

**MATERIALS**

**SECTION 2**

## SECTION 2 – MATERIALS

### 1. GENERAL

All materials to be incorporated in the project shall be first quality, new and undamaged material conforming to all applicable portions of these specifications.

### 2. CONCRETE

Cement – Cement shall be Portland Cement of a brand approved by the Engineers and shall conform to “Standard Specifications for Portland Cement”, Type 1, ASTM Designation C150, latest revision. Cement shall be furnished in undamaged 94 pound, one cubic foot sacks, and shall show no evidence of lumping.

Concrete Fine Aggregate – Fine aggregate shall be clean, hard uncoated natural sand conforming to ASTM Designation C33, latest revision, “Standard Specifications for Concrete Aggregate”.

Concrete Coarse Aggregate – Coarse aggregate shall consist of clean, hard, dense particles of stone or gravel conforming to ASTM designation C33, latest revision, “Standard Specifications for Concrete Aggregate”. Aggregate shall be well graded between 1 ½” and #4 sieve sizes.

Water – Water used in mixing concrete shall be clean and free from organic matter, pollutants, and other foreign materials.

Ready Mix Concrete – Ready-mix concrete shall be secured only from a source approved by the Engineer, and shall conform to ASTM Designation C94, latest revision, “Specifications for Ready-Mix Concrete”. Before any concrete is delivered to the job site, the supplier must furnish a statement of the proportions of cement, fine aggregate and coarse aggregate to be used for each mix ordered and must receive the Engineer’s approval of such proportions.

Class “A” Concrete – Class “A” concrete shall have a minimum compressive strength of 4000 pounds per square inch in 28 days and shall contain not less than 6 sacks of cement per cubic yard.

Class “B” Concrete – Class “B” concrete shall have a minimum compressive strength of 2000 pounds per square inch in 28 days and shall contain not less than 4 ½ sacks of cement per cubic yard.

Metal Reinforcing – Reinforcing bars shall be intermediate grade steel conforming to ASTM Designation A15, latest revision, “Standard Specifications for Billet Steel Bars for Concrete Reinforcement”. Bars shall be deformed with a cross sectional area at all points equal to that of plain bars of equal nominal size.

### 3. CRUSHED STONE

Crushed stone for pipe bedding shall be Tennessee Department of Transportation (TDOT), Bureau of Highways, Standard Size No. 57 and shall meet TDOT Standards for road surfacing.

4. PEA GRAVEL

Pea gravel for shaping cradle bedding shall be #4 to ½” size Ohio River, or approved local gravel of similar character.

5. DUCTILE IRON PIPE

Ductile iron pipe for water mains shall conform to USA Standard A21.51 for centrifugally cast ductile iron pipe. The pipe shall be manufactured of iron having acceptance values of 60-42-10. Pipe shall be at least Class 51 or heavier where indicated on the drawings. Minimum allowable wall thickness shall be as follows:

<u>Nominal Dia., In.</u>	<u>Minimum Wall Thickness, In.</u>	<u>Minimum Thickness Class</u>
3	0.28	52
4	0.29	52
6	0.31	52
8	0.33	52
10	0.35	52
12	0.34	51
14	0.36	51
16	0.37	51
18	0.38	51
20	0.39	51
24	0.41	51
30	0.43	51

Pipe shall be furnished in lengths of 18’ to 20’ and unless otherwise indicated shall be provided with a compression type slip joint equal to the Fastite joint as manufactured by American. Gaskets and lubricants shall be furnished with the pipe.

Pipe shall be furnished with standard thickness cement lining on the inside with a bituminous seal coat and a bituminous coating on the outside. Cement lining shall conform to USA Standard A21.4. The exterior of the pipe shall be clearly marked to indicate the manufacturer, date of manufacture, the pipe class and weight. Exterior markings shall also positively identify the pipe as being Ductile Iron.

Pipe manufacturer shall furnish, upon request, the test date for quality control during the manufacturing period for pipe furnished on the project. Testing and inspection shall be in accordance with ASA A.21.51. Tests to include hydrostatic test (500 psi – 10 sec.); tensile test; impact test; one sample to be taken during each casting period of approximately 3 hours.

