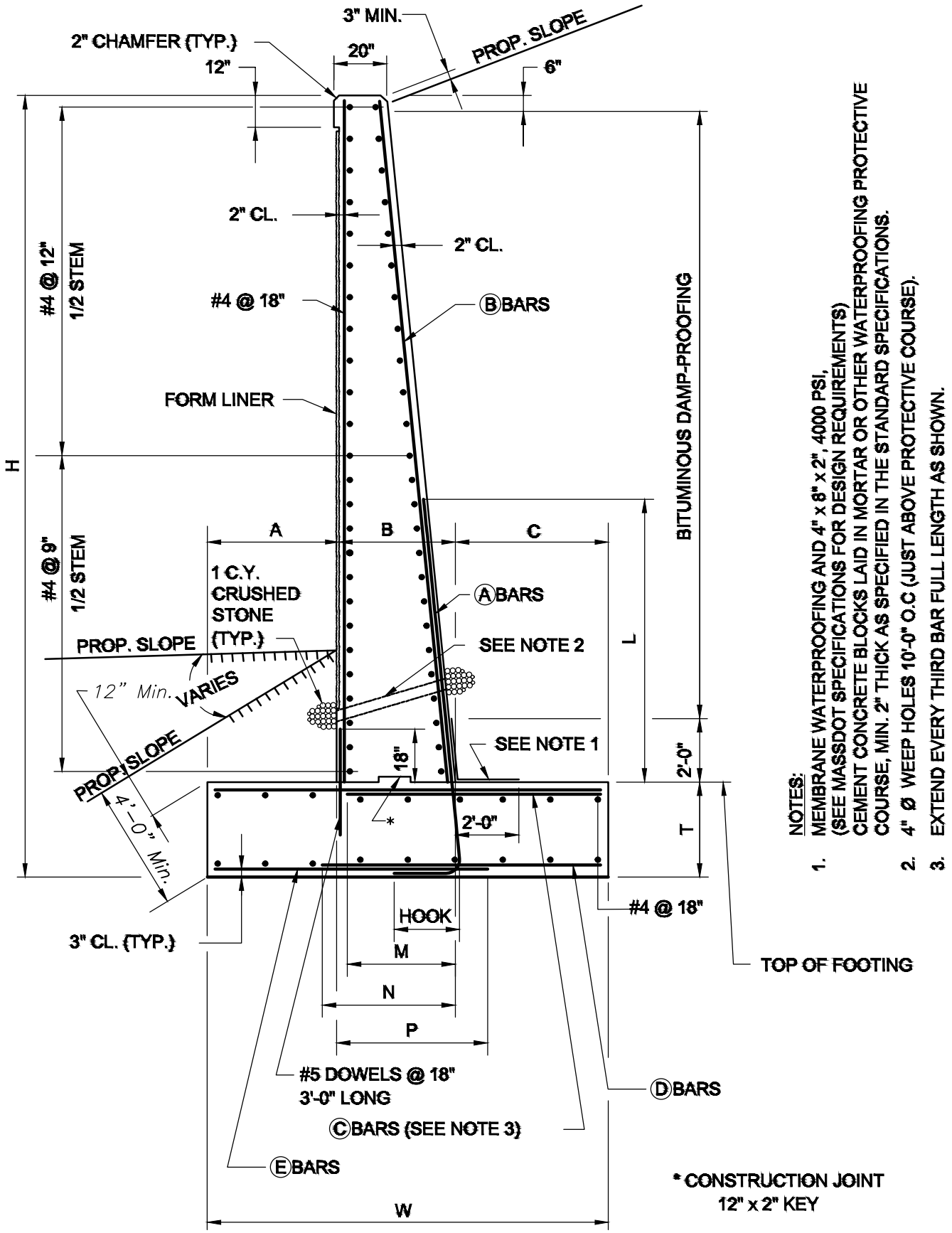


SIDE VIEW

FOR DESIGNS A AND C, SEE SHEET 1 OF 2. REFERENCE MASSDOT STANDARD CONSTRUCTION DETAIL E 304.1.0.
MASSDOT DESIGN B HAS BEEN DISCONTINUED.

	DESIGN A						DESIGN C					
STEP NOS.	QUANTITIES - CU. FT.				TOTAL C.Y.	REINF. STEEL LBS	QUANTITIES - CU. FT.				TOTAL C.Y.	REINF. STEEL LBS
	BASE	STEPS	2-WALLS	TOTAL			BASE	STEPS	2-WALLS	TOTAL		
2	5.55	7.33	6.26	19.15	0.71	--	4.72	6.71	5.65	17.08	0.63	--
3	5.55	11.00	8.48	25.03	0.93	--	4.72	10.06	7.69	22.48	0.83	--
4	5.55	14.66	10.70	30.92	1.15	--	4.72	13.42	9.73	27.87	1.03	--
5	5.55	18.33	12.92	36.81	1.36	--	4.72	16.77	11.78	33.27	1.23	--
6	5.55	22.00	15.15	42.70	1.58	--	4.72	20.12	13.82	38.66	1.43	--
7	5.55	25.66	17.37	48.59	1.80	--	4.72	23.48	15.86	44.06	1.63	--
8	5.55	29.33	19.59	54.47	2.02	--	4.72	26.83	17.90	49.46	1.83	--
9	5.55	33.00	21.81	60.36	2.24	99	4.72	30.19	19.94	54.85	2.03	92
10	5.55	36.66	24.03	66.25	2.45	109	4.72	33.54	22.00	60.25	2.23	102

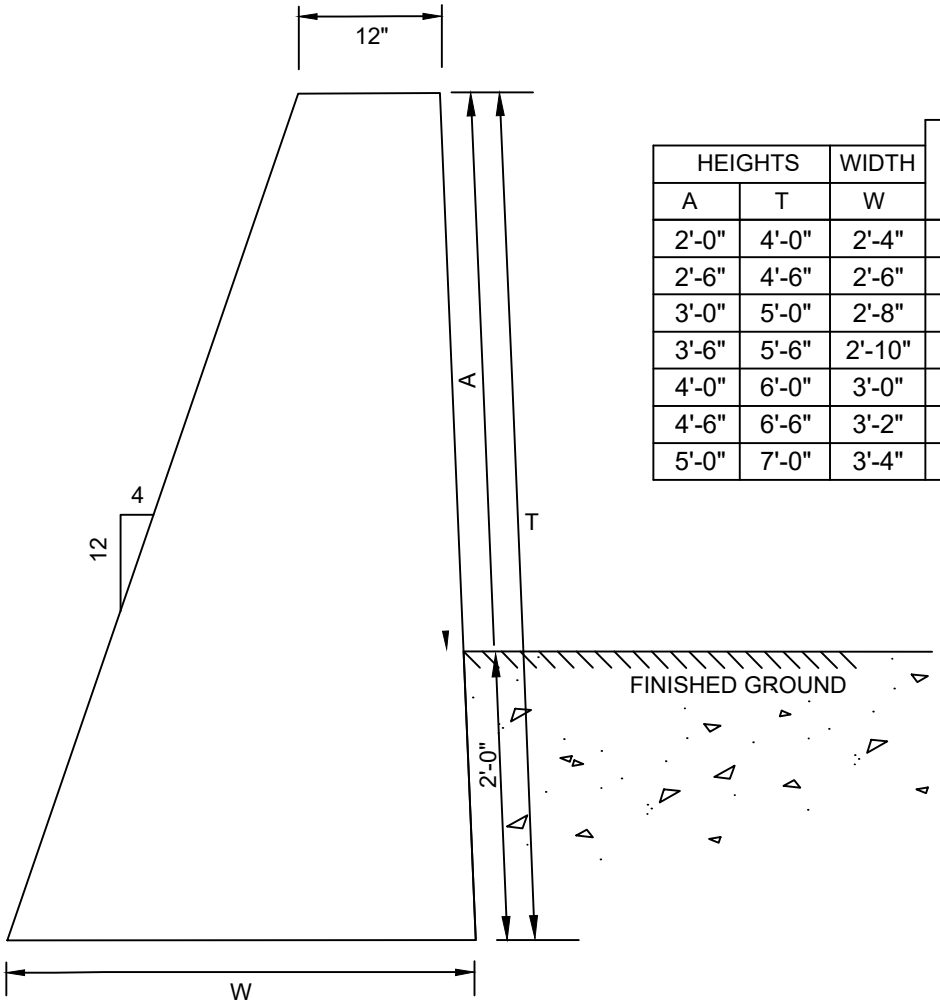
ALL CONCRETE SHALL BE 4,000 PSI (SEE MASSDOT SPECIFICATION FOR DESIGN REQUIREMENTS).



NOTES:

1. MEMBRANE WATERPROOFING AND 4" x 8" x 2", 4000 PSI, (SEE MASSDOT SPECIFICATIONS FOR DESIGN REQUIREMENTS) CEMENT CONCRETE BLOCKS LAID IN MORTAR OR OTHER WATERPROOFING PROTECTIVE COURSE, MIN. 2" THICK AS SPECIFIED IN THE STANDARD SPECIFICATIONS.
2. 4" Ø WEEP HOLES 10'-0" O.C (JUST ABOVE PROTECTIVE COURSE).
3. EXTEND EVERY THIRD BAR FULL LENGTH AS SHOWN.

MARCH 7, 2025	DEPARTMENT OF PUBLIC WORKS AND PARKS Engineering Division 20 East Worcester St, Worcester MA 01604	1	3/7/25	Typ. Precast Cantilever Retaining Wall Section	NW
ITEM #461 - 8'-6" RET. WALL					
NOT TO SCALE					
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



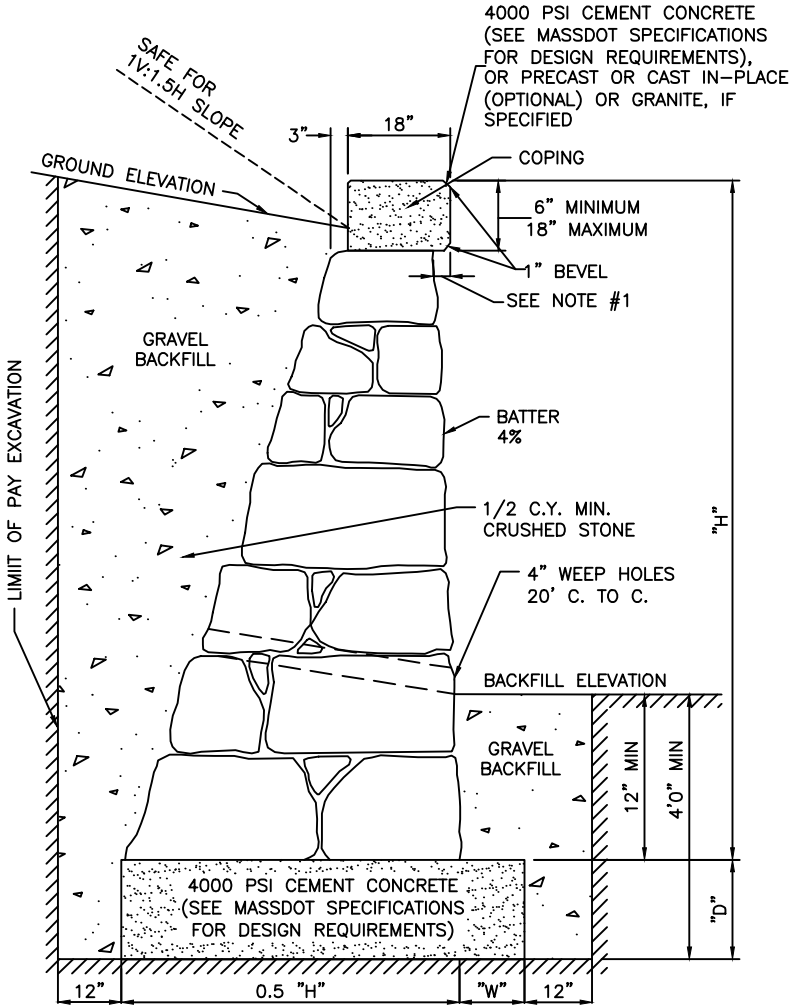
HEIGHTS		WIDTH	AREA (SQ. FT.)	CU. YDS. PER LIN. FT.
A	T	W		
2'-0"	4'-0"	2'-4"	4.67	0.247
2'-6"	4'-6"	2'-6"	7.88	0.292
3'-0"	5'-0"	2'-8"	9.17	0.339
3'-6"	5'-6"	2'-10"	10.54	0.390
4'-0"	6'-0"	3'-0"	12.00	0.444
4'-6"	6'-6"	3'-2"	13.54	0.502
5'-0"	7'-0"	3'-4"	15.16	0.562

NOTES:

1. CLASS "A" CEMENT CONCRETE TO BE USED.
2. EXPANSION JOINTS TO BE PLACED 90 FEET O.C. MAXIMUM WITH INTERMEDIATE CONSTRUCTION JOINTS PLACED AT 30 FEET O.C. MAXIMUM.
3. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
4. PAYMENTS WILL BE BASED ON THE TABLE INCLUDED.

