

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 Engineer 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 A 15, 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 bedding or backfill 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 1/2" size Ohio River, or approved local gravel of similar character.

5. MANHOLE FRAMES AND COVERS

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 solid indented type with the words "SANITARY SEWER" 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 Department of Public Works.

Vented lids shall be furnished and installed at ends and at approximately 1400 feet along line segments. Locations of all vented lids shall be at locations determined by the Engineer.

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

TRAFFIC	John Bouchard No. 1155
NON-TRAFFIC	Same as traffic type specified above
WATERTIGHT	To be used where manhole casting is subject to flood or submergence by surface runoff
	John Bouchard No. 1123

All sanitary sewer manhole frames and covers shall have a minimum opening of 24 inches.

Watertight insert to be used only as directed by Engineer. Manhole frame and cover to be same as non-traffic type as specified above or the watertight insert may be installed on an existing manhole. Insert to be Sewer Guard as manufactured by Preco Industries Ltd., or equal.

Exceptions to the above shall be noted on Construction Drawings.

6. 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.

7. PRECAST 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 2.06, 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.

All precast manholes shall be cast with XYPEX® Admix C-1000 in the concrete for waterproofing and corrosive protection. The manufacturer's recommended addition rate for Concentrate C-1000 is 3% by weight of cement. XYPEX® Concentrate C-1000 shall be as supplied by Tom Williams; 1231 Antioch Pike; Nashville, Tennessee.

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 by 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.

8. RESILIENT CONNECTORS

All connections of pipes to manhole sidewalls shall be made with resilient connectors. Resilient connectors for connection of pipes to manhole sidewalls shall be Kor-N-Seal or approved equal.

Openings in the manhole sidewall shall be so constructed as to include the resilient connector such that it is an integral part of the sidewall and to provide for the required size and location of the pipe to connect to the manhole. The sidewall opening shall be manufactured to allow for lateral and vertical movement, as well as angular adjustments through 20°. The resilient connectors shall be Kor-N-Seal, A-LOK, or approved equal. The resilient connector shall meet all physical and performance requirements as set forth by ASTM C-923.

9. CONCRETE SEWER PIPE (To only be used with special interior protective coating)

9.1 Materials

Reinforced Concrete Sewer Pipe shall conform to ASTM, C76, latest revision. Pipe shall be of Class shown on Plans or designated by Engineer and wall thickness shall be "B". Curing

shall be method of ASTM C76, 9.2. Lift holes are not permitted unless written permission is granted by the Owner or his authorized representative.

Centrifugally cast reinforced concrete sewer pipe shall conform to all applicable sections above and shall meet the following additional requirements:

- Minimum concrete compressive strength, 28 day: 6,000 psi
- Absorption of sample taken from wall not to exceed 5% of dry weight.
- Steam curing shall be used.
- Pipe to be manufactured by Cen-Vi-Ro centrifugal casting method, or approved equal.

9.2 Joints

Joints shall be compressive type with either the steel ring type designed for use with a continuous round rubber gasket or with resilient seals embedded in the pipe with a continuous O-Ring rubber gasket. Either type joint shall form a watertight seal against infiltration or leakage.

The steel ring joint shall consist of a bell ring and spigot ring, each being embedded in the concrete wall of the pipe. The steel rings, which form the joint, shall be made so that they will joint with a close sliding fit. The joint surfaces shall be such that the rubber gasket shall be confined on all sides and not support the weight of the pipe. Each ring shall be precisely sized by expansion beyond the elastic limit of the steel and then gauged on an accurate template. All exposed surfaces of both rings shall be protected by a corrosion resistant coating of zinc applied by an approved process.

The circular rubber gasket shall be accurately sized so that it will completely fill the space provided for it between the two joint rings.

Steel ring joints and rubber gaskets shall conform to these Specifications and to ASTM Designation C-361.

The resilient embedded seal joint shall consist of joints with the resilient seals embedded in both the bell and spigot ends, in accordance with ASTM Designation C-361, Type R-4. The resilient seals shall be as manufactured by Anderson Seal, or equal.

The rubber for resilient embedded end rings shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free of porosity, blisters, pitting and other imperfections. The basic polymer shall be E.P.D.M. hydrocarbon rubber. The compound shall conform to the following requirements:

The rubber EPDM material shall meet ASTM C-443 with the exception of the 40-60 duro hardness. For resilient interlocked and seals the hardness duro A shall be 40 to 70 \pm 5. The resilient material shall be resistant tot ultraviolet radiation.