Pipe manufacturer shall provide certified test reports to the Engineer to verify that all pipe furnished was manufactured and tested in compliance with all requirements of ANSI 21.51 / AWWA C-151 and ANSI A 21.10 / AWWA C-110.

Furnish detection tape as per specifications in this section.

6. POLYVINYL CHLORIDE (PVC) CLASS 200 PRESSURE PIPE

As determined by the City Engineering Department, PVC pressure pipe may be allowed for use in water main construction in certain situations. PVC pressure pipe shall conform to Class 200 rating or heavier manufactured in accordance with ASTM D-2241, latest revision. All pipe shall be manufactured from Class 12454-B polyvinyl chloride plastic (PVC 1120) as defined by ASTM D-1784. The pipe shall be NSF approved. The following tests shall be performed for each machine and on each size and type of pipe being produced with test results furnished to the Engineer prior to any pipe being installed:

Flattening Test – Once per shift in accordance with ASTM D-2412. Upon completion of the test, the specimen shall not be split, cracked, or broken.

Acetone Test (Extrusion Quality Test) – Once per shift in accordance with ASTM D-2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.

Quick Burst Test – Once per 24 hours in accordance with ASTM 1599.

<u>SDR</u>	<u>Pressure Rating</u>	<u>Pressure, psi</u>
13.5	315	1,000
17	250	800
21	200	630

Wall Thickness and Outside Dimensions Tests – Once per hour in accordance with ASTM D-2122.

Bell Dimensions Test – Once per hour in accordance with ASTM D-3139.

In addition to the above, the pipe manufacturer shall furnish a certificate stating that he is fully competent to manufacture PVC pipe of uniform texture and strength and in full compliance with these Specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer’s equipment and quality control facilities must be adequate to ensure that each extrusion of pipe is uniform in texture, dimension, and strength. Also furnish a certificate from the manufacturer certifying that the pipe furnished for this project meets the requirements of these Specifications.

All pipes shall be manufactured in the United States of America. All pipe for any one project shall be made by the same manufacturer.

The pipe may be furnished in the manufacturer’s standard laying lengths of 20 feet. The Contractor’s methods of storing and handling the pipe shall be approved by the Engineer. All pipe shall be supported within 5 feet of each end; in between the end supports at least every 15 feet. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipes out along the proposed water line routes will be allowed.

Certain information shall be applied to each piece of pipe. At the least, this shall consist of:

- Nominal Size
- Type of Material
- SDR or Class
- Manufacturer
- NSF Seal of Approval

Pipe that fails to comply with the requirements set forth in these Specifications shall be rejected.

Compression joints conforming to ASTM D-3139 and F-477 shall be used for 4-inch or larger. All joints shall be designed to withstand the same pressure as required for the pipe.

Fittings for Class 200 PVC pressure pipe 4-inch and greater shall be ductile iron conforming to USA Std. 21.10.

Furnish detection tape and tracer wire as per specifications in this section.

#### 7. PIPELINE DETECTION TAPE AND TRACE WIRE

Detectable pipeline location tape shall be plastic compositions film containing one layer of metalized foil laminated between two layers of inert plastic film specifically formulated for prolonged use underground. Tape shall be a minimum of 5.5 mils thickness, blue in color, and continuously printed in permanent ink to indicate caution for a buried water line below.

Tape shall be a minimum of 2 inches in width with a minimum tensile strength of 5,000 psi. Tape shall be Terra-Tape as manufactured by Reef Industries, Inc. or approved equal.

In addition to the detectable tape described above, a tracer wire shall also be installed by taping to the top of the water main. This tracer wire shall be 12-gauge insulated copper wire. All splices shall be by the solder or compression fitting methods. Wire nuts are not permitted.

#### 8. FITTINGS

All fittings shall be ductile iron, cement line bituminous coated, manufactured in accordance with USA Standard A.21.10-1964. Fittings shall be furnished with mechanical joints conforming to USA A21.11-1964, unless otherwise indicated or directed.