MARCH 11, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/11/25	Typ. Design for Low Concrete Ret. Walls	NW
LOW RETAINING WALLS		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

H (FT)	W (FT)	D (FT)	CONCRETE MASONRY FOOTING		STONE MASONRY EXCLUDING COPING	
			SECTION AREA (SQ.FT.)	VOLUME PER UNIT LENGTH (CU.YD./LIN.FT.)	SECTION AREA (SQ.FT.)	VOLUME PER UNIT LENGTH (CU.YD./LIN.FT.)
5.0	0.75	1.25	4.06	0.150	9.00	0.333
5.5			4.38	0.162	10.63	0.394
6.0			4.69	0.174	12.38	0.458
6.5			5.00	0.185	14.16	0.524
7.0			5.31	0.197	16.05	0.594
7.5			5.63	0.208	18.06	0.669
8.0	1.0	1.5	7.50	0.278	20.16	0.747
8.5			7.88	0.292	22.40	0.829
9.0			8.25	0.306	24.75	0.917
9.5			8.63	0.319	27.22	1.008
10.0	1.2	2.0	12.40	0.459	29.80	1.104
10.5			12.90	0.478	32.50	1.204
11.0			13.40	0.496	35.28	1.307
11.5			13.90	0.515	38.21	1.415
12.0			14.40	0.533	41.25	1.528
12.5			14.90	0.552	44.41	1.645
13.0	1.5	2.5	20.00	0.741	47.68	1.766
13.5			20.63	0.764	51.07	1.891
14.0			21.25	0.787	54.53	2.020
14.5			21.88	0.810	58.14	2.153
15.0			22.50	0.833	61.88	2.292
15.5			23.13	0.856	65.72	2.434
16.0			23.75	0.880	69.68	2.581
16.5	1.8	3.0	30.15	1.117	73.76	2.732
17.0			30.90	1.144	77.90	2.885
17.5			31.65	1.172	82.21	3.045
18.0			32.40	1.200	86.63	3.208
18.5			33.15	1.228	91.38	3.384
19.0			33.90	1.256	96.25	3.565
19.5			34.65	1.283	101.25	3.750
20.0			35.40	1.311	106.38	3.940
20.5			36.15	1.339	111.63	4.134
21.0			36.90	1.367	117.00	4.333
21.5			37.65	1.394	122.50	4.537
22.0			38.40	1.422	128.13	4.745
22.5			39.15	1.450	133.88	4.958
23.0			39.90	1.478	139.75	5.176
23.5			40.65	1.506	145.75	5.398
24.0			41.40	1.533	151.88	5.625
24.5			42.15	1.561	158.13	5.856
25.0			42.90	1.589	164.50	6.093
25.5			43.65	1.617	171.00	6.333
26.0			44.40	1.644	177.63	6.579
26.5			45.15	1.672	184.38	6.829



NOTES:

1. COPING OVERHANG TO BE APPROXIMATELY 3" FOR WALLS 10' OR MORE IN HEIGHT AND APPROXIMATELY 2" FOR WALLS LESS THAN 10' IN HEIGHT; IN A CONTINUOUS WALL OF VARYING HEIGHT THE OVERHANG WILL BE APPROXIMATELY 2" OR 3" FOR THE ENTIRE LENGTH.
2. ALL DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENT WILL BE BASED ON THE ACCOMPANYING TABLE
4. TO BE FOUNDED ON SUITABLE SOIL

COPING TO BE PRECAST CONCRETE OR GRANITE OF UNIFORM DEPTH FOR THE ENTIRE LENGTH. DEPTH OF CONCRETE TO BE 1/12 THE AVERAGE "H" WITHIN THE LIMITS SHOWN. DEPTH OF GRANITE TO BE AS SHOWN ON THE PLANS, 6" OR 9".

FOR CHAIN LINK FENCE ON TOP OF WALL, THE COPING SHALL BE CONCRETE CAST-IN-PLACE WITH A MINIMUM DEPTH OF 12". THE LENGTH OF THE GALVANIZED PIPE SLEEVES FOR FENCE POSTS SHALL BE EQUAL TO THE DEPTH OF THE COPING.

MARCH 7, 2025

ITEM #464 - STONE MASONRY WALL

NOT TO SCALE

SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/7/25	TYPICAL DESIGN CEMENTED STONE MASONRY	NW

Revision Date 2-27-2026

MARCH 7, 2025

CONCRETE SPLASH PADS

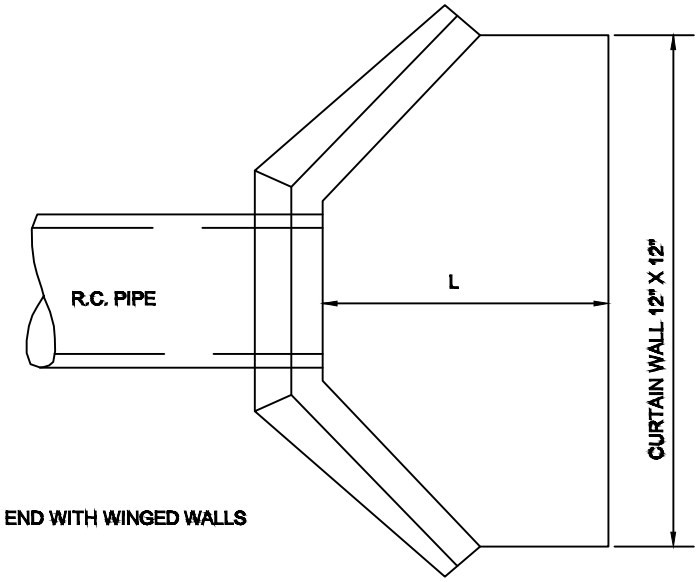
NOT TO SCALE

SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS

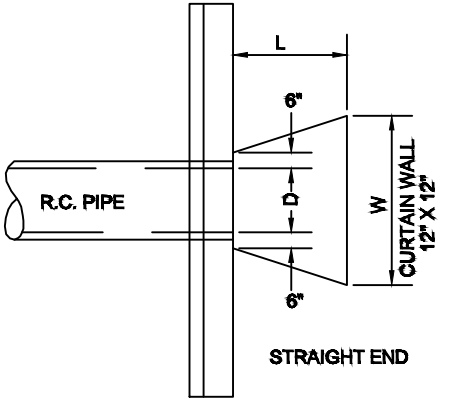
Engineering Division

20 East Worcester St, Worcester MA 01604



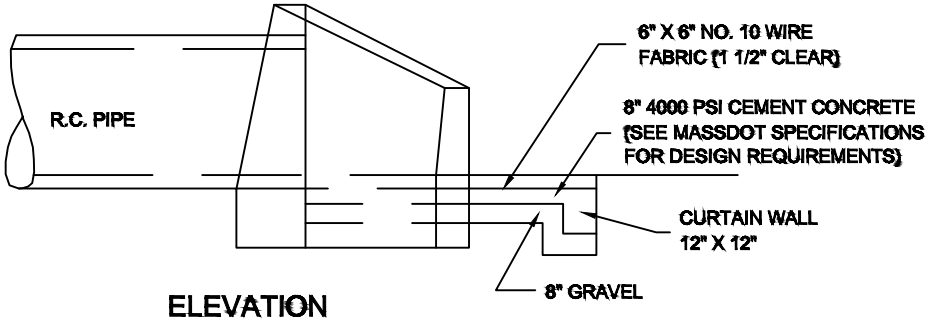
END WITH WINGED WALLS

PLAN

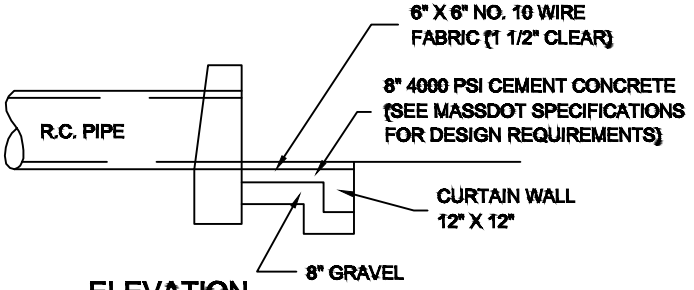


STRAIGHT END

PLAN



ELEVATION



ELEVATION

PIPE DIAM. (IN)	36	42	48	54	60	66	72	84
L (FT)	6	7	8	9	10	11	12	14

PIPE DIAM. (IN)	12	15	18	21	24	30
L	3'-0"	3'-0"	3'-0"	3'-6"	4'-0"	5'-0"
W	4'-0"	4'-0"	4'-6"	5'-3"	6'-0"	7'-6"

NOTE:

1) ALL PIPE DIAMETERS NOMINAL SIZE

NO.	DATE	DESCRIPTION	BY
1	3/7/25	Typical Design for Concrete Splash Pads	NW

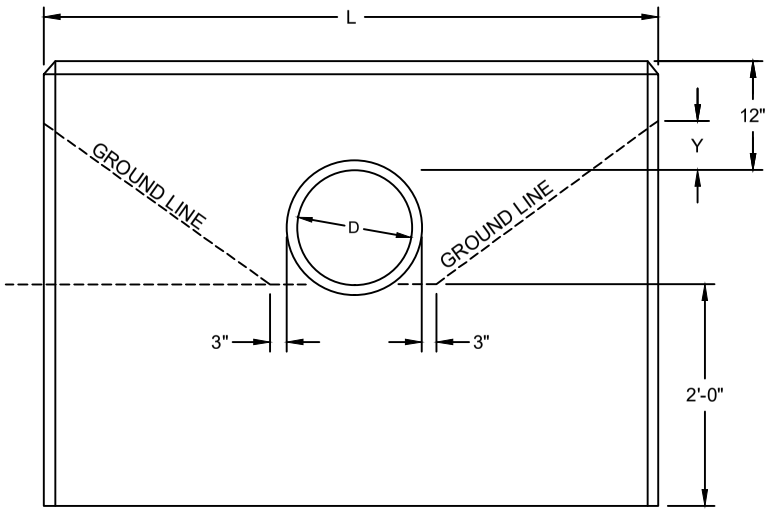
MARCH 10, 2025

CONCRETE & FIELD STONE MASONRY ENDS - 8" TO 30"

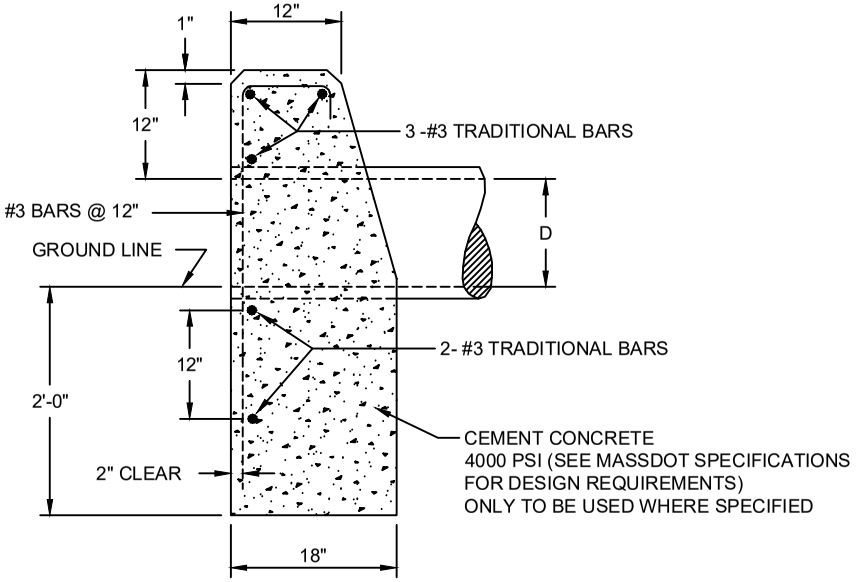
NOT TO SCALE

SHEET 1 OF 2

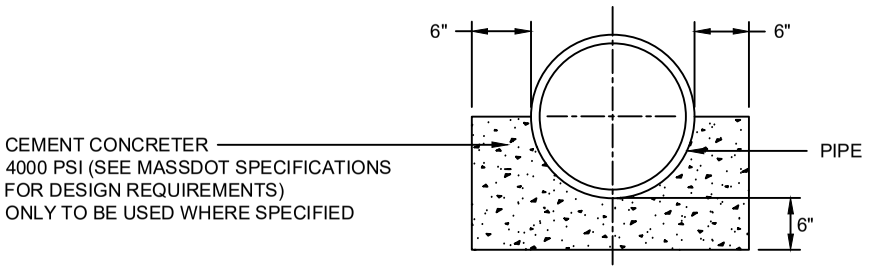
DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604



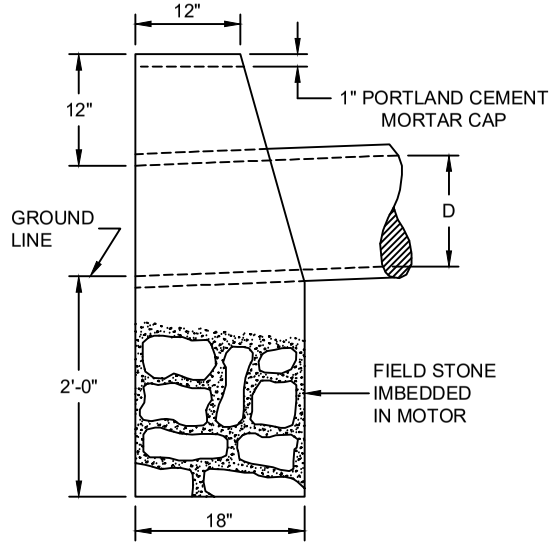
FRONT ELEVATION



END ELEVATION



CONCRETE CRADLE
FOR PIPE CULVERTS



END ELEVATION

NOTES:

1. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST STANDARD SPECIFICATIONS.
2. ALL CONCRETE DIMENSIONS SHOWN ARE MINIMUM.
3. PAYMENTS WILL BE BASED ON THE ACCOMPANYING TABLE.
4. FOR QUANTITY TABLES SEE E 206.4.1

NO.	DATE	DESCRIPTION	BY
1	3/10/25	Conc./Field Stone Masonry Ends for 8"– 30" Culvert	NW

ENGLISH UNITS								
PIPE DIAM. D	1 1/2 : 1 SLOPE				2 : 1 SLOPE			
	L	CONC. OR F.S.M. CU. YDS.	STEEL LBS.	TRENCH EXCAV. 1'-0" DEPTH CU. FT.	L	CONC. OR F.S.M. CU. YDS.	STEEL LBS.	TRENCH EXCAV. 1'-0" DEPTH CU. FT.
8"	4'-2"	0.77	15	21.60	5'-10"	1.08	21	27.40
10"	4'-10"	0.92	20	23.91	6'-8"	1.28	23	30.35
12"	5'-6"	1.08	21	26.25	7'-6"	1.49	29	33.25
15"	6'-6"	1.34	24	29.75	8'-9"	1.82	32	37.63
18"	7'-6"	1.61	30	33.25	10'-0"	2.18	39	42.00
21"	8'-6"	1.95	34	37.35	11'-6"	2.62	43	47.25
24"	9'-3"	2.16	35	39.38	12'-6"	2.97	50	50.75
30"	3.86	3.86	44	43.75	15'-0"	3.86	62	59.50
	Y	4" FOR 1 1/2 : 1 SLOPE						
		6" FOR 2 : 1 SLOPE						