9.3 Testing and Inspection

Test requirements for the pipe shall be as outlined in ASTM Designation C-76 except that absorption shall not exceed 5%. Testing shall be done in accordance with ASTM Designation C-497, latest revision. In the event any pipe tested fails to meet the Specifications, additional pipe may be furnished for testing to the extent permitted by the applicable Specifications; otherwise the pipe will be rejected.

The Manufacturer shall furnish certification by testing laboratory as follows:

- 1) The materials used in the manufacture of the pipe conform to requirements of ASTM C-76.
- 2) That the pipe was manufactured in accordance with ASTM C-76 and these Specifications, including amount and placement of steel.
- 3) Test results for one three edge bearing test made on each side of pipe to be furnished, showing load to produce a 0.01 thick crack and ultimate load. Each section of pipe shall be clearly marked to identify manufacturer, class, and date of manufacture.

9.4 Marking

Each pipe section to be marked with date of manufacturer, pipe class and manufacturer's mark indented on pipe or legibly painted thereon with waterproof paint.

10. CAST IRON SEWER PIPE

Note: Cast iron pipe will only be approved for house service lines on private property.

10.1 Material

Cast iron sewer pipe shall conform to ASA Specifications A21.6 or A21.8 for centrifugally cast pipe. Bell and spigot pipe shall be furnished in laying lengths of 16' or longer except for special construction conditions. Pipe shall have a coal tar coating outside and bituminous seal coat inside with a cement lining (Federal Spec. WW-P-421b). Pipe shall be made from 18/40, or stronger, iron and thickness class shall be Class 21 unless shown otherwise on the Construction Drawings.

10.2 Joints

Unless otherwise indicated on the Construction Drawings, cast iron pipe may utilize slip-on joint equal to Tyton or Fastite. Joints used must be approved by the Owner or his authorized representative.

10.3 Testing and Inspection

Testing and inspection shall be accomplished at factory by the manufacturer in accordance with provisions of ASA, A21.6 or A21.8. An independent testing laboratory approved by the Owner or his authorized representative shall perform tests and furnish Owner or his authorized representative with three copies of all test reports. Test reports

to include results of Talbot strip test, ring test, full length bursting test and chemical analysis.

10.4 Marking

Each length of pipe shall be marked with the date of manufacture, pipe class, weight and manufacturer's identification.

11. DUCTILE IRON SEWER PIPE AND FORCE MAIN

11.1 Material

Ductile iron sewer pipe shall conform to ASA Spec. A21.51 for ductile iron pipe centrifugally cast in metal or sand lined molds. Laying lengths shall be 16 feet or longer, except for special construction conditions. Pipe shall have bituminous coating outside, cement lining inside – ASA 21.4, and bituminous seal coating inside. Pipe shall be made with 60-42-10 grade ductile iron, or stronger. Thickness Class 52 shall be used for force mains and Class 50 for gravity sewers unless noted otherwise on the Construction Drawings.

11.2 Joints

Joints to be as specified under 2.9.2.

11.3 Testing and Inspection

Testing and inspection shall be accomplished at the factory in accordance with ASA A21.51. An independent testing laboratory approved by the Owner or his authorized representative shall perform tests and furnish the Owner or his authorized representative with three copies of all test reports. Tests to include: hydrostatic test (500 psi – 10 sec); tensile test and impact test with one sample to be taken during each casting period of approximately 3 hours.

11.4 Marking

The weight, class, manufacturer's mark, year of manufacture and letters "DI" or "DUCTILE" shall be cast or stamped on pipe.

12. POLYVINYL CHLORIDE FORCE MAIN

12.1 Material

Polyvinyl chloride (PVC) force main shall conform to ASTM D-2241, latest revision, and shall be no less than Class 200 (SDR 21). Cell classifications shall be 12454-B, unless otherwise approved. Type 1, Grade 1 (PVC 1120) resin shall be used. Pipe shall be produced by a continuous extrusion with joint lengths at least 16 feet.

12.2 Joints

Joints shall be of the bell and spigot or similar type utilizing a rubber gasket. Joints shall be in accordance to ASTM D-3139, approved by the Owner or his authorized representative and equal to Clow Bell-Tite or Certain-teed Fluid-Tite. Rubber gasket shall conform to ASTM F477, latest revision.