In addition, compact ductile iron, cement lined and bituminous coated fittings manufactured in accordance with USA Standards A 21.53-84, latest revision. Minimum pressure rating shall be 350 psi for 4" to 24" and 250 psi for fittings above 24" in diameter. Unless indicated otherwise on the contract drawings, mechanical joint fittings shall be used.

Mechanical Joint Restraints (mega lugs) are allowed to be installed. Thrust Blocks are still required when mega lugs are used.

## 9. GATE VALVES

All gate valves shall be iron body bronzed mounted, double disc valves with non-rising stems. Valves shall be furnished with mechanical joint ends in accordance with USA Standard A.21.11 unless otherwise shown or directed. Valves shall be suitable for installation in approximately vertical position in buried pipelines. Stem seal shall consist of O-ring seals. All valves shall open to the left (counter-clockwise), and shall be provided with 2" square operating nut.

Valves shall be Class C, for working pressures up to 200 psi and shall be equal to latest specifications of AWWA in all respects. Valves shall be equal to Mueller A-2380-20, unless otherwise on Project Drawings.

## 10. RESILIENT SEAT GATE VALVES

Resilient seat gate valves shall be iron body, machined surface, modified wedge disc, resilient rubber seat ring type valves with non-rising stems (NRS). Resilient seat gate valves shall have the bronze stem nut cast integrally with the cast iron valve disc. The valve shall have machined seating surface and capable of being installed and operated in either direction. Valves shall be furnished with mechanical joint ends in accordance with USA Standard A21.11 unless otherwise shown or directed. Valves shall be suitable for installation in approximately vertical position in buried pipelines. Stem seal shall consist of O-ring seals. All valves shall open to the left (counter-clockwise), and shall be provided with 2" square operating nut. All underground gate valves which have nuts deeper than 30" below the valve box top shall have extended stems with nuts located within one foot of the valve box cap.

Valves shall be for working pressures up to 200 psi and shall be equal to latest specifications of AWWA C-509 in all respects. Valves shall be equal to Mueller A-2370-20 unless shown otherwise on project drawings.

Iron body resilient seat gate valves shall be as manufactured by Mueller, U.S. Pipe, or equal.

## 11. BUTTERFLY VALVES

All butterfly valves shall be the tight closing, resilient seat type with seats that are securely fastened to the valve body or valve disc. Valves shall be bubble-tight at rated pressure with flow in either direction and valve discs shall rotate 90 degrees from the full open to the tight shut position. Valves shall meet the latest requirements of AWWA Standard C504 for Class 150B, and shall be Henry Pratt Company, Mueller, American or approved equals.

Valve manufacturer shall furnish certificates that all valves furnished have been tested and manufactured in compliance with AWWA C-504 in all respects.

Valves to be installed above ground or in vaults shall have flanged (ANSI B16-1) connections and buried valves shall have mechanical joint connections, unless otherwise shown on the Drawings.

Valve bodies shall be constructed of cast iron ASTM A-126, Class B. Valve discs shall be constructed of either alloy cast iron ASTM A-436 (Ni-Resist) or Ductile Iron, Grade 65-45-12, ASTM A-536. Shafts of all valves shall be turned, ground and polished. Valve shafts

shall be constructed of 18-8, Type 304 stainless steel. Valves with seats in the valve body shall have seats that are simultaneously molded in, vulcanized and bonded to body. Valve seats on 24" valves and larger shall be retained in the valve body by mechanical means without metal retainers or other devices in the flow stream. Seats shall be of a synthetic rubber compound and shall be field adjustable and replaceable without dismantling operator, disc or shaft. Valves with the seal on the disc shall be fitted with a resilient seat of natural rubber bonded to a stainless steel retainer ring and secures to the disc by stainless steel screws. The rubber disc seat shall be adjustable and replaceable in the field. Valve body seats shall be stainless steel. Valves shall be fitted with sleeve-type bearings. Bearings shall be corrosion resistant and self-lubricating.

Manual operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Operators shall be equipped with mechanical stop-limiting devices to prevent over travel of the disc in the open and closed positions. Valves shall close with a clockwise rotation. Operators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 lb. on the handwheel or chainwheel. Operator components shall withstand an input of 450 ft. lbs. at extreme operator position without damage. Operators shall be equipped with a 2-inch square operating nut opening counter-clockwise.