MARCH 10, 2025

CONCRETE & FIELD STONE MASONRY ENDS - 8" TO 30"

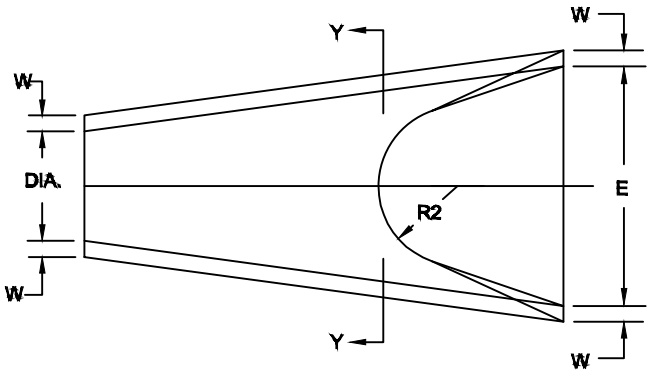
NOT TO SCALE

SHEET 2 OF 2

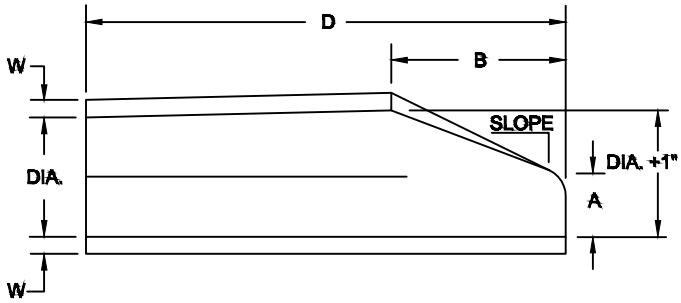
DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/10/25	Conc./Field Stone Masonry Ends for 8"– 30" Culvert	NW

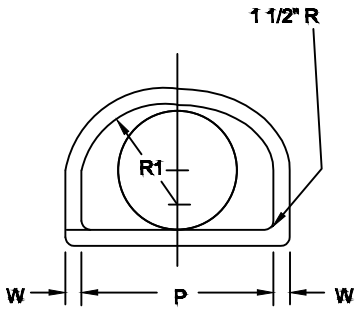
Revision Date 2-27-2026



PLAN



SECTION



SECTION Y-Y

TABLE
[ALL DIMENSIONS ARE inches OR feet]

DIAMETER Inch	W	A	B	D	E	P	DIA. +1"	R1	R2	SLOPE
12"	2"	4"	2'-0"	6'-0"	2'-0"	19.94"	13"	10.13"	9"	1V : 3H
15"	2.25"	6"	2'-3"	6'-0"	2'-6"	24.31"	16"	12.5"	11"	1V : 3H
18"	2.5"	9"	2'-3"	6'-0"	3'-0"	29"	19"	15.5"	12"	1V : 3H
21"	2.75"	9"	2'-11"	6'-0"	3'-6"	31.63"	22"	16.13"	13"	1V : 3H
24"	3"	9.5"	3'-7.5"	6'-0"	4'-0"	33.19"	25"	16.81"	14"	1V : 3H
27"	3.25"	10.5"	4'-0"	6'-0"	4'-6"	36"	28"	17.56"	14.5"	1V : 3H
30"	3.5"	12"	4'-6"	6'-0"	5'-0"	37"	31"	18.5"	15"	1V : 3H
36"	4"	15"	5'-3"	8'-0"	6'-0"	47.81"	37"	24.31"	20"	1V : 3H
42"	4.5"	21"	5'-3"	8'-0"	6'-6"	53.88"	43"	27.5"	22"	1V : 3H
48"	5"	24"	6'-0"	8'-0"	7'-0"	56.5"	49"	28.5"	22"	1V : 3H

NOTES:
1. SEE STANDARD SPECIFICATIONS FOR THE TYPE OF PIPE TO BE USED (BELL & SPIGOT OR TONGUE & GROOVE)
2. SEE STANDARD SPECIFICATIONS FOR THE TYPE OF PIPE AND PLACING OF STEEL REINFORCEMENT.
3. THE JOINTS ARE TO BE COMPATIBLE WITH THE MAIN RUN OF PIPE.

MARCH 10, 2025		DEPARTMENT OF PUBLIC WORKS AND PARKS Engineering Division 20 East Worcester St, Worcester MA 01604	1	3/10/25	Reinforced Concrete Pipe Flared Ends	NW
REINFORCED CONCRETE PIPE FLARED ENDS						
NOT TO SCALE						
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

MARCH 11, 2025

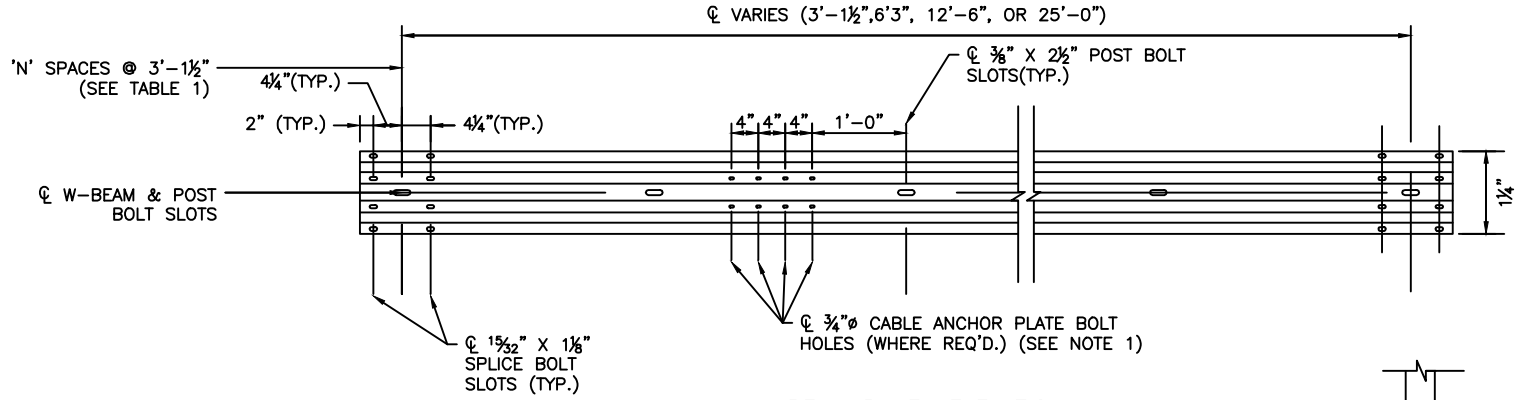
ITEM #468 - GUARDRAIL TYPE SS

NOT TO SCALE

SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/11/25	Typical Design Guardrail Steel Type SS	NW



W–BEAM PANEL ELEVATION

TABLE 1: PANEL SUMMARY

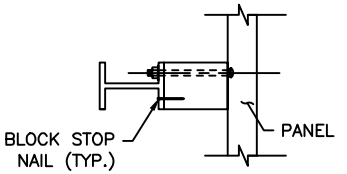
PANEL TYPE	NUMBER OF SPACES 'N'	GAUGE
6'–3" W–BEAM	2	12
9'–4½" W–BEAM	3	12
12'–6" W–BEAM	4	12
25'–0" W–BEAM	8	12

TABLE 2: 5/8" BUTTON–HEAD BOLT LENGTHS

APPLICATION(S)	LENGTH 'L'	MIN. THREAD LENGTH
PANEL SPLICE	1¼"	FULL LENGTH
STEEL POST MOUNT–SINGLE FACED	10"	4"
TIMBER POST MOUNT–SINGLE FACED	18"	4"
STEEL POST MOUNT–DOUBLE FACED	10"	4"
TERMINAL CONNECTOR SPLICE	2"	FULL LENGTH

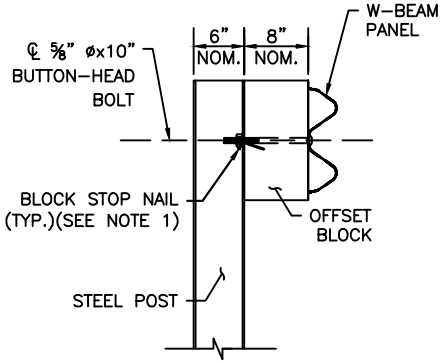
NOTES:

1. INCLUDE ¾"ø CABLE ANCHOR PLATE BOLT HOLES ONLY WHERE REQUIRED FOR THE INSTALLATION OF THE CABLE ANCHOR PLATE SHOWN ON 400.4.1 AND 400.4.2.
2. INSTALL BUTTON–HEAD BOLTS FOR POST MOUNTS AND SPLICES, AS REQUIRED. BOLT LENGTHS SHALL CONFORM TO TABLE 2 UNLESS OTHERWISE INDICATED. PLACE WASHERS UNDER NUTS; WASHERS ARE OPTIONAL AGAINST STEEL FLANGES. DO NOT PLACE WASHERS BETWEEN BOLT HEADS AND PANELS UNLESS OTHERWISE INDICATED.

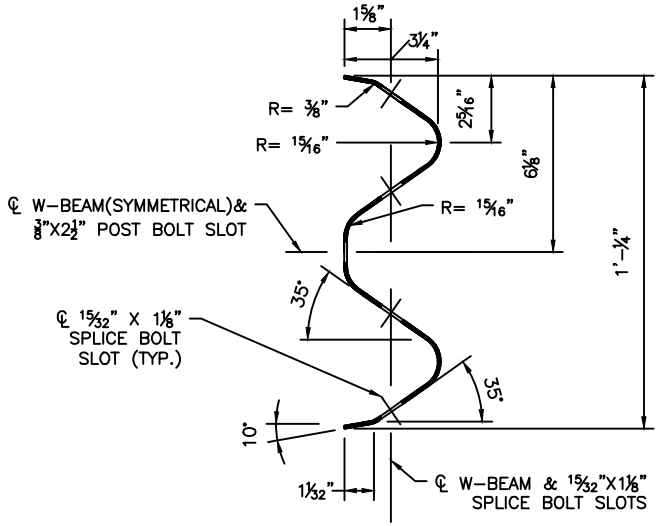


PLAN

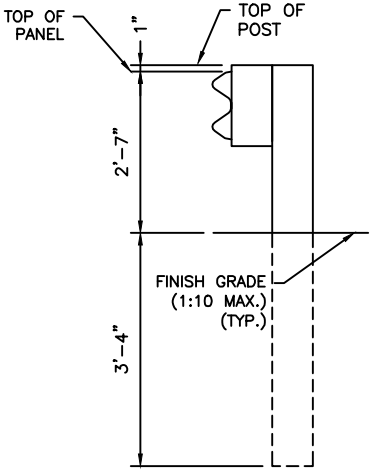
W–BEAM STEEL POST



SECTION



W–BEAM PANEL SECTION



W–BEAM

MARCH 12, 2025

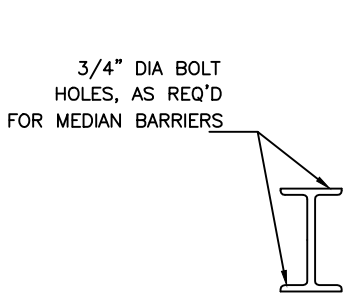
468 - ITEM DESCRIPTION

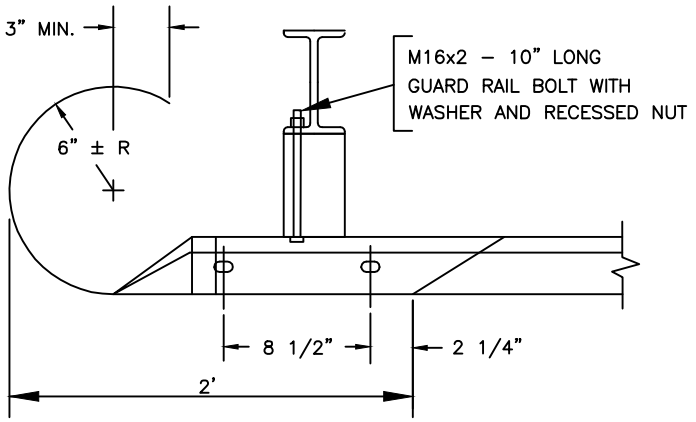
NOT TO SCALE

SHEET 1 OF 1

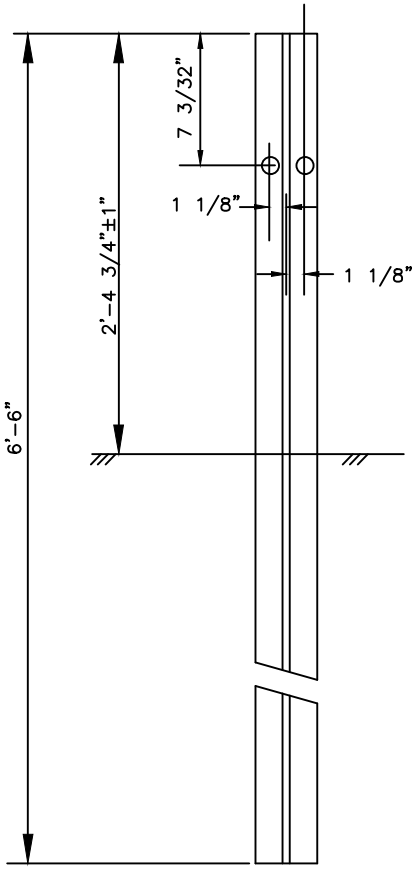
DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
01	03/12/2025	GUARDRAIL STEEL TYPE SS/W	TK