12.3 Testing and Inspection

Testing and inspection shall be accomplished at the factory in accordance with ASTM D-2241 by an independent laboratory approved by the Owner or his authorized representative. The laboratory shall furnish the Owner or his authorized representative with three copies of all test reports. Tests are to include:

- Quick Burst Test – hydrostatic strength shall meet the following based on ASTM D1599: 600 psi minimum 90-sec. burst pressure-7,400 psi minimum hoop stress.
- Sustained Pressure Test – Sample shall withstand without failure for 1,000 hours in accordance with ASTM D1598: 340 psi hydrostatic pressure-4,200 psi hoop stress.
- Tensile Strength – Shall be conducted in accordance with ASTM D-638. Minimum tensile strength shall be 7,400 psi.
- Chemical Resistance – Sample shall be completely immersed in anhydrous acetone for a 60-minute period with examination at 20 minute intervals. Test shall meet requirements of ASTM D-2152.
- Test shall be run on the maximum of specimens called for under ASTM D-2241 for all pipe manufactured in each size and strength classification.

12.4 Marking

Each length of pipe is to be permanently marked with: manufacturer's name, nominal size, Class pressure rating or SDR number, material designation and ASTM D-2241.

13. POLYVINYL CHLORIDE (PVC) SEWER PIPE

13.1 Materials

PVC sewer pipe shall be SDR 35, or heavier, manufactured in accordance with ASTM D3034, latest revision, for type PSM sewer pipe and fittings, 4" through 15". ASTM F679 (wall thickness T-1), 18" through 27". Pipe shall be furnished in lengths not exceeding 13 feet. Pipe shall be furnished with integral bells: gaskets and lubricants shall be furnished by the pipe manufacturer. Pipe fittings shall be made of PVC plastic having a cell classification of 12454-B or 12454-C as defined in ASTM D 1784.

Pipe manufacturer shall be approved by the Owner or his authorized representative before use on any project.

13.2 Joints

Joints shall be compression type utilizing an elastomeric gasket providing a positive seal against ground water and root intrusion as well as sewage leakage and shall be in accordance with ASTM D3212. Gaskets shall comply with physical requirements specified in ASTM F477, latest revision. Lubricant shall be furnished with the gaskets and entirely compatible with gasket and pipe material.

Joints shall show no signs of leakage when tested as follows (supersedes ASTM D3034): Typical joint assembly shall be subjected to internal hydrostatic pressure of 10.8 psig for 10 minutes without leakage; assembly shall also be subjected to internal vacuum of 22 inches of mercury or external pressure of 10.8 psig for 10 minutes without leakage. The above internal pressure and vacuum (or external pressure) tests shall be run on a typical joint assembly in concentric alignment and in a position of angular deflection to at least 3 degrees.

Joint design shall be approved by the Owner or his authorized representative before use on any project.

13.3 Testing and Inspection

Testing and inspection of all pipe shall be done at the factory with a certified copy of the test results furnished to the Owner or his authorized representative before any pipe is installed.

For projects using less than 2,000 feet of sewers (not including service lines) such testing shall be done by the manufacturer. For larger projects testing shall be done by an independent testing laboratory approved by the Owner or his authorized representative (unless this requirement is waived in writing by the Owner or his authorized representative in which case testing shall be done as if for projects using less than 2,000 feet of sewers).

Tests shall be done in accordance with ASTM D3034 or ASTM F679 and shall include: Pipe and Fitting Dimensions; Pipe Flattening; Impact Resistance; Pipe Stiffness; Joint Tightness (see Part 2); and Extrusion Quality. At least 1% of the production of each size furnished for this project shall be tested.

13.4 Marking

Each pipe section shall be marked with the following information:

4" to 15":

Manufacturer's name or trademark; nominal pipe size; PVC cell classification; Legend "Type PSM DR 35 PVC Sewer Pipe"; ASTM D3034.

18" to 27":

Manufacturer's name or trademark; nominal pipe size; PVC cell classification; Legend "PS 46 PVC Sewer Pipe"; ASTM F679.

Fittings shall be clearly and permanently marked to show: manufacturer's name or trademark; nominal size; material designation "PVC"; designation PSM or PS 46; ASTM designation D3034 or F679.

13.5 Installation

Installation of PVC sewer pipe shall follow requirements of Section 3.

14. FITTINGS AND COUPLINGS

Unless otherwise indicated on the Construction Plans or directed by the Owner or his authorized representative, fittings shall be of the same material as the pipe line in which they are to be installed. The fittings for a PVC sewer force main may be cast iron with mechanical joints. Fittings shall be furnished with joints of the same type used throughout the rest of the pipe line unless such joint shall not be available and the Owner or his authorized representative should approve a substitute type joint. Fittings shall be of the type indicated on the drawings and shall be the manufacturer's standard conforming to all applicable standard specifications and dimensional tolerances appropriate for the material of construction.