Manually operated valves above ground or in vaults shall be furnished with handwheels, unless chainwheel operators are required. Manually operated valves that are buried shall be equipped with valve boxes as listed in these Specifications and with extension stems, if required, to bring the operating nut within one foot of the ground surface.

Extension shafts, brackets, and other accessories required for installation of the valves as shown on the Drawings shall be furnished with valves.

## 12. TAPPING SLEEVES AND VALVES

Tapping sleeves shall consist of mechanical joint tapping sleeve Mueller H-615, or approved equal, and a valve with mechanical joint outlet Mueller H-667, or approved equal. The valve shall conform to all applicable specifications for gate valves. Tapping sleeves will be Ford Stainless Steel with stainless steel flange on all taps up to 12". Mains to be tapped over 12" will be Ductile Iron Mueller tapping sleeve unless approved by City Engineer.

## 13. FIRE HYDRANTS

Single Pumper Hydrant – The single pumper fire hydrant shall be Mueller A-423 or M & H 129 Traffic Hydrant.

All fire hydrants shall be ironed bodied, fully bronze mounted hydrants manufactured to equal or exceed AWWA Specification C502-85 for Dry-Barrel Fire Hydrants. Hydrants shall be suitable for 150 psi working pressure and shall be subjected to a test pressure of 300 psi. Inlet connection shall be 6" mechanical joint unless noted otherwise on Project Drawings. Main hydrant valve shall be compression type, closing with the pressure, with 5-1/4" valve opening.

Hydrants shall be of the "dry head" type with an oil reservoir and provision for automatic lubrication of stem threads and bearing surfaces each time the hydrant is operated. Double

O-ring seals shall be provided to keep water out of the hydrant top. Operating nut shall be 1-1/2" pentagon, opening to left, and shall be equipped with a weather cap.

Hydrants shall be provided with automatic multiport drain ports arranged to momentarily flush under pressure each time hydrant is operated. A positive stop shall be provided on the operating stem to prevent over travel when operating valve.

Fire hydrant shall be supplied with a bituminous coating for buried portion of hydrant and a yellow enamel finish for above ground portions of the hydrant.

Single pumper fire hydrants shall be equipped with two 2-1/2" hose nozzles, one 5-1/4" pumper nozzle, breakable safety flange and safety stem coupling. Bronze nozzles shall be securely locked to prevent them from blowing off. Hose threads shall be National Standard. Nozzle caps shall be equipped with non-kink chains.

Note: See Standard Detail for anchoring of fire hydrant assembly.

#### 14. AIR RELEASE VALVE

Automatic air release valves shall be designed to allow a quantity of air to escape out of the orifice when air accumulates at high points in the water line. Valves shall be tested for service to pressures of 300 psi and can be made of cast iron housings. Valves shall be of similar construction to APCO 200A or approved equal. Inlet size shall be 1" diameter.

#### 15. VALVE BOXES

Heavy roadway type cast iron valve boxes shall be used. Inside diameter shall be not less than 5 inches. The base section shall be enlarged to enclose and protect the valve operating nut without actually being in contact with the pipe or valve. Top section shall be adjustable for elevation. Cover shall be heavy cast iron with the word "WATER" cast in raised letters. Boxes shall be adjustable type with lid marked "WATER" equal to John Bouchard and Sons Company, Nashville, Tennessee, No. 8004, Roadway Type, or approved equal.

#### 16. PRECAST MANHOLES FOR AIR RELEASE MANHOLES

Precast manholes shall conform to the latest revision of ASTM C-478. Drawings of manhole sections proposed for use on this project must be submitted to the Owner or his authorized representative for approval prior to use. Steps shall be furnished in accordance with Paragraph 6, and care must be taken to assure a firmly embedded step with no cracks from mortar shrinkage, which will allow leakage. Aluminum in contact with concrete shall be coated with heavy bitumastic paint. Loose steps and shrinkage cracks passing through manhole walls shall be cause for rejection.

Manhole sections showing evidence of cracking, crazing, honeycombing, crumbling or excessive roughness will not be acceptable. Sections with improper cut-outs, misalignments or other defects shall not be utilized in the project.