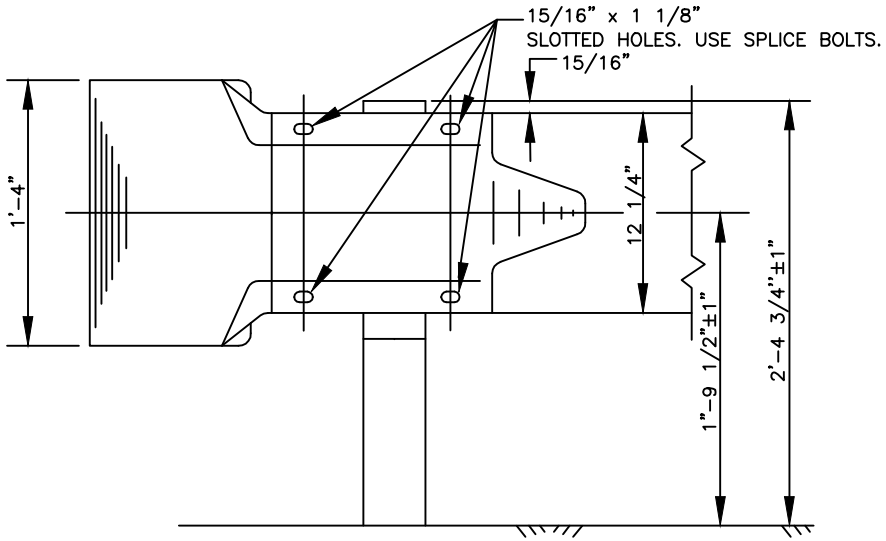




PLAN
TERMINAL SECTION



POST

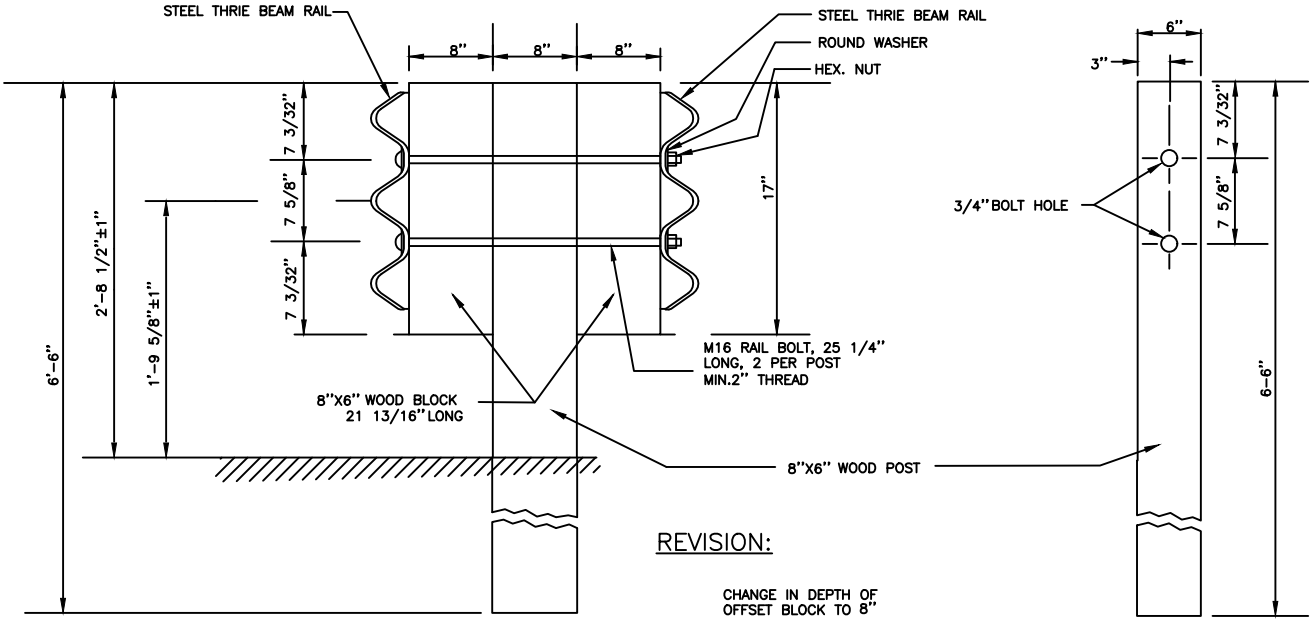


FRONT
TERMINAL SECTION

DIRECTION
OF TRAFFIC

NOTES:

1. POST TO BE FABRICATED FROM W6"X9" STEEL SECTIONS AS SHOWN.
2. POST TO BE 3/4" DIA. (STD GALV WASHERS TO BE USED AT THESE CONNECTIONS).
3. FOR BLOCK–OUT DETAILS SEE E 401.20.0.

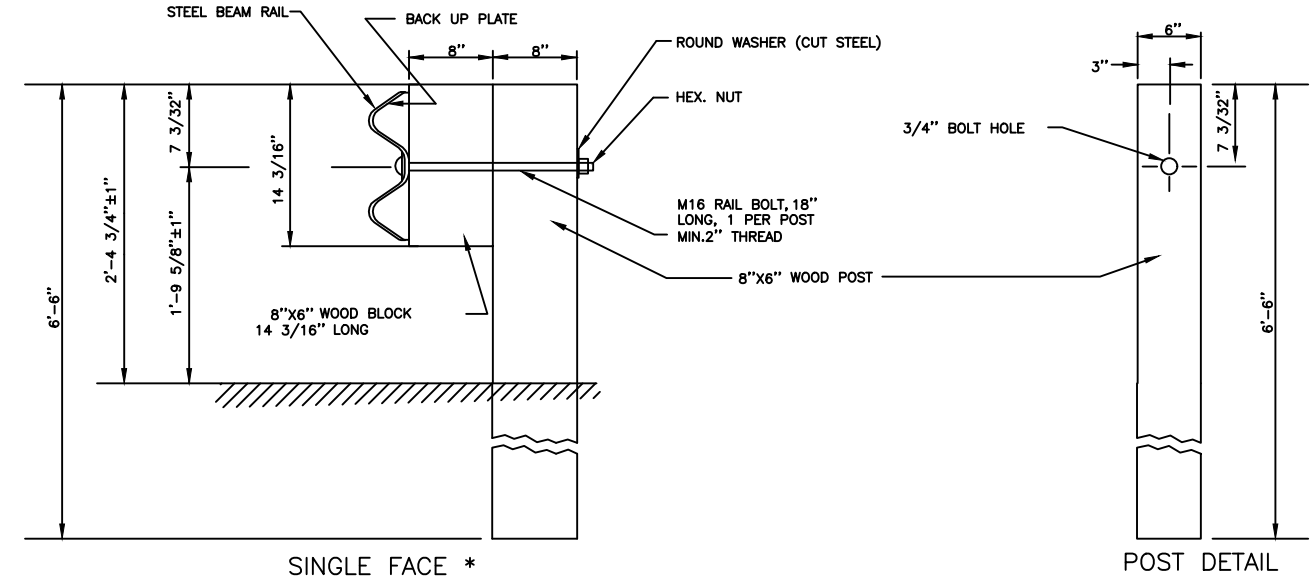


REVISION:

CHANGE IN DEPTH OF OFFSET BLOCK TO 8"

DOUBLE FACE

POST DETAIL



SINGLE FACE *

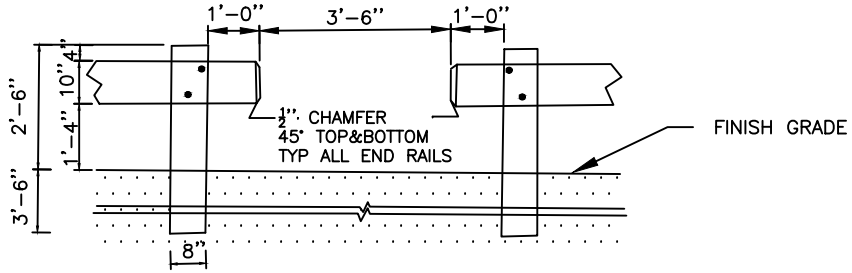
POST DETAIL

* WHEN PLACED IN MEDIAN CHANGE TO THRIE BEAM, AND CHANGE HEIGHT TO 2'–8 1/2''±1''.

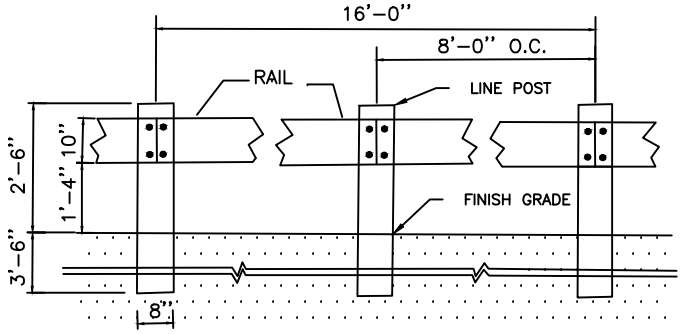
NOTES:

1. POST SPACING , APPROACH END & TRAILING ENDS ARE THE SAME AS THOSE SHOWN FOR STEEL "H" POSTS.
2. ALL NUTS,BOLTS & WASHERS ARE TO BE GALVANIZED.
3. ALL MATERIALS & DIMENSIONS OF FITTINGS NOT SHOWN ABOVE ARE TO BE SIMILAR TO THE CORRESPONDING ELEMENTS SHOWN FOR STEEL "H" POSTS.
4. TERMINAL SECTIONS FOR DOUBLE FACE & SINGLE FACE GUARD RAIL ARE SHOWN ON DRAWINGS :(MASS DOT 2016) E 401.6.0 , E 401.8.0
5. ALL SPLICES ARE TO BE MADE AT POSTS.
6. FOR THE TYPE OF WOOD & WOOD TREATMENT, OTHER MATERIALS & METHODS OF CONST, SEE STANDARD SPECIFICATIONS & SPECIAL PROVISIONS.
7. FOR DETAILS OF SLOT IN BACK–UP PLATE SEE (MASS DOT 2016) E 401.7.0 & E 401.8.0
8. BACK–UP PLATE IS PLACED BEHIND RAIL ELEMENTS AT INTERMEDIATE POSTS, I.e. NON SPLICE LOCATION.
9. STEEL POSTS ARE TO BE SUBSTITUTED AT THE SAME BID PRICE, FOR CERTAIN WOOD POSTS IN A WOOD POST RUN WHEN CEMENT CONCRETE EMBEDMENT IS REQUIRED.

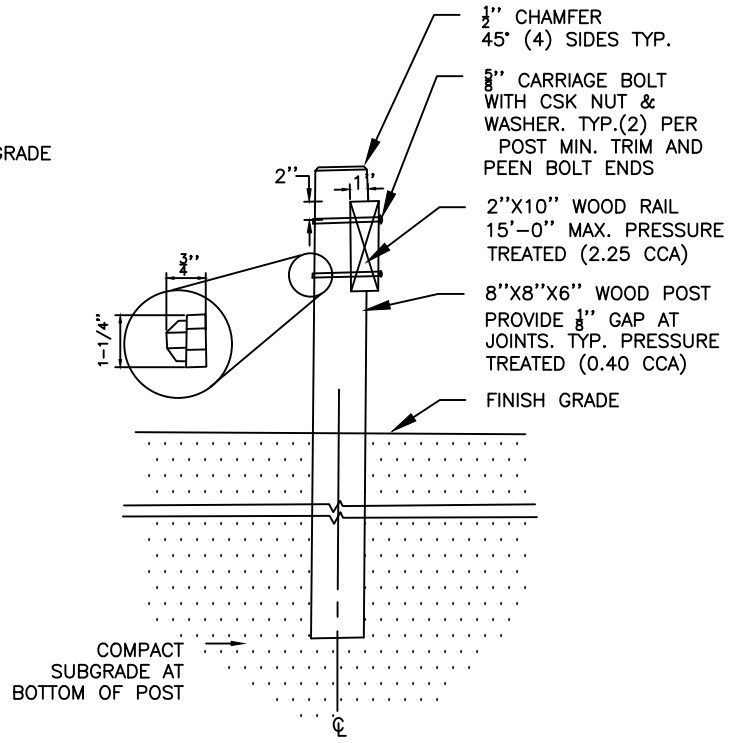
MARCH 17, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	01	03/17/2025	STEEL BEAM HIGHWAY GUARD WITH WOOD POST	TK
468.2 - ITEM DESCRIPTION		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



TYPICAL 42'' RAILING OPENING



TYPICAL RAILING ELEVATION



TYPICAL SECTION

MARCH 11, 2025

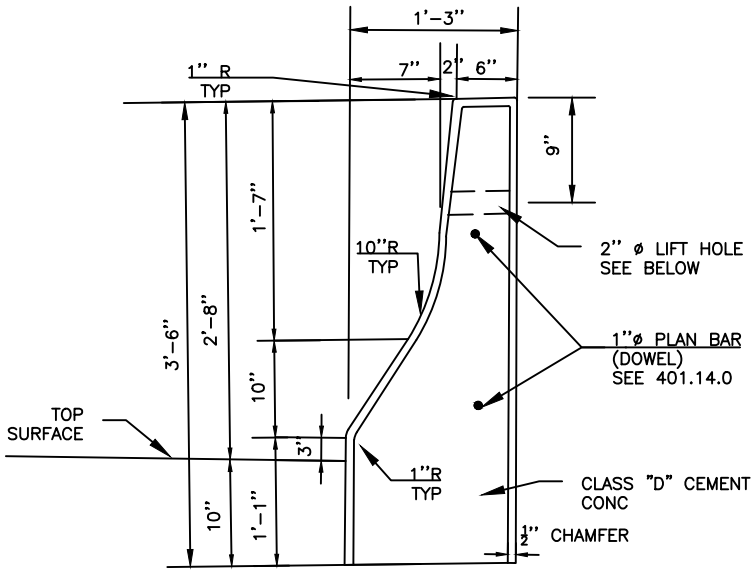
468.1 - ITEM DESCRIPTION

NOT TO SCALE

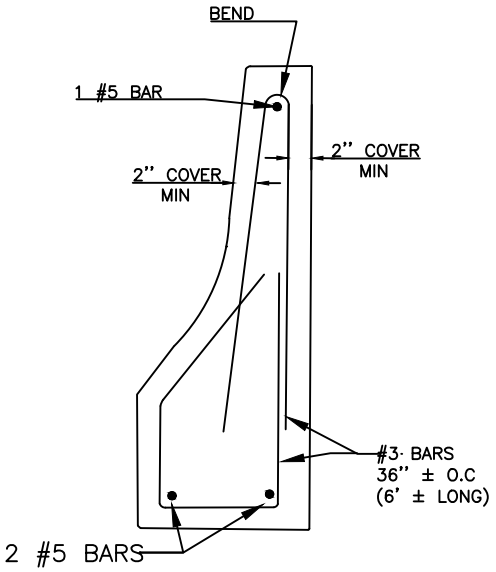
SHEET 1 OF 1

DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

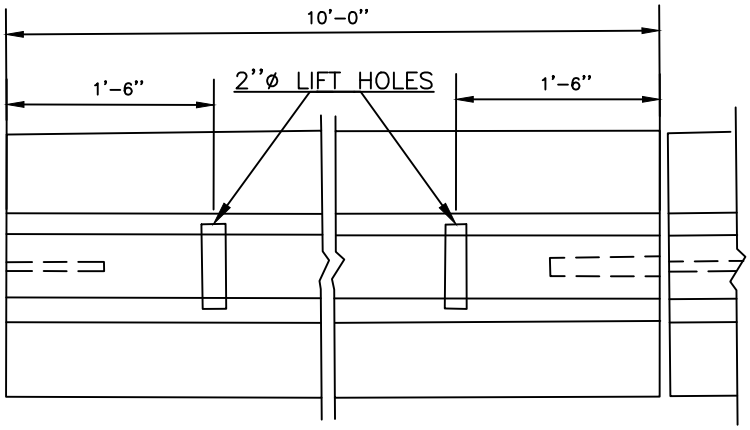
NO.	DATE	DESCRIPTION	BY
01	03/11/2025	WOOD GUARDRAIL DETAIL	TK



END ELEVATION



REINFORCING DIAGRAM



NOTES:

