

SECTION 15

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STORM SEWERS AND PIPE CULVERTS

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SECTION 15

STORM SEWERS AND PIPE CULVERTS

1. DESCRIPTION: This work shall consist of the construction of storm sewers and pipe culverts for the removal of water from collection points in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Plans. This section shall also include all necessary excavation and backfilling construction requirements for this installation.

2. MATERIALS: The pipe for storm sewers, pipe culverts and flared end sections shall be reinforced concrete, Class III, corrugated metal, or polyethylene corrugated, pipe meeting the requirements of the following Specifications. The Contractor will install the herein described storm sewer and pipe culverts as set forth on the Construction Plans. Materials shall conform to the requirements of the respective Specifications described herein.

- 2.1 Reinforced Concrete Pipe: Reinforced concrete round pipe shall meet all applicable requirements of the "Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe", AASHTO Designation: M 170. The class of pipe shall be Class III or higher for round pipe as shown on the plans. Flared end sections for reinforced concrete round pipe shall meet all applicable requirements of AASHTO Designation: M 170 for Class III pipe or higher classes of pipe.
- 2.1.1 Acceptability of pipe in sizes less than 72 inches in diameter shall be based on the following items:
- a. The results of three-edge-bearing tests for the load to produce a 0.01 inch crack and the ultimate load.
 - b. The loading to destruction of selected pieces of pipe to determine ultimate strength, area and placement of steel and absorption characteristics of the concrete.
 - c. Absorption tests on selected samples from the wall of the pipe.
 - d. By inspection of the finished pipe to determine its conformance with the design prescribed in this Specification and its freedom from defects.
- 2.1.2 Acceptability of flared end sections and beveled end sections shall be based on the following items:
- a. The conformance of the concrete to the compressive strength requirements as AASHTO Designation: M 170 for Class III pipe. Tests shall be conducted on concrete cylinders molded from portions of the same concrete that used to cast the end sections or upon cores drilled from the flared part of the end

section. Cylinders for this test shall be prepared as set forth in Section 9 of AASHTO Designation: M 170. The average compressive strength of all cylinders or cores tested shall be equal to or greater than minimum compressive strength of the concrete as required for Class III pipe.

- b. The conformance of the end sections to the dimensions shown on the Plans.
- c. Quality of workmanship used in fabrication of the end sections as reflected in the relative absence of flaws, cracks and other defects.

2.1.3 Pipe furnished under this Specification shall be tested in accordance with the requirements of AASHTO Designation: M 170 for reinforced concrete round pipe, with the following exceptions and additions:

- a. Cores for compressive strength tests, drilled from the walls of round concrete pipe 72 inches in diameter and larger, shall have a minimum diameter of 3 inches.
- b. When the $1/d$ ratio of cores drilled to determine the compressive strength of concrete pipe is more than 1.00, the compressive strength shall be computed according to ASTM Designation: C 42. When the $1/d$ ratio is less than 1.00, the core strength without correction shall be not less than 6,000 psi. No cores shall be tested for strength when the $1/d$ ratio is less than 0.65.
- c. Tests to determine the absorption of concrete shall be conducted on not less than two cores drilled from the walls of the pipe. The cores shall have a nominal diameter of not less than 3 inches. Cores tested for absorption shall not be used for compressive strength tests.

2.2 Corrugated Metal Pipe: Corrugated steel culvert pipe furnished under these Specifications shall comply with applicable requirements of the "Standard Specifications for Corrugated Metal Pipe", AASHTO Designation: M 36, with the following revisions and additions:

2.2.1 Fabrication: The first paragraph of Section 9 of AASHTO Designation: M 36 shall be deleted and the following added as a revision:

Culverts shall be of the following types:

2.2.1.1 Type 1- This type shall have spiral (helical) corrugations with continuous welded seam HEL-COL and hugger bands.

2.2.1.2 Helical Welded Seams: Helical continuous welded seams shall be parallel to the corrugations and shall extend from end to end of each length of pipe. Welding shall be by approved methods utilizing ultra high frequency resistance equipment. Seams shall be welded in such a manner that they will develop the full strength of the pipe and not affect

shape or nominal diameter of the pipe. Welded seams shall be controlled such that the combined width of weld and adjacent coating burned by welding does not exceed three times the metal thickness. Drainage outside the width shall be repaired as required and described hereinafter. The manufacturer shall certify that the welds have been tested and found satisfactory.