Manhole sections shall be steam or water cured and shall not be delivered to job site until at least 7 days old. Each section shall be marked with date of manufacture and manufacturer's mark in a permanent manner.



Testing and Acceptance of precast manhole sections shall be done in accordance with ASTM C-478 y an independent laboratory suitable to the Owner or his authorized representative. Compression tests shall be run on specimens obtained from each day's production: a minimum of 2 cylinders or cores per day's run but no less than the maximum number designated by ASTM C-478. The absorption test shall be run on a minimum of 2 randomly selected manhole sections per each day's production.

#### 17. MANHOLE FRAMES AND COVERS FOR AIR RELEASE MANHOLES

Manhole castings shall conform to ASTM Designation A48, latest revision, Class 20 and shall be free from scale, lumps, blisters, sand holes and defects of every nature which would impair their use. Castings shall be well cleaned with a smooth tough asphaltic coating. Covers shall be of the vented indented type with the words "WATER" cast in raised letters thereon. Bearing surfaces of frames and covers shall be machined to provide a solid bearing and prevent rocking. Pattern drawings and weights of castings shall be submitted for the approval of the Owner or his authorized representative.

Manhole frames and covers shall be equal to those listed below for particular applications.

NON-TRAFFIC (Standard)	John Bouchard No. 1155
TRAFFIC	Same as Non-Traffic type as specified above

Exceptions to the above shall be noted on Construction Drawings.

#### 18. MANHOLE STEPS

Steps shall be (1) aluminum, equal to #15295 by Alcoa; (2) ductile iron equal to Neenah No. R-1981-Q; or (3) plastic encapsulated steel equal to No. PS 1-45 as manufactured by M.A. Industries, Inc. East Point, Georgia.

#### 19. SERVICE LINE MATERIALS

19.1 Corporation stops shall be Mueller H-1500, Ford 100Q (compression fitting), or a McDonald equivalent to Ford 100Q (for service corporation to meter). Furthermore, an approved equal with compression type connections for copper tubing will be permitted.

19.2 Service clamps shall be all bronze construction with neoprene gasket.

19.3 All service lines shall be a minimum of 3/4" in size Type "K" copper or Minicipex-Pex-A-200 PSI.

19.4 Small copper piping in the ground shall be of standard soft water pipe (tubing) for water service, ASTM B88, Type "K" with bronze fittings, corporation stops and valves having compression type connection for copper pipe (tubing).

19.5 Municipex – Pex – A 200 PSI - Where Municipex piping is installed tracer wire is required. Tracer wire is to be secured to the Minicipex piping with tape or other acceptable methods. Proper inserts must be used when installed Municipex piping.

## 20. SERVICE INSTALLATIONS

Service lines including corporation stop, water line, curb stop and meter box to be installed by the Developer. The meter to be installed by the Department of Public Services. NO taps or meters are to be installed in driveways.

When casing pipe is used at Sidewalk, Roadway and Railroad tracks. A 2" schedule 40 PVC casing pipe is required for ¾" and 1" service lines. A 4" schedule 40 PVC casing pipe is required for 2" service lines. Detection tape is required where PVC casing pipe is installed.

All service lines shall be run in a straight line from the water main to the meter box and shall be one solid line without couplings.

For sites proposing 4 or more services (¾" or 1"), gang meter vault(s) will be required.

Backflow preventers shall be required in all non-residential services. Backflow must be located at meter in an above ground hot box.

### 20.1 Material Furnishing

A. Services on main extensions: Contractor is responsible for all materials and connection activities except furnishing and placing the meter(s), which will be done by the City.

B. ¾" & 1" on existing line: Contractor is responsible for all excavation from main to proposed meter location. For individual services, City will tap the main and provide materials including service line, meter, and box. When gang meter vault(s) are required, the Contractor is responsible for providing all materials except meters. Contractor will backfill and restore area to previous condition or better.

C. 2" on existing line: Contractor is responsible for all excavation from main to proposed meter location. City will tap the main, provide service line materials to the 2" brass nipple extending from the meter vault, and the 2" meter. Contractor to provide 2" meter vault with 2" meter setter as shown in the detail. Contractor will backfill and restore area to previous condition or better.