Approved type commercial couplings shall be used in making transitions from one type material to another. Couplings for transitions between clay and cast iron, concrete and cast iron or between concrete and clay pipe shall be a heavy reinforced rubber coupling with stainless steel clamps as manufactured by Tex-Vit or approved equal.

15. PIPELINE DETECTION TAPE AND TRACE WIRE

Detectable pipeline location tape shall be plastic composition film containing one layer of metallized 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, green in color, and continuously printed in permanent ink to indicate caution for a buried line below.

Tape shall be a minimum of 3 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. Pipeline detection tape shall be used as directed by the City Engineer.

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 14-gauge insulated copper wire. All splices shall be by the solder or compression fitting methods. Wire nuts are not permitted.

16. 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 A 21.11 unless otherwise shown or directed. Valves shall be suitable for installation in approximately vertical position in buried pipe lines. Stem seal shall consist of O-ring seals. All valves shall open to the left (counterclockwise), 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 pressure 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, or equal.

17. COMBINATION AIR AND VACUUM RELIEF VALVES FOR 4-INCH AND LARGER FORCE MAINS

Automatic combination air and vacuum valves shall be APCO Generation II, Model 445WA (w/attachments) or approved equal as per special detail on the Contract Drawings.

18. REDUNDANT CHECK VALVE

Each service pressure line and/or connection assembly shall include a check valve for installation in the discharge line between the grinder pump and the sewer force main to ensure maximum protection against backflow in the event of sewer service line break.

The valve shall be 1-1/4-inch E-1 (Environment One Corporation) glass line check valve.

19. SMALL MISCELLANEOUS VALVES

Unless otherwise shown on the Drawings, gate valves 2-inch and smaller shall be all-bronze, single wedge disc, non-rising stem, and handwheel operated. Such valves shall be Crane No. 438, Lunkenheimer Figure 2129, or equal, for screwed end valves, and Crane No. 1320, Lunkenheimer Figure 2133, or equal, for solder joint valves. Check valves 2-inch and smaller shall be bronze body, composition disc, with screwed ends, similar to Crane No. 34-1/2, Lunkenheimer Figure 230-70, or equal.

Standard screwed end globe valves 2-inch and smaller shall be bronze valves with plug disc and shall be Crane No. 14-1/2 P, Lunkenheimer Figure 73-PS, or equal. Needlepoint globe valves 3/4-inch and smaller shall be bronze valves similar to Crane No. 88, Jenkins or equal.

20. VALVE BOXES

Valve boxes for pressure sewer valves, cleanout and service connections shall be as indicated on the Contract Drawings or a standard plastic meter box with a nominal size of 16" x 10-3/4" x 12" and 6" extensions. The meter box shall be injection molded meeting ASTM D-2853-70, Class 1212. It shall be a rigid combination of polyolefin with

inorganic component reinforcing and UV stabilizer additive to assure resistance to material degradation from ultraviolet light. The cover shall be molded of the same material and design with no molded protrusions for latching. A 2-1/2-inch diameter 16-gauge steel reflector with dichromate coating shall be applied to the underside of the plastic cover for electronic detection. The cover shall be green with the words "SEWER" imprinted on the top. If valve box is located in a roadway or roadway shoulder subject to traffic, then valve box shall be constructed of cast iron.

21. BALL VALVES

Valves on pressure sewers 1½-inch through 3-inch shall be PVC ball valves of true union design with permanently lubricated teflon seats and elastomer "O"-ring seals. The valves are to be opened and closed with a quarter turn. Working pressure at 70 degrees F shall be 150 pounds per square inch.

22. SEWER SERVICE CLEAN-OUTS, WYES, BOXES, AND COVERS

Typical sewer service clean-outs (6-inch or 4-inch) shall be installed as per Standard Details. The clean-out shall consist of a clean-out wye (no tees) along with a 45° bend. The 6-inch or 4-inch plug or cap shall be contained in a plastic (meter type) box.

The box shall be a minimum of 16" x 10-3/4" x 12" and 6-inch extensions made of injection molded plastic meeting ASTM D-2853-70, Class 1212, as manufactured by Brooks Products, Inc. or approved equal. The cover shall be green with "SEWER" imprinted on the top. The box and lid shall have UV stabilizer additive to assure resistance to material degradation from ultraviolet light. A 2½-inch diameter, 16-gauge steel reflector with dichromate coating shall be applied to the underside of the plastic cover for electronic detection.