Continuous welded seams shall be tested in accordance with AASHTO

T 241, Cup Test Procedure. For a length of pipe to be acceptable, the sum of the lengths of cracks or other defects on either side of the cup shall not exceed 1/4 inch. If the first cup indicates a failure, a second test shall be run at another location on the weld not less than 3 inches nor more than 12 inches from the first cup and in the direction of the center of the pipe. If the second test indicates a failure, the pipe shall be rejected. AASHTO T 241, Referee Test Method, shall be used in case of disagreement over the results of the cup test or visual examination.

2.2.1.3 Repair of Damage Coating: Units on which the metallic coating has been burned by welding beyond the accepted limits or has been otherwise damaged in fabrication or handling, shall be repaired. The repair shall be done so the completed unit shows careful finished workmanship in all particulars. If the City so elects, the repair shall be done in his presence. In any case, the material used and application shall meet the approval of the City.

- a. The coating damaged during fabrication or handling in the fabricating shop shall be repaired by recoating by the hot-dip process, by the metallizing process, with one coat of red lead and one coat of aluminum paint, or with two coats of zinc dust-zinc oxide or zinc-rich paint.
- b. Coating damaged in the field shall be repaired by relocating by the hot-dip process or by the metallizing process except that in instances of minor damage to areas in the upper two-thirds of the perimeter as installed, the City may permit repair in the same manner as specified for repair during fabrication.
- c. Damaged areas shall be cleaned to bright metal by blast cleaning, power disk sanding, or wire brushing. The cleaned area shall extend at least 1 1/2 inch into the undamaged section of the coating. The cleaned area shall be coated within 24 hours and before any rusting or soiling.

2.2.1.4 Repair of Hot-Dip Process: The type of paint repair may be any one of those specified above. Paint shall be applied over the damaged section and surrounding cleaned undamaged area. Any of the allowed repair paint systems may be used for repair of zinc or aluminum coatings.

2.2.1.5 Repair by Metallizing Process: The damaged area shall be cleaned as described hereinbefore except it shall be cleaned to the near-white condition. The repair coating applied to the cleaned section shall have a thickness of not less than 0.005 inch over the damaged section and shall taper off to zero thickness at the edges of the cleaned undamaged section.

- a. When zinc coating is to be metallized, it shall be done with zinc wire containing not less than 99.98 percent zinc.
- b. When aluminum coating is to be metallized, it shall be done with aluminum wire containing not less than 99 percent aluminum.

2.2.3 Dimensions: Section 11 of AASHTO Designation: M 36 shall be deleted and the following added as a revision:

The outside circumference, width of laps, gauges, and dimensions of pipe arch shall be as shown in Tables 1 and 2. The dimensions given for the diameter are nominal.

TABLE 1
PIPE REQUIREMENTS (STEEL)
TYPE 1 AND TYPE 2 PIPE*

Pipe Nominal Diameter (Inches)	Galvanized	Galvanized	Connected Bands Sheet Gauge	Outside Circumference (Inches)	For Type 2 Only
	2 2/3-Inch x 1/2-Inch Corrugated Sheet Gauge	3-Inch x 1-Inch Corrugated Sheet Gauge			Minimum Width of Lap** (Inches)
8	16	16	16	26.7	1-1/2
10	16,14	16	16	33.1	1-1/2
12	16,14	16	16	40.8	1-1/2
15	16,14,12	16	16	50.2	1-1/2
18	16,14,12	16	16	59.5	1-1/2
21	16,14,12	16	16	68.8	1-1/2
24	16,14,12,10	16	16	78.2	2
30	14,12,10,8	16	16	96.9	2
36	14,12,10,8	16	14	115.6	2
42	12,10,8	16	14	134.4	3
48	12,10,8	16	14	153.1	3
54	12,10,8	16	14	171.1	3
60	10,8	16	12	190.6	3
72	10,8	16	12	229.9	3
84	8	14	12	265.4	3
96	8	14	12	302.7	3

* Different gauges are shown for use in design for various heights of fill over the top of the pipe. Unless otherwise shown on the Plans, the lightest gauge listed may be furnished.