D. 2" with 1" irrigation on existing line: Contractor is responsible for all excavation from main to proposed meter location. City will tap the main, provide service line materials to the 2" brass nipple extending from the meter vault, the 2" meter, and 1" meter. Contractor to provide 2" meter vault with 2" meter setter and 1" line setter as shown in the detail. Contractor will backfill and restore area to previous condition or better.

E. 4" and Larger on existing line: Contractor is responsible for all excavation, materials, and site restoration. City will provide meter.

### 20.2 Service Disconnection

Any existing service line that will be abandoned must be done in the following manner: The contractor is to perform all excavation to expose the service at the main. The City will

disconnect the existing service and collect updated GPS information. The contractor is to backfill and restore area after disconnection to previous condition or better.

## 21. METER BOX MATERIALS

### 21.1 ¾" and 1" Meter Box W/ Lid: DFW 1800A-18-1MT

A. Meter Box Lid: DFW 1200-1MT-LID Deep Meter Box Lid Marked "WATER" W/ magnet Detector Installed W/ Molded 2" Touch Reader Hole.

B. Meter Box: DFW 1800A-18-BODY

### 21.2 2" Meter Vault W/Lid

A. Meter Box Lid: Halliday S1R029059CBD Hatch, A&L 6234ALM Hatch, or approved equal.

B. Meter Box: Meter box dimensions shall be as follows: 66-67" Length, 37-38" Width, 33.5" Height.

### 21.3 4" to 8" Meter Vault for master and combination meters

A. Meter Box Hatch: Aluminum hatch shall be 4' by 6', centered over the meter, and offset to the steps.

B. Meter Box: Meter box/vault dimensions shall be as follows: 108" Length, 84" Width, 72" Height.

### 21.4 2" Meter Vault with 1" Irrigation Meter

A. Meter Box Lid: Halliday S1R029059CBD Hatch, A&L 6234ALM Hatch, or approved equal.

B. Meter Box: Meter box dimensions shall be as follows: 66-67" Length, 37-38" Width, 33.5" Height.

### 21.5 Gang Meter Vault

A. Meter Vault Lid: Halliday S1R029059CD or approved equal.

B. Meter Vault: Meter vault dimensions shall be as follows: 67" Length, 37" Width, 41.5" Height.

## 22. METER BOX INSTALLATIONS

22.1 Traffic areas will require a traffic rated meter box and lid W/ lit marked "WATER".

22.2 Meter Box must be placed on undisturbed or properly compacted soil.

22.3 Meter has to be installed in the CENTER of the Meter Box for ¾” and 1” meters.

22.4 The Bottom of the meter box and meter have to be a minimum of 18” deep below FINAL GRADE and NO deeper than 24”.

22.5 Contractor shall contact City of Lebanon Water Department for on-site preconstruction meeting for installation of all 4” or larger water meters.

### 23. CASING PIPE

Where noted on the Drawings or required by these Specifications, roadway, railroad or other crossings shall be made utilizing carrier pipe within a casing pipe. Sizes of carrier pipe and casing pipe shall be as noted on the Drawings or described in these Specifications. **The minimum size of the steel casing pipe shall be large enough to allow the use of casing chocks described below. The Contractor may utilize a larger casing pipe size, if desired, as long as the carrier is properly secured to the satisfaction of the Owner / Engineer.**

Casing pipe and joints shall be of leak-proof construction. The steel casing pipe shall have a minimum yield strength of 35,000 psi and shall have the minimum wall thickness shown in the following table or as shown on the Drawings.

TABLE OF MINIMUM WALL THICKNESS  
FOR STEEL CASING PIPE  
(COOPER E-80 LOADING)

Casing Diameter, inches	Wall Thickness with approved protective coating, inches	Wall Thickness without approved protective coating, inches
Under 14	0.188	0.251
14 & 16	0.219	0.282
18	0.250	0.313
20	0.281	0.344
22	0.312	0.375
24	0.344	0.407
30	0.406	0.469
36	0.469	0.532
42	0.500	0.563

Note: In situations where the bore method is utilized with a steel casing pipe, the carrier pipe shall be secured inside the steel casing pipe with casing spacers (minimum three per joint) as manufactured by Powerseal Pipeline Products Corporation of Wichita Falls, Texas, or Engineer approved equal. Additionally, the ends of the steel casing pipe shall be sealed with casing pipe “End Seals”, “Link-seal”, or Engineer approved equal.