1. THE MAXIMUM OPENING BETWEEN SECTIONS TO BE NO GREATER THAN $\frac{1}{4}$ INCH.
2. A $\frac{1}{2}$ INCH PREMOULDED EXPANSION JOINT FILLER TO BE PLACED EVERY 40 FEET.
3. FOR FOUNDATION DETAILS SEE 401.15.0.
   FOR DESCRIPTION ,MATERIALS, AND CONSTRUCTION METHOD SEE LATEST SPECIFICATIONS.
   FOR BARRIER DETAILS ON STRUCTURES, SEE BRIDGE MANUAL

MARCH 7, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	01	03/07/2025	PRE–CAST CONCRETE MEDIAN BARRIER SINGLE FACE	TK
469 - ITEM DESCRIPTION		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY

MARCH 10, 2025

474,475,476 - ITEM DESCRIPTION

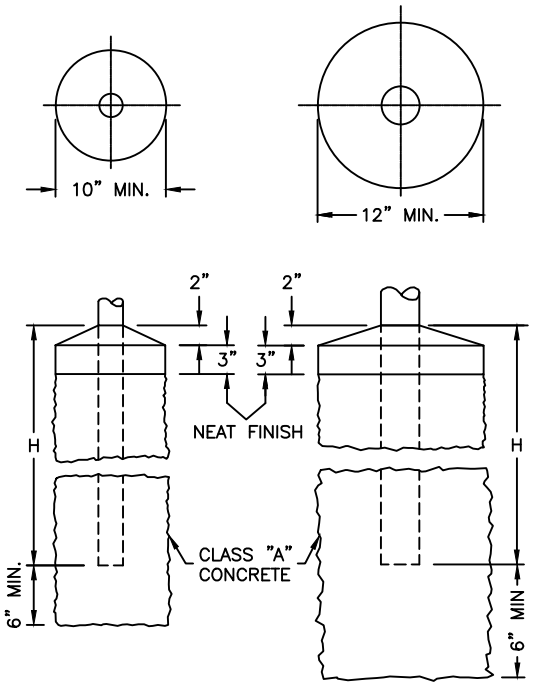
NOT TO SCALE

SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/10/25	CHAIN LINK FENCE	TK

POST BASES

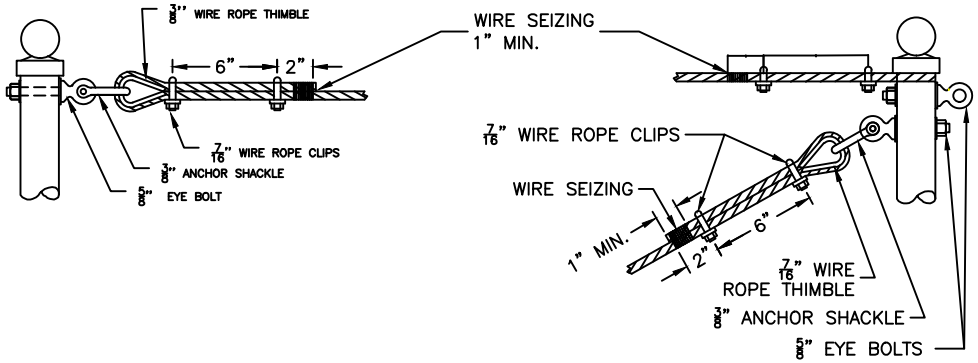


FOR CORNER, END, LINE, AND PULL POSTS

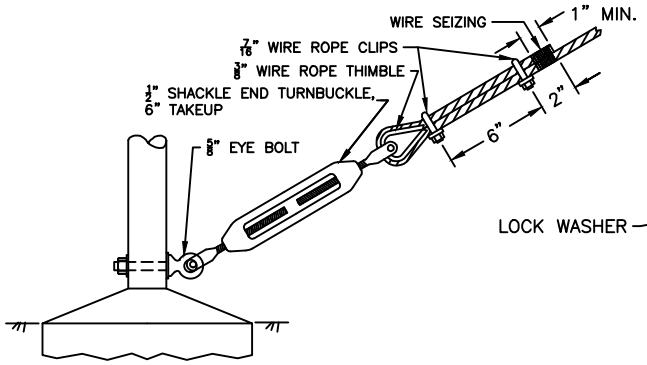
FOR GATE POSTS

FENCE HIEGHT	MIN. H
5' OR LESS	2'-6"
OVER 5'	3'-0"

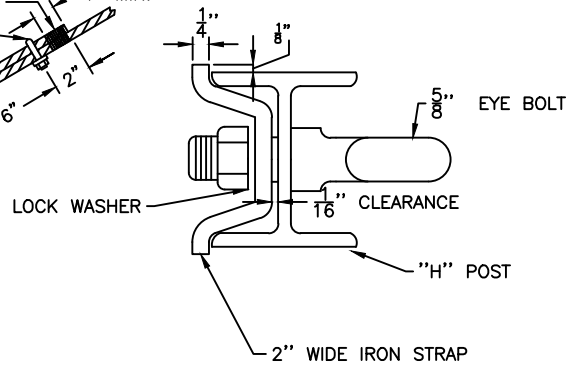
DETAILS OF CABLE ATTACHMENTS



FOR END PULL POST



FOR FASTENING TO BASE OF POST



EYE BOLT TO "H" COLUMN POST

NOTE:
FOR EYE BOLT INSTALLATION THROUGH PIPE SECTIONS, USE 2 WASHERS ON " SHOULDER SIDE" AND 1 WASHER WITH LOCK WASHERS ON "NUT SIDE" OF POSTS.

MARCH 7, 2025

475,476 - ITEM DESCRIPTION

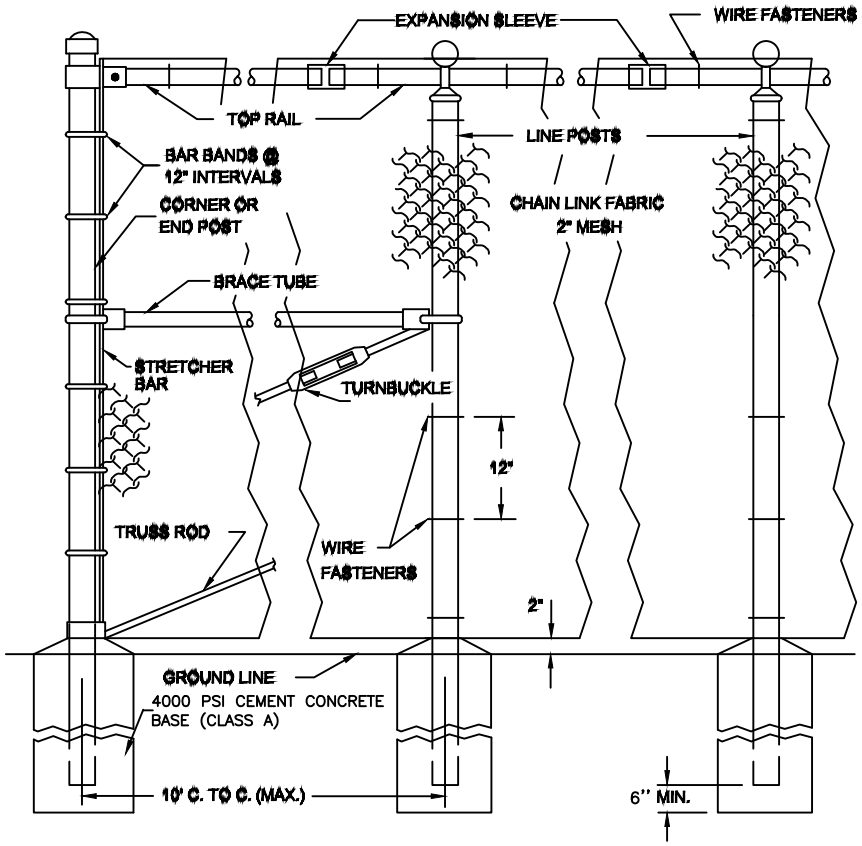
NOT TO SCALE

SHEET 1 OF 1

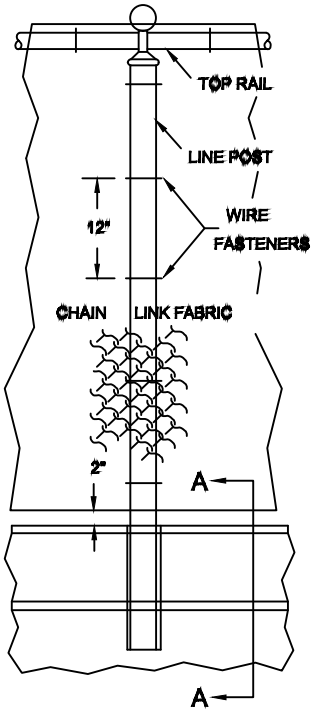
DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

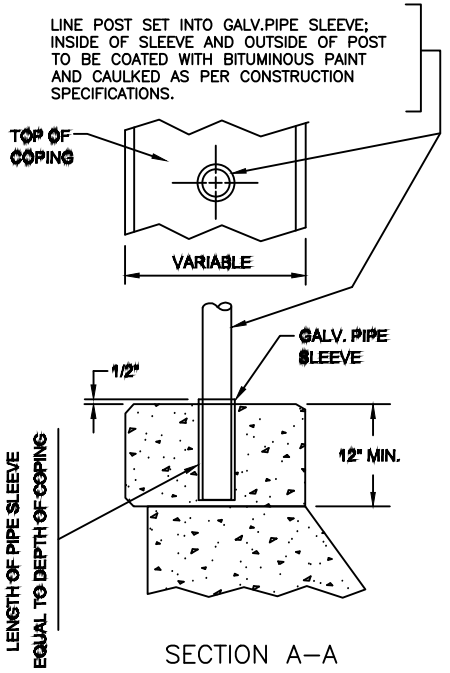
NO.	DATE	DESCRIPTION	BY
01	03/07/2025	CHAIN LINK FENCE WITH TOP RAIL	TK

FENCE ON GROUND



FENCE ON CONCRETE WALL





SECTION A–A

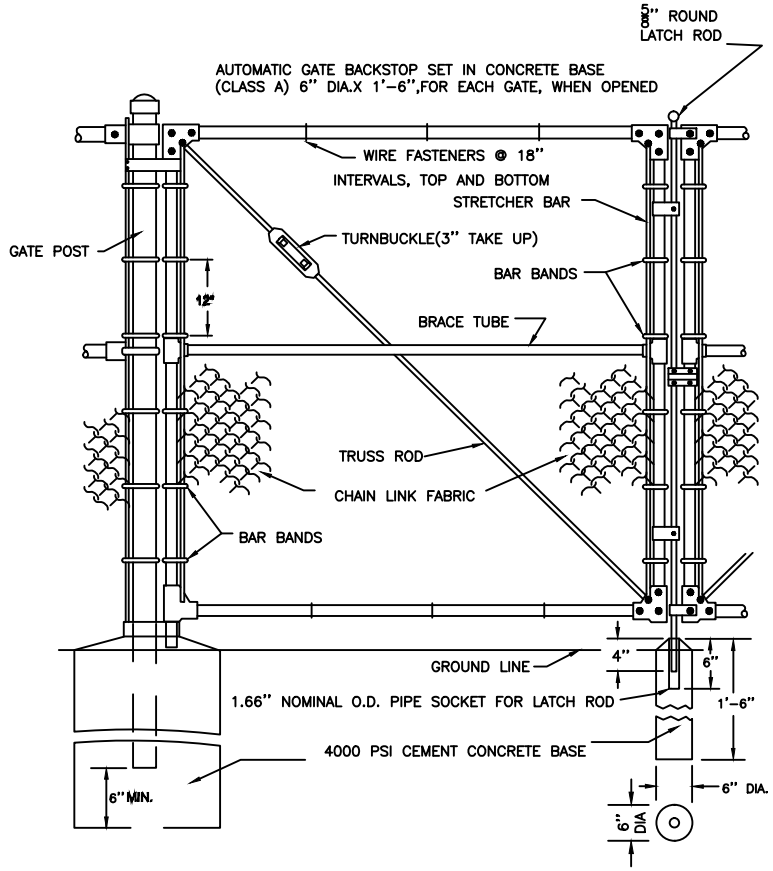
NOTES:

1. FABRIC FOR FENCES 4' OR LESS IN HEIGHT.
   TOP SELVAGE TO HAVE KNUCKLED FINISH .BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
   FABRIC FOR FENCES 5' OR OVER IN HEIGHT.
   BOTH TOP AND BOTTOM SELVAGE TO HAVE TWISTED AND BARBED FINISH UNLESS OTHERWISE NOTED.
2. THE HEIGHT OF FENCE TO BE AS SPECIFIED.
3. GRADE OF FENCE TO BE PARALLEL WITH THE GRADE OF SIDEWALKS, CURBING, GROUND OR TOP OF WALL.
4. LINE POSTS TO BE SPACED 10'–0" C.TO C. MAXIMUM EXCEPT ON CURVES WHERE THEY SHALL BE SPACED AS FOLLOWS:

CURVES 200' TO 500' RADIUS	8'–0" C. TO C. MAXIMUM
CURVES 100' TO 200' RADIUS	6'–0" C. TO C. MAXIMUM
CURVES LESS THAN 100' RADIUS	5'–0" C. TO C. MAXIMUM

5. FOR POST BASES AND CBLE ATTACHMENTS , SEE DRAWING MASS DOT E404.5.0
6. FOR DESCRIPTION, MATERIALS AND CONSTRUCTION METHODS, SEE STANDARD SPECIFICATION.