** For riveted joints.

TABLE 2

PIPE ARCH REQUIREMENTS (STEEL)

Waterway Area (Sq.Ft.)	Span* (Inches)	Rise* (Inches)	Diameter of Equivalent Round Pipe** (Inches)	T* (Inches)	B* (Inches)
1.1	17	13	15	8-3/4	4-1/4
1.6	21	15	18	11-1/4	4-3/4
2.2	24	18	21	12-1/2	5-1/2
2.9	28	20	24	13-1/2	6-1/2
4.5	35	24	30	16	8
6.5	42	29	36	19-1/4	9-3/4
8.9	49	33	42	22-3/4	11-1/4
11.6	57	38	48	25	13
14.7	64	48	54	28-1/4	14-3/4
18.1	71	47	60	30-3/4	16-1/4
21.9	77	52	66	34-1/4	17-3/4

* A tolerance of plus or minus 2 inches will be permissible in span, rise T and B.

* T is the vertical distance from the highest point of the intrados of the arch to a horizontal line cross the widest portion of the arch.

* B is the vertical distance from a horizontal line across the widest portion of the arch to the lowest portion of the base.

* All dimensions are measured from the inside crests of the corrugations.

** Pipe requirements shown in Table 1.

2.2.4 Corrugations: Corrugations shall meet the requirements of Table 3.

TABLE 3

Nominal Diameter (Inches)	Type "A"		Type "B"	
	Depth (Minimum) (Inches)	Pitch (Maximum) (Inches)	Depth (Minimum) (Inches)	Pitch (Maximum) (Inches)
8 and 10	1/4	2-3/4	--	--

- 2.2.5 Gauge Determination and Thickness: Section 15 of AASHTO Designation: M36 shall be deleted and the following added as a revision: The gauge thickness of metal shall be determined by measuring the thickness of the galvanized sheets prior to fabrication. The thickness of sheet shall be as shown in Table 4 of these Specifications.

TABLE 4**GAUGE, EQUIVALENT THICKNESS AND TOLERANCE FOR STEEL PIPE**

Galvanized Sheet Gauge Number	Weight of Sheet (Oz./S.F.)	Mean Thickness Inches	Coil Widths Up to 15"	Permissible Variation in Thickness (Inches)	
				Coil Widths Over 15" to 32"	Coil Widths Over 32" to 40"
8	112.5	0.1681	0.008	0.009	0.010
10	92.5	0.1382	0.008	0.009	0.010
12	72.5	0.1084	0.008	0.009	0.010
14	52.5	0.0785	0.007	0.008	0.008
16	42.5	0.0635	0.007	0.007	0.007
18	34.5	0.0516	0.006	0.007	0.006

2.2.6 Repair of Damaged Spelter Coating: Paragraph 24 (a) of AASHTO Designation: M 36 shall be deleted and the following added as a revision:

- a. Areas of spelter coating that have been damaged during the fabrication of elbows or other special fittings shall be regalvanized or painted with zinc dust-zinc oxide primer or with High Zinc Dust Content Paint,. Regalvanizing shall be done by the hot-dip process or by the metalizing process.

Paragraph 24 (d) of AASHTO Designation: M 36 shall be deleted and the following added as a revision:

- b. After the completion of all fabrication, the interior and exterior surfaces of the damaged area shall be cleaned and all welding flux, loose or cracked spelter coat and all other foreign material removed.
- c. The cleaned area and 1/2 inch of the adjacent undamaged area of spelter coat shall be painted with two coats of Zinc-Dust, Zinc-Oxide Primer meeting the requirements of Subsection Q3-7, or with two coats of High Zinc Dust Content Paint meeting the requirements or Subsection Q3-11. The first coat shall be thoroughly dried before the second coat is applied.