The casing pipe shall extend to the points indicated on the Drawings. The ends of the casing shall be protected against the entrance of foreign material but not tightly sealed, in a manner approved by the Engineer.

#### 24. TUNNEL LINER PLATE

The steel lining shall consist of 8-gauge steel plates conforming to ASTM A-569 not to exceed 18 inches wide. Each circumferential ring shall be composed of the number and length of plates to complete the required diameter. The Contractor shall submit details of the lining for approval.

The strength of the casing or tunnel lining will be determined by its section modulus. Thickness of the metal for these steel plates shall not be less than 8 gauge allowing for standard mill tolerance conforming to AASHTO M167.

All plates shall be punched for bolting on both longitudinal and circumferential seams, shall be of the four flange type equal to gauge of metal for full width of plates including flanges and shall have staggered-bolt construction so fabricated as to allow the cross-section of the plate to be continuous through the seam. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

The new material used for the construction of these plates shall be new and unused and suitable for the purpose intended. Workmanship shall be first class in every respect.

After the plates are formed to shape and after all holes are punched, the plates shall be galvanized conforming to ASTM A-123. Plates shall then be bituminous coated conforming to AASHTO M190.

All nuts and bolts shall be galvanized and conform to ASTM A-307, Grade A and ASTM A-153.

Plates shall be fabricated with grout holes to facilitate grouting above and around the tunnel liner. These grout openings shall be 2-inch I.P.T. half couplings welded into a hole in the center corrugation of a plate, and a galvanized C.I. plug shall be provided for each opening to permit tight closure after grout holes so that the spacing of holes will be on a maximum spacing of 18-inch centers at the top of the tunnel and at the top quarter points, staggered with holes at the top.

Field coating material shall be asphaltic mastic, Trumbull 5X or approved equal, and shall be applied with hydraulic spray equipment using a minimum of 2,400 pounds of pressure at the nozzle tip. The material shall be supplied at spraying consistency and shall be applied both to the outside and inside of the liner plates. Plates may be hot-dipped to produce a similar coating.

#### 25. TUNNEL LINER GROUT

The grout shall consist of Portland cement, water, sand and 2% approved additive (Bentorite, Septamine Seax, Hydrocide liquid, etc.). One part Portland cement with additive shall be combined to four parts clean sand and sufficient water added to provide a grout having the consistency of thick cream when well mixed.

#### 26. TUNNEL BACKFILL

Material used to backfill the tunnel shall be pea gravel as approved by the Engineer.

27. WATER LINE / VALVE MARKERS

Where indicated on the Contract Drawings, markers for valves and/or water lines shall be one piece for driving or settling in the ground. Marker units shall be weather resistant with identifying color and permanently affixed marker identifying water main and/or water valve and shall be a minimum of 62 inches in length. Units shall be flexible and resistant to damage by vehicles, animals, or vandals. Marker units shall be Tri-View Marker, manufactured by Rhino Marker or approved equal.

Please note detail included in the Contract Drawings showing concrete collar at ground level for marker.

28. SPECIAL FITTING - METER VAULT

Special fittings, 4-inch compound meter, strainer, double 8-inch water check valves, etc. shall be as shown on the Contract Drawings.

Note: The Contractor's Attention is directed to the requirement for spare parts to be provided with the 4-inch compound meter. These spare parts shall consist of a complete repair kit for reconditioning and repairs for both sides and register mechanism of the compound meter.

These spare parts shall be delivered to the Lebanon Water Department's main complex at 200 Carver Lane.

29. FOSTER ADAPTOR

Foster Adaptors shall be used on Fire Flow/Combination meters.

30. TIE RODS

Tie Rods shall be non-rusting materials (Zinc coated 3/4").

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