DOUBLE GATES



NOTE:

1. TUBULAR GATE POSTS – STEEL ALUMINUM

SINGLE GATE OPENING UP TO 6'.	4" NOM O.D	2 7/8" NOM O.D.
DOUBLE " " " " 12'.	"	"
SINGLE " " 7'–13'.	4" NOM O.D	4" NOM O.D.
DOUBLE " " 13'–25'.	"	"
SINGLE " " 14'–18'.	4" NOM O.D	6 5/8" NOM O.D
DOUBLE " " 27'–38'.	"	"

THE ABOVE LIMITS OF OPERATIONS ARE INCLUSIVE

2. GATE FRAMES & BRACES STEEL ALUMINUM

SINGLE GATE FRAME UP TO 6' W.	L66 NOD	L90 NOM O.D
SINGLE GATE FRAME OVER 6' W.	L90 NOD	L90 NOM O.D

3. TRUSS RODS	STEEL	ALUMINUM
DIAMETER	3/8"	3/4"

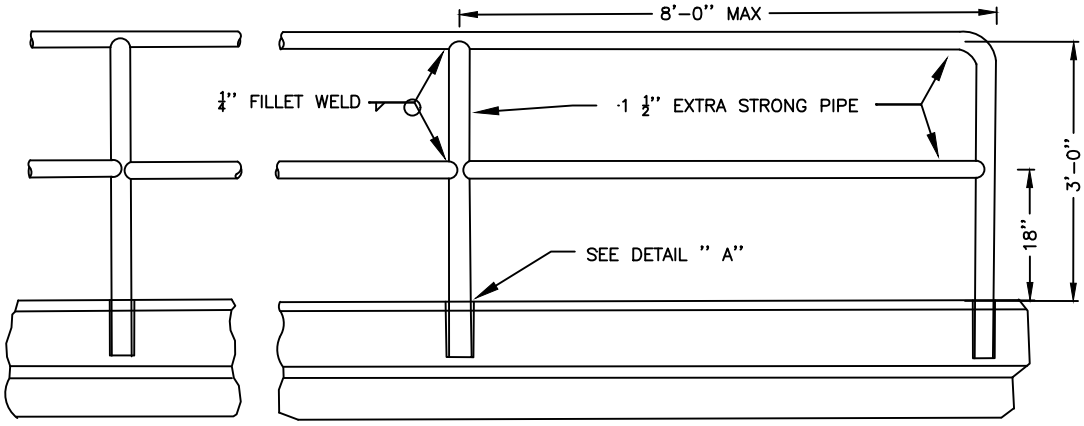
4. CHAIN LINK FABRIC FOR GATES TO BE THE SAME AS AS REQUIRED FOR FENCE.

5. FOR GATE POST BASE, SEE 404.5.0

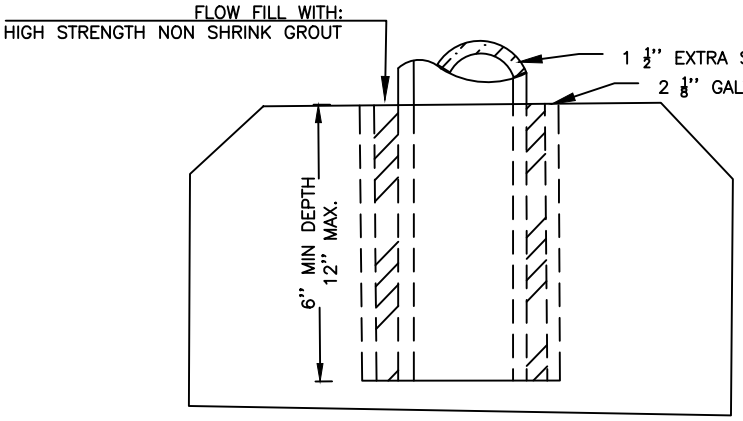
6. FOR DESCRIPTION, MATERIALS, AND CONSTRUCTION METHODS, SEE SPECIFICATIONS.

END POSTS TO BE USED ON LATCH SIDE OF SINGLE GATE OPENINGS.

FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	01	02/26/2025	CHAIN LINK FENCE–GATE	TK
474-475-476 - ITEM DESCRIPTION	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY



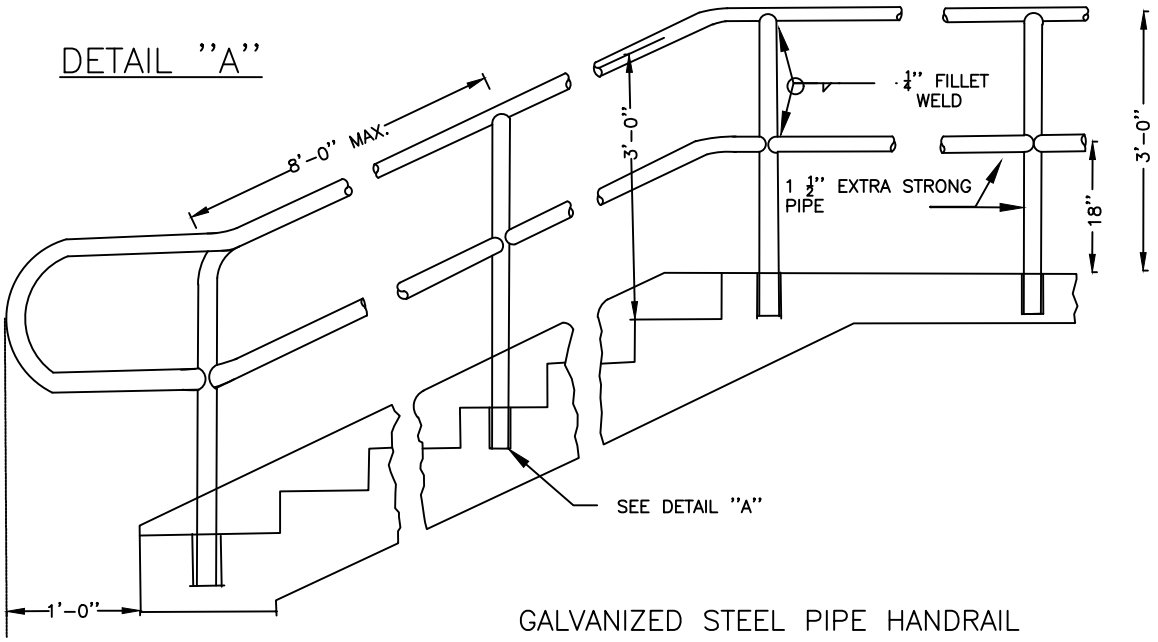
GALVANIZED STEEL PIPE HANDRAIL



NOTES:

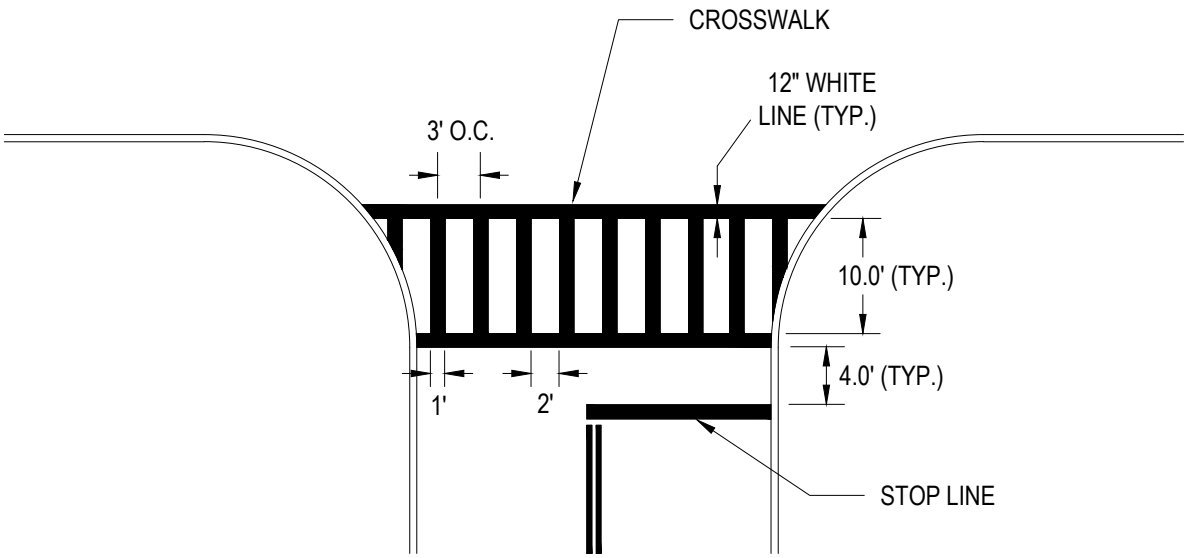
1. WHEN USED ON A CURVE ALL RAILINGS TO BE CURVED TO LINE BEFORE ELECTION.
2. GALV.STEEL PIPE FENCE & HAND RAIL TO FOLLOW GRADE OF COPING OR STRUCTURE.
3. STANDARD OR SPECIAL FITTINGS ARE TO BE USED OR JOINTS MAY BE WELDED
4. FOR DESCRIPTIONS, MATERIALS AND CONSTRUCTION METHODS, SEE LATEST SPECS.

DETAIL "A"



GALVANIZED STEEL PIPE HANDRAIL

MARCH 12, 2025		**DEPARTMENT OF PUBLIC WORKS AND PARKS**	01	03/12/2025	GALVANIZED STEEL PIPE HAND RAIL GALVANIZED STEEL PIPE FENCE	TK
478 - ITEM DESCRIPTION		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY



GENERAL APPLICATION OF TRAFFIC PAINT OR THERMOPLASTIC MARKINGS:

ALL CENTERLINES, LANE LINES AND SKIP LINES SHALL HAVE A WITH OF SIX (6) INCHES TO SIX AND ONE-HALF (6-½) INCHES. ALL CROSSWALK LINES, STOP BARS AND DELINEATORS SHALL A WIDTH OF TWELVE (12) INCHES TO THIRTEEN (13) INCHES.

ALL YELLOW GORE LINES SHALL HAVE A WIDTH OF TWELVE (12) TO THIRTEEN (13) INCHES.

ALL PERPENDICULAR RAILROAD LINES SHALL HAVE A WIDTH OF TWENTY FOUR (24) INCHES WITH THE X-ING SYMBOL TO HAVE A WIDTH OF TWELVE (12) INCHES.

APPLICATION SHALL BE AT A RATE OF ONE (1) GALLON PER HUNDRED SQUARE FEET UNLESS OTHERWISE RECOMMENDED BY THE MANUFACTURER.

BEADS MUST BE APPLIED IN ALLOWANCE WITH PRESENT STANDARDS OF THE COMMONWEALTH OF MASSACHUSETTS.

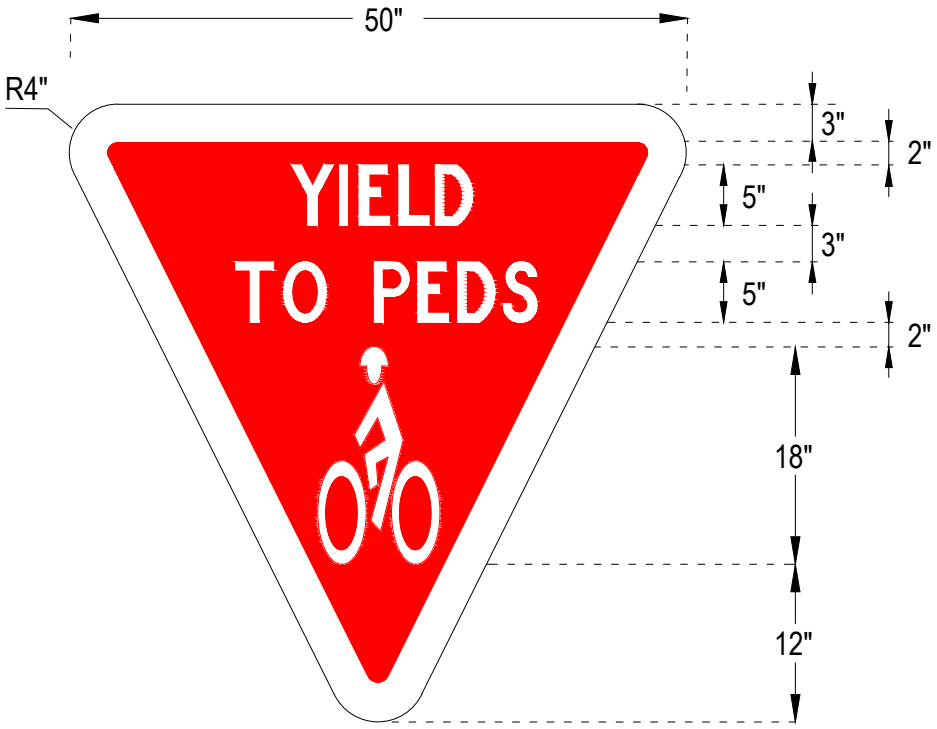
PAINTING SHALL BE DONE ONLY IN SEASONABLE WEATHER CONDITIONS IN ACCORDANCE WITH THE MANUFACTURERS SPECIFICATIONS.

IN THE EVENT PARKED VEHICLES ARE BLOCKING THE APPLICATION OF THE MARKINGS, THE CONTRACTOR WILL BE REQUIRED TO RETURN TO THE SITE TO COMPLETE THE MARKINGS.

NON-SIGNALIZED INTERSECTION TYPICAL CROSSWALK MARKINGS

CITY OF WORCESTER STANDARD DETAILS

SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 504	-



NOTE:

PAVEMENT MARKINGS SYMBOLS SHALL BE CONSISTED OF PREFORMED THERMOPLASTIC.