2.2.7 End Sections: End sections shall conform to the sizes and dimensions shown on the Plans. Materials used in the fabrication of end sections shall comply with all the requirements of materials for culvert pipe as set forth in these Specifications.

2.3 Mortar for concrete pipe joints shall be composed of one part by volume of portland cement and two parts of sand. Portland cement shall conform to Federal Specification SS-C-192, Type I or Type II. Sand shall conform to AASHTO Designation: M 45. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Mortar shall be used within 30 minutes from the time the dry ingredients are mixed with the water.

2.4 Plastic Joint Compound for sealing concrete pipe joints shall be a homogeneous blend of bitumen, inert fillers, and suitable solvents or plasticizers compounded as a trowel consistency bulk material or as an extruded tape or rope. When tested under the specified tests, the results shall be within the listed limits.

<u>Test Method</u>	<u>Results</u>	
	<u>Minimum</u>	<u>Maximum</u>
ASTM Designation: D 147 Bitumen soluble in CS 2 percent by weight	45	
Ash, percent by weight	15	50
ASTM Designation: D 5 Penetration(measured on bitumen portion) standard cone, 150g., 5 sec., 25 degrees C. Trowel consistency	110	215

- 2.5 Polyethylene Pipe: The use of high density polyethylene corrugated pipe as approved by the City.
- 2.5.1 The prescribed sizes of pipes are nominal inside diameters. Pipes shall be of the size and length shown on the plans.
- 2.5.2 Pipe shall be high density polyethylene (HDPE) with corrugated exterior and smooth interior. Twelve (12) to twenty-four (24) inch diameter shall conform to AASHTO Designation: M 294 Classification "Type S".
- 2.5.3 Joints, gaskets and fittings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation of joints. Only fittings supplied or recommended by the pipe manufacturer shall be used.

3. **CONSTRUCTION REQUIREMENTS:**

- 3.1 Excavation and Forming Bed: The trench shall be excavated beginning at the outlet end and proceeding toward the upper end, true to line and grade shown on the Plans. The width of the trench shall be sufficient to lay and backfill the pipe satisfactorily but in no case shall be less than the external diameter of the pipe plus six (6) inches on each side. When necessary, the trench shall be adequately shored or sheeted to insure safe and satisfactory construction and backfilling. If it is necessary to remove an existing street surface in constructing the pipe, an equivalent surface shall be placed at the expense of the Contractor unless provision for the removal and reconstruction is otherwise provided on the Plans.
- 3.1.1 The foundation in the trench shall be so formed as to prevent subsequent settlement. If the foundation is in rock, hard pan or other unyielding material is encountered, an equalizing bed of well-compacted sand or similar material at least twelve (12) inches in thickness shall be placed upon the rock. If the foundation is in good firm earth, the earth shall be pared or molded to give full support to each pipe for a depth at least six (6) inches. If the excavation has been made deeper than necessary, proper bearing shall be secured by means of a layer of sand or other suitable material.