If the valve box must be located in a roadway or roadway shoulder subject to traffic, then valve box shall be constructed of cast iron in accordance with the following:

Valve Boxes - Valve boxes are to be made of pre-cast concrete sections measuring 11" x 13-1/4" inside dimensions and 17" x 19-1/4" outside dimensions with the height of 12 to 15 inches. Reinforcement shall be placed and shall conform to the requirements of ASTM A-15 and ASTM A-305 for intermediate grade.

Footing blocks for standard concrete valve boxes are to be pre-cast in blocks measuring 12" x 12" x 4". No reinforcing steel is required in footing blocks.

Valve Box Frames and Covers shall be made of heavy cast iron and shall meet the requirements of ASTM A-48, Class 40.

All casting shall be made accurately to the required dimensions and shall be sound, smooth, clear and free of blemishes or other defects. Defective castings which have been plugged or otherwise treated to remedy defects shall be rejected. Contact surfaces of frames and covers to be machined so that the covers rest securely in the frames with no rocking. The cover shall be in contact with the frames for the entire perimeter of the contact surface.

The valve box frames and covers shall be as manufactured by Bouchard No. 8006, Roadway Type, Nashville Standard or equal. The cover shall be marked "SEWER."

23. 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 M-167.

All plates shall be punched for bolting on both longitudinal and circumferential seams, shall be of the lap type with offset 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 M-190.

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, Trumball 5X or approved equal, and shall be applied with hydraulic spray equipment using a minimum of 2,400 pounds 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.

24. 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.

25. TUNNEL BACKFILL

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

26. PLUG VALVES

Plug valves shall be non-lubricated, eccentric type, with seats suitable for 200 PSI water under throttling service and for the 150 psi working pressure. Lengths shall be the same as gate valves. Port area shall be at least 75 percent of full pipe area.

Valves 3-inch and larger shall have cast iron, Type I ni-resist, or bronze bodies; resilient faced plugs; and nickel seats. Smaller valves shall have Type I ni-resist bodies and seats and resilient faced plugs.

Manually operated valves 8-inch and larger shall have worm gear operators and hand or chain wheels. Valves smaller than 8-inch may have nuts for wrench operation or operating handles. One wrench for each three valves shall be furnished for each size of operating nut for wrench operated valves.

Valves in horizontal lines shall be installed with the stem horizontal and the plugs on top when the valves are open. Valves in vertical lines shall be installed with the plug at the top when closed. Valves shall be tagged or marked by the manufacturer to indicate the proper mounting position.

All valves shall open to the left (counterclockwise) and shall be provided with 2-inch square operating nut. All underground gate valves, which have nuts deeper than 30 inches below the valve box top, shall have extended stems with nuts located within one foot of the valve box cap.

Iron body resilient seat gate valves shall be as manufactured by Mueller or equal.

27. MANHOLE/VALVE/FORCE MAIN MARKERS

Manhole/valve markers, if required, shall be Carsonite Markers as supplied by Consolidated Pipe and Supply Company, Inc., Nashville, Tennessee or approved equal.

28. 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. Casing pipe joints shall be of leakproof construction either steel (in accordance with the following table) or bituminous-coated corrugated metal (conforming

to AREA specifications), unless specifically shown otherwise on the Drawings or in the Specifications describing construction requirements at a particular casing location.

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

Casing Diameter, <u>inches</u>	Wall Thickness with approved protective coating, <u>inches</u>	Wall thickness without approved protective coating, <u>inches</u>
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

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.

“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 chocks (minimum three per joint) as manufactured by Powerseal Pipeline Products Corporation of Wichita Falls, Texas, or Engineer approved equal. Where casing chocks are used inside steel casing pipes, the requirement for sand or pea gravel backfill can be eliminated. Additionally, the end of the steel casing pipe shall be sealed with casing pipe “End Seals”, “Link-seal” or Engineer approved equal.”

29. RIP-RAP

Rip-Rap stone material shall be sound, durable, free from cracks, pyrite intrusion and other structural defects. Wear shall not exceed sixty by the Los Angeles Method. When crushed aggregate is subjected to five alterations of the sodium sulfate soundness test, the weighted percentage of loss shall not be more than fifteen. At least 90 percent of the stone shall not be less than 8 inches wide by 12 inches long by 12 inches deep and shall be approximately rectangular in shape.

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