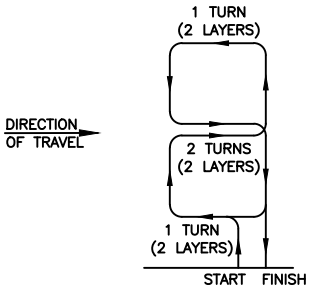
YIELD TO PEDESTRIAN MARKING

CITY OF WORCESTER STANDARD DETAILS

SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM 509	-

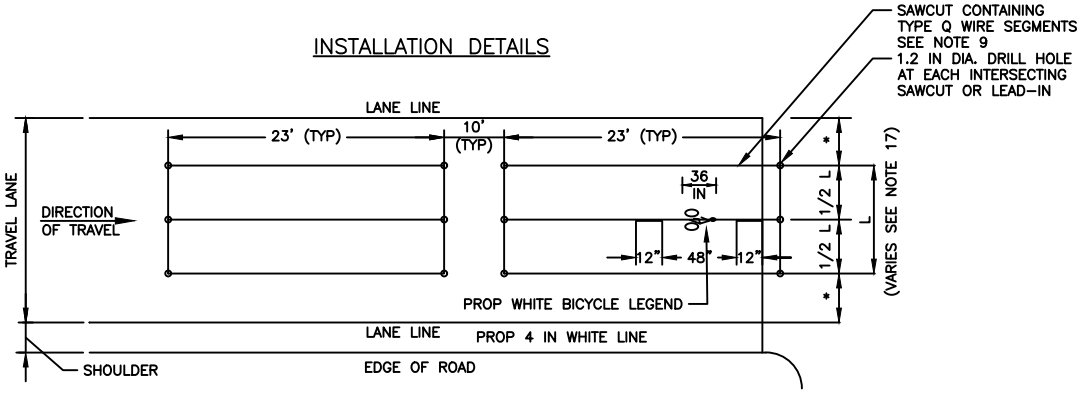
BICYCLE LOOP DETECTOR DETAILS

WINDING DETAILS

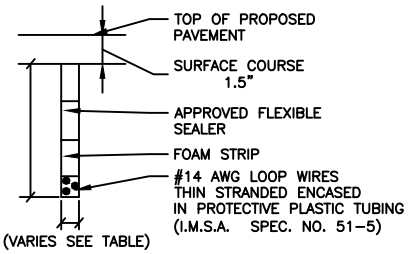


TYPE Q DETECTOR

INSTALLATION DETAILS



TYPE Q DETECTOR-STANDARD QUADRUPOLE
WITH STANDARD PAVEMENT MARKINGS



SECTION THRU LOOP DETECTOR

SAWCUT SLOT DEPTH GUIDE		
TURNS OF WIRE	SLOT SIZE	
	DEPTH (IN)	WIDTH (IN)
1	1.5	0.5
2	1.5	0.5
3	1.5	0.5
4	2.0	0.5
5	2.0	0.5
6	2.0	0.5
7	2.0	0.5
8	2.0	0.5

NOTES:

1. REFER TO VEHICLE LOOP DETECTOR DETAIL SHEET FOR ADDITIONAL NOTES AND CONSTRUCTION DETAILS.
2. ALL DETAILS ARE GRAPHICAL WITH NO SCALE.
3. THE NUMBER, SIZE, LOCATION AND LENGTH OF DETECTION AREA VARIES AND SHALL BE DETERMINED BY THE DESIGNER REFER TO TRAFFIC SIGNAL PLAN.
4. BICYCLE LOOPS SHALL BE CONNECTED TO SEPARATE LOOP DETECTOR AMPLIFIERS CAPABLE OF HIGHER LEVELS OF SENSITIVITY.
5. BICYCLE LOOPS SHALL BE INSTALLED IN THE BASE COURSE OF EXISTING PAVEMENT. THE EXISTING PAVEMENT SHALL BE COLD PLANED TO THE BASE COURSE AND SAWCUT FOR LOOP INSTALLATION.
6. SIGNS AND PAVEMENT MARKINGS SHALL BE INSTALLED FOR ALL BICYCLE DETECTORS TO INFORM CYCLISTS OF THE DETECTION AREA.
7. OFFSETS FROM LANE LINE EQUAL UNLESS OTHERWISE NOTED. SEE PLANS.
8. TYPE Q DETECTORS SHALL BE WIRED IN A FIGURE EIGHT PATTERN WITH A DOUBLE LAYER DESIGN ("2-4-2") WITH 2 TURNS IN THE PERIMETER SLOTS AND 4 TURNS IN THE CENTER SLOT AS SHOWN IN THE WINDING DETAIL.
9. BICYCLES WILL BE DETECTED WITHIN 4 IN. OF THE INTERIOR LONGITUDINAL LOOP WIRES FOR TYPE Q AND D-Q DETECTORS.
10. PROVIDE 3 TURNS FOR TYPE D-1 DETECTORS.
11. INSTALL 2 LAYERS OF WIRE WOUND IN THE SAME DIRECTION IN BOTH LAYERS FOR TYPE D-2 DETECTORS. THE RESULT IS 4 TURNS IN EACH DIAGONAL.
12. RIGHT JUSTIFIED LOOP DETECTORS SHALL BE CONSIDERED FOR THE FOLLOWING CONDITIONS:
    a) BICYCLE STOPPING ON THE RIGHT SIDE OF A THRU TRAVEL LANE .
    b) BICYCLE STOPPING ON THE RIGHT SIDE OF AN EXCLUSIVE LEFT TURN LANE.
13. LEFT JUSTIFIED LOOP DETECTORS SHALL BE CONSIDERED FOR THE FOLLOWING CONDITIONS:
    a) BICYCLE STOPPING ON THE LEFT SIDE OF A SHARED LEFT /THRU LANE.
    b) BICYCLE STOPPING JUST TO THE RIGHT OF THE CENTERLINE WHEN TURNING LEFT ON A TWO-LANE ROADWAY.
14. RECTANGULAR LOOP DETECTORS SHALL BE CONSIDERED FOR BICYCLES STOPPING ON EITHER THE LEFT OR RIGHT SIDE OF A TWO-LANE ROADWAY. THE MINIMUM OFFSET FROM LANE LINE OR CURB LINE SHALL BE 1.0 FT.
15. PAVEMENT CORES OR TEST PITS MAY BE REQUIRED TO DETERMINE THE DEPTH OF EXISTING PAVEMENT AND CONFIRM THAT THE DETECTION OPTION CHOSEN AND CORRESPONDING WINDING PATTERN CAN BE ACCOMMODATED.
16. THESE DETAILS APPLY TO BICYCLE LOOPS INSTALLED IN ROADWAYS. PUSH BUTTON ACTUATION SHALL BE CONSIDERED FOR RECREATIONAL BIKE PATHS.
17. THE MINIMUM DIMENSION FOR L SHALL BE 6 FT FOR DETECTORS TYPE D-Q, D-1 & D-2. FINAL DIMENSIONS SHALL BE DETERMINED BY THE DESIGN ENGINEER.

FEBRUARY 26, 2025	**DEPARTMENT OF PUBLIC WORKS AND PARKS**	1	3/4/2025	BICYCLE LOOP DETECTOR	MW
ITEM 511.1	**Engineering Division**				
NOT TO SCALE	20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1		NO.	DATE	DESCRIPTION	BY

FEBRUARY 26, 2025

ITEM 511.2

NOT TO SCALE

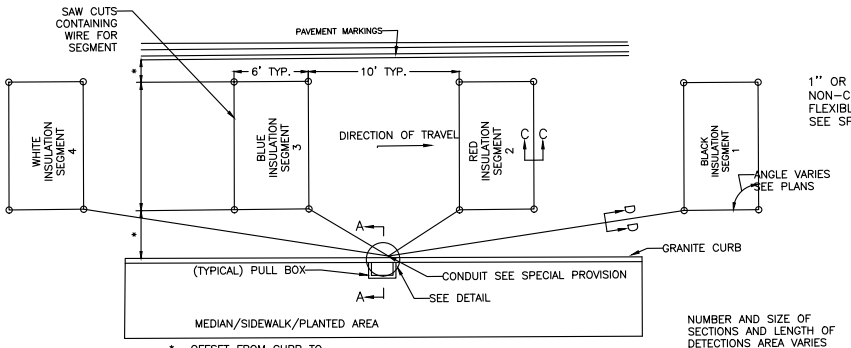
SHEET 1 OF 1

DEPARTMENT OF PUBLIC WORKS AND PARKS

Engineering Division

20 East Worcester St, Worcester MA 01604

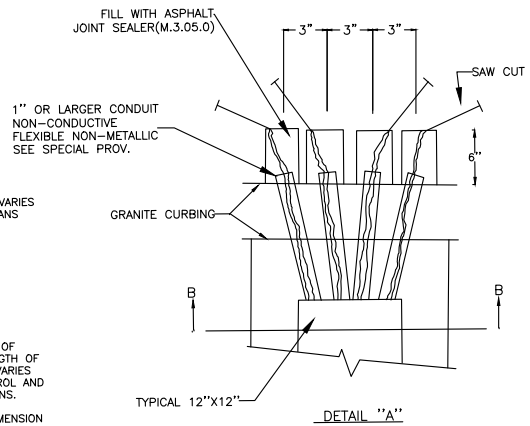
NO.	DATE	DESCRIPTION	BY
1	3/4/2025	WIRE LOOP IN ROADWAY	MW



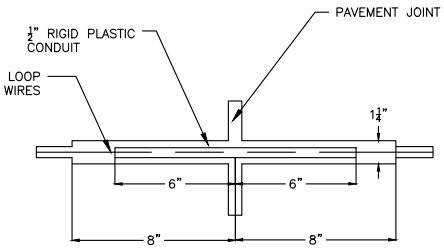
PLAN OF SEGMENTED DETECTOR DETAIL
NOT TO SCALE

NUMBER AND SIZE OF SECTIONS AND LENGTH OF DETECTIONS AREA VARIES SEE TRAFFIC CONTROL AND CONSTRUCTION PLANS.

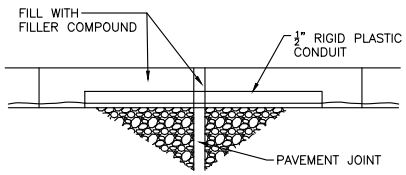
TYPICAL SHOWN DIMENSION MAY VARY SEE PLANS FOR VARIATIONS



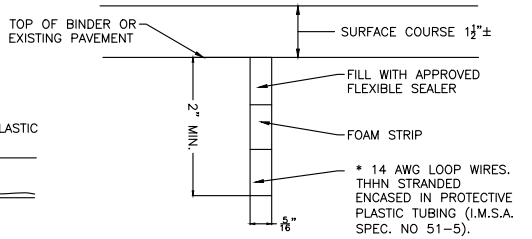
DETAIL "A"



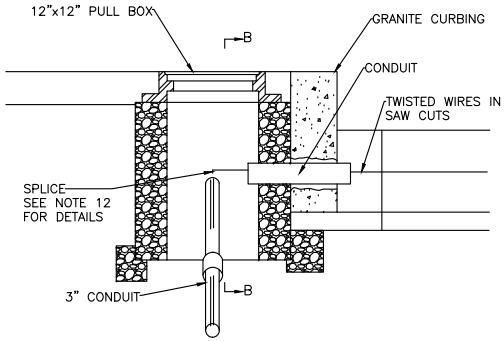
PLAN
TREATMENT AT PAVEMENT JOINTS.
NOT TO SCALE



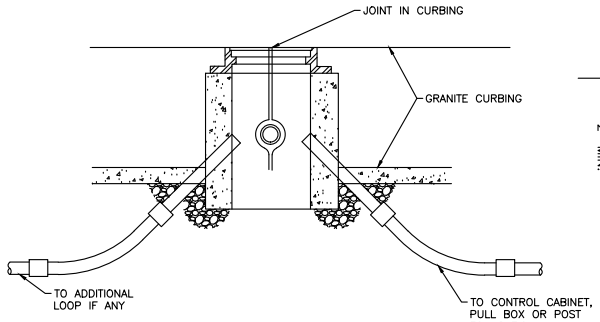
VERTICAL SECTION
TREATMENT AT PAVEMENT JOINTS.
NOT TO SCALE



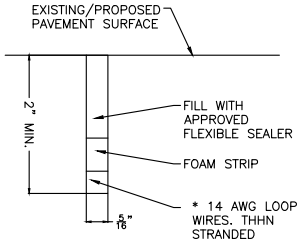
DETAIL "A"



SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE

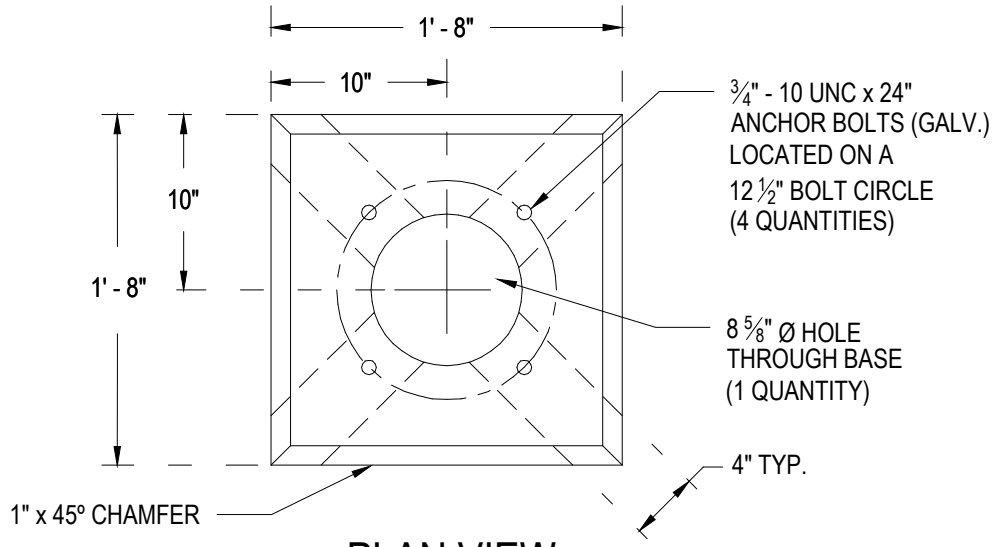


DETAIL "A"