- 3.1.2 When indicated on the Plans, or if ordered in writing by the City, in order to provide a suitable foundation for the pipe, a concrete cradle or encasement shall be placed under or around the pipe. Encasement concrete shall be Class B and the dimensions shall be as indicated on the Plans or ordered by the City.
 - 3.1.3 Where rock is encountered in the toe wall excavation for multiple box structures, concrete box culverts or concrete head walls for pipe culverts and rock is such quality that will prevent erosion, part of the toe wall may be eliminated in the rock strata as directed, but the toe wall shall be keyed into the rock strata.
- 3.2 Laying: The laying of pipes in finished trench shall be started at the outlet end so that the spigot ends (when bell and spigot pipe is used) point in the direction of flow. All pipes shall be laid with ends abutting and true to line and grade. They shall be laid in the beds so that the lower portion of each pipe is supported for its entire length to a depth at least equal to Paragraph 3.1. They shall be fitted and matched so that when laid in the trench, they will form a culvert with a smooth, uniform invert. Pipes shall be so lowered as to avoid unnecessary handling in the ditch. No pipe culverts shall be placed until the foundations have been approved by the City.
- 3.2.1 Sections of corrugated metal pipe shall be placed with the ends abutting and jointed with the manufacturer's coupling bands.
 - 3.2.2 Where two (2) or more culverts are to be placed adjacent to each other, they shall be separated by a distance equal to at least one-half (1/2) the diameter of the pipe with a minimum distance of eighteen (18) inches for pipe culvert and a minimum distance of two (2) feet in all cases for metal and culvert.
 - 3.2.3 Joints of pipe shall be cemented with a cement mortar composed of one (1) part portland cement and three (3) parts of fine aggregate mixed with sufficient water to form a plastic mortar. As each section of pipe is laid, the bell or hub of the preceding pipe shall be cleaned and the bottom portion filled with the mortar. After the pipe is placed, the remaining portion of the joint shall be filled. The inside of the joint shall be finished smooth and wiped clean. The mortar on the south side shall, after its initial set, be protected from the sun with earth or other covering.
 - 3.2.4 Plastic joint compound may be used in lieu of the portland cement mortar. If plastic joint compound is used, it shall be prepared and applied in accordance with the manufacturer's recommendations.
- 3.3 Sheeting and Bracing: Sheeting and bracing shall be provided where necessary to prevent caving and to safeguard the workmen. The trench or excavation shall be dug to such a width that proper allowance is made for the space occupied by the sheeting and bracing. Sheeting and bracing shall be removed as backfilling progresses.

4. INSTALLATION:

- 4.1 General: Each pipe shall be carefully inspected immediately before it is laid and defective pipe shall not be used. Pipe shall be laid to the grade and alignment indicated or as directed. Pipes shall be cambered when directed. Any pipe which has its grade or joint disturbed after laying shall be taken up and relaid. Under no circumstances shall pipe be laid in water and no pipe shall be laid when the trench or the weather is unsuitable for such work. The pipe shall be laid upgrade, beginning at the lower end. Proper facilities shall be provided for lowering the pipe into the trenches.
- 4.2 Corrugated Metal Pipe shall be laid with the separate sections joined firmly together with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the side.
- 4.3 Concrete Pipe: The first pipe shall be bedded to the established gradeline, placing the bell end upstream. Pipe shall be laid with the spigot end centered the full length into the adjacent section of pipe. Joints shall be sealed with a plastic joint compound or concrete mortar.
- 4.3.1 Sealing Concrete Pipe with Mortar: The interior surface of the bell shall be carefully cleaned with a wet brush and the lower portion of the bell filled with mortar to such depth as to bring the inner surfaces of the abutting pipes flush and even. The spigot end of each succeeding pipe section shall be cleaned with a wet brush and uniformly matched into the bell so that the sections are closely fitted. The bottom inside joint shall be filled with mortar and then wiped and finished smooth. After each succeeding section is laid, the outside joint shall be filled with mortar, and bead shall be formed around the joint with a sufficient amount of additional mortar. The mortar bead on the outside shall immediately be protected from the air and sun with a cover of wetted burlap or earth, and shall be kept protected for such period as is necessary to obtain satisfactory curing.
- 4.3.2 Sealing Concrete Pipe with Plastic Joint Compound: The compound shall be applied to the entire interior surface of the bell and upper portion of the spigot. The joints shall be forced together with excess compound extruding both inside and outside of the joint. Excess compound shall be removed from the interior surface where accessible. The joint between the bell and spigot shall be uniform for the full circumference and care shall be taken to prevent the bell from supporting the spigot.
- 4.4 Polyethylene Pipe: Shall be laid according to manufacturer's recommendation or ASTM D2321 with the exception that a minimum one (1) foot of cover shall be required in trafficked areas.
- 4.5 Connections to Existing Structures: At locations shown on the Plans, storm sewers shall be connected to existing inlets, catch basins, or manholes. The Contractor shall make entry into the existing structure in a

manner that will create the minimum opening required and that will not damage the existing structure. After the new pipe is installed, the opening around the pipe shall be neatly closed with concrete or mortar and caulked to insure that no leakage occurs.

- 4.6 Connections to Drainage Pipe: At