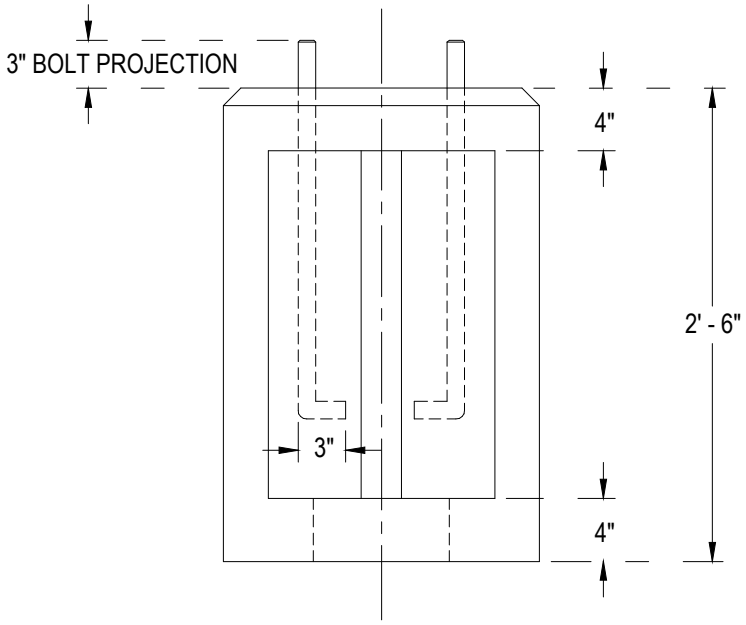
DETECTOR NOTES

1. IN BASE OR HANDHOLE, SPLICE ALL SEGMENTS TO TYPE II-SHIELDED LOOP DETECTOR LEAD-IN CABLE. SEGMENTS SHALL BE SPLICED IN PARALLEL, IN SERIES, OR IN A COMBINATION OF PARALLEL & SERIES AS SHOWN ON THE PLAN SHEET FOR EACH DETECTOR. NUMBER OF TURNS OF WIRE SHALL ALSO BE AS SHOWN ON THE PLAN SHEET FOR EACH DETECTOR. SEE NOTE 12.
2. SEE SPECIAL PROVISIONS FOR REQUIREMENTS OF DETECTOR AMPLIFIER.
3. LEAD-IN WIRES SHALL BE TWISTED FROM SEGMENT TO SPLICE WITH SHIELDED CABLE FIVE TURNS PER FOOT. LEAD-IN SHALL BE TYPE II (M8.16.11).
4. BEFORE STARTING ANY SPLLICING THE ELECTRICAL CONTRACTOR SHALL FURNISH DATA SHEETS ON THE MATERIALS AND/OR METHODS TO BE USED IN ACCORDANCE WITH THE DEPARTMENTS STANDARD OPERATING PROCEDURES FOR APPROVAL OF SHOP DRAWINGS. SEE SECTION815.64, ESPECIALLY PARAGRAPH 1.
5. THE METALLIC SHIELD WHICH SHALL ENCASE THE DETECTOR LEADS FROM A SPLICE (TYPICALLY LOCATED IN A PULL BOX NEAR THE ROADWAY COMPONENT OF THE DETECTOR) TO THE CONTROLLER, AND THE DRAIN WIRE UNDER THE METALLIC SHIELD, SHALL BE FIRMLY BONDED TO THE EARTH GROUNDING BUS IN THE CONTROLLER. HOWEVER, THE SHIELD AND DRAIN WIRE SHALL BE CAREFULLY INSULATED FROM THE TRANSFORMER NEUTRAL OR THE EARTH GROUND AT ALL OTHER POINTS ALONG ITS LENGTH. SPECIFICALLY, THIS INCLUDES CAREFUL INSULATION OF THE EXPOSED PORTION OF THE SHIELD AND THE DRAIN WIRE AT THE END AWAY FROM THE CONTROLLER WHERE IT IS SPLICED TO WIRES LEADING TO THE ROADWAY COMPONENT OF THE DETECTOR. THIS IS IMPORTANT TO AVOID A GROUND RETURN LOOP.
6. FILL ALL CONDUIT OPENINGS WITH DUCT SEAL.
7. AFTER SAW CUTS ARE COMPLETE, BLOW OUT WATER WITH OIL-FREE COMPRESSED AIR UNTIL CUTS ARE CLEAN AND DRY. INSERT WIRE INTO CLEAN SLOT WITH A BLUNT, SMOOTH, ROUND EDGED TOOL OF WOOD OF WOOD OR PLASTIC HOLD DOWN STRIPS, SIMILAR TO ETHA FOAM SB. STRIPS SHALL BE ABOUT 2" LONG, PLACED IN THE SLOT ABOUT EVERY 2 FEET THEN POUR SEALER, TAKING CARE TO ELIMINATE BUBBLES.
8. THE COMBINED ROADWAY LOOP, TWISTED LEAD-IN WIRES, SPLICE AND SHIELDED LEAD-IN CABLE SHALL HAVE AN ISOLATION RESISTANCE TO GROUND OF AT LEAST 100 MEGOHMS. SEE SPECIAL PROVISIONS FOR ADDITIONAL REQUIREMENTS.
9. FOR INSTALLATION OF SINGLE (ONE SEGMENT) SMALL WIRE LOOP DETECTOR, DETAIL IS THE SAME.
10. FOR NEW INSTALLATION, CUT LOOPS IN BINDER AND FILL WITH APPROVED FLEXIBLE SEALER.
11. DETECTOR WIRE SHALL BE A DIFFERENT COLOR FOR EACH SEGMENT OF A DETECTOR GROUP. SEE DETAIL
12. SPLICING PATTERN P = SERIES/PARALLEL: SPLICE SEGMENTS 1 AND 3 OF AN INDIVIDUAL DETECTOR IN SERIES,. SPLICE SEGMENTS 2 AND 4 IN SERIES. SPLICE THE RESULTANT TWO GROUPS IN PARALLEL. SPLICE THE RESULTANT COMBINATION TO ONE LEAD-IN CABLE. CONNECT THIS CABLE TO AN OTHERWISE UNUSED AMPLIFIER CHANNEL.

    SPLICING PATTERN S = SERIES: SPLICE ALL SEGMENTS (TYPICALLY FOUR, BUT MAY BE LESS) OF AN INDIVIDUAL DETECTOR IN SERIES. SPLICE THE RESULTANT COMBINATION TO ONE LEAD-IN CABLE TO AN OTHERWISE UNUSED AMPLIFIER CHANNEL.



PLAN VIEW



ELEVATION

NOTES:

1. CONCRETE: 28 DAY COMPRESSIVE STRENGTH F' E = 5,000 PSI TYPE III.
2. REBAR: GRADE 60 PER ASTM A615 (EPOXY).

RECTANGULAR RAPID FLASHING BEACON (RRFB) SIGNAL POST FOUNDATION 520 Lbs. MHD

CITY OF WORCESTER STANDARD DETAILS

SCALE:	DATE OF ISSUE:	SPEC. SECTION REF#:	DRAWING NUMBER
N.T.S.	-	ITEM- 610.8	-

MARCH 6, 2026

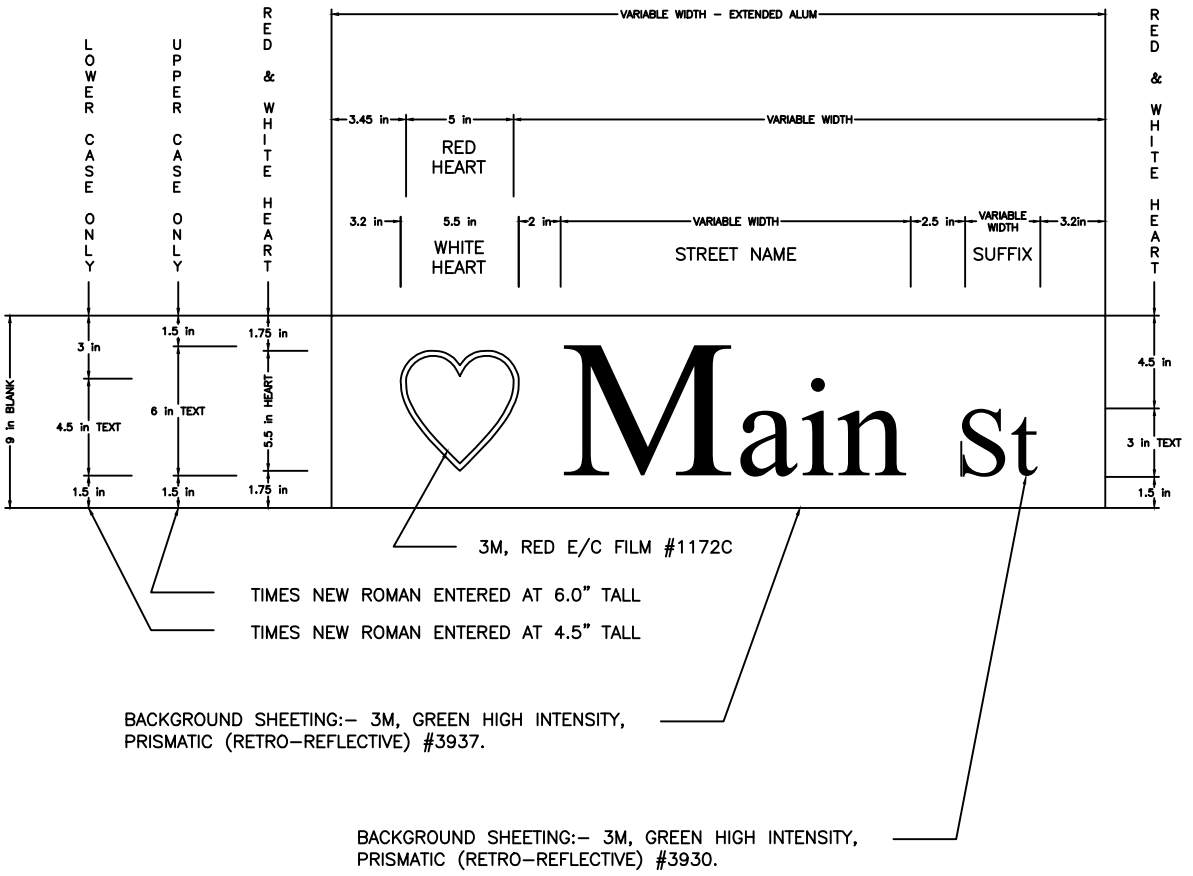
ITEM 522 - TYPE B STREET SIGN

NOT TO SCALE

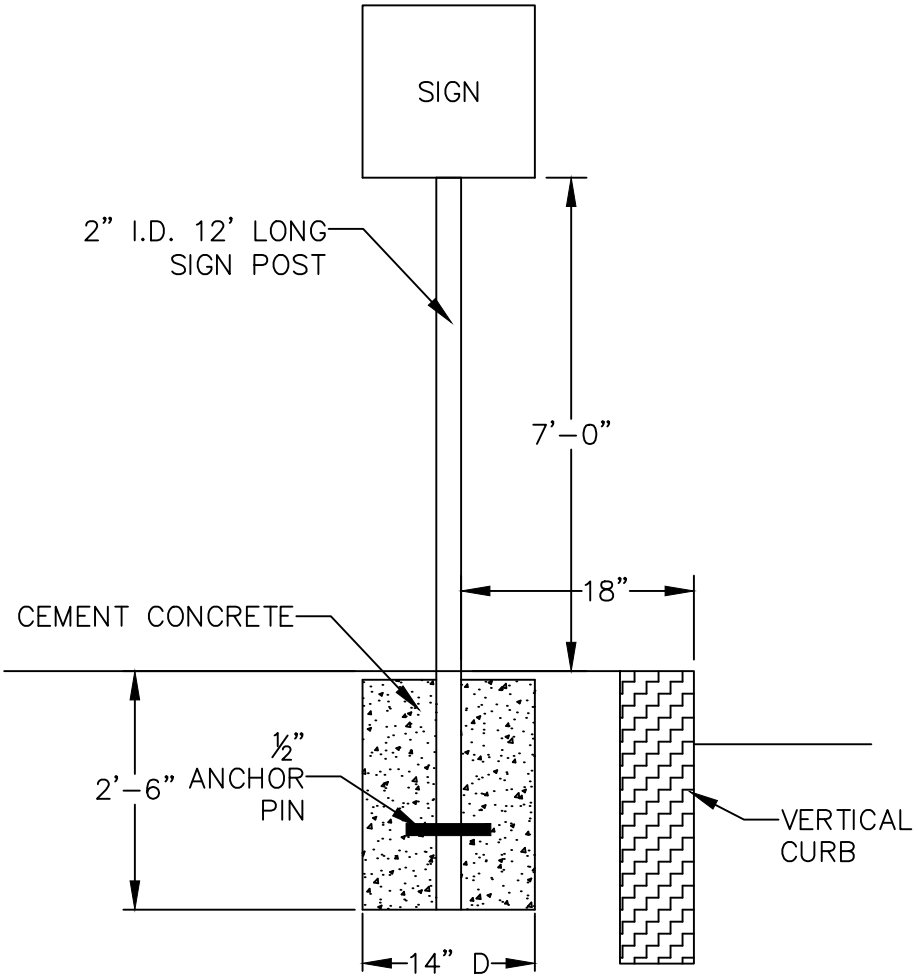
SHEET 1 OF 1

DEPARTMENT OF
PUBLIC WORKS AND PARKS
Engineering Division
20 East Worcester St, Worcester MA 01604

NO.	DATE	DESCRIPTION	BY
1	3/6/2026	TYPE B STREET SIGN	MW



TYPE B STREET SIGN



12' SIGN POLE INSTALLATION

JANUARY 2016		**DEPARTMENT OF PUBLIC WORKS AND PARKS**				
12' SIGN POLE INSTALLATION		**Engineering Division**				
NOT TO SCALE		20 East Worcester St, Worcester MA 01604				
SHEET 1 OF 1			NO.	DATE	DESCRIPTION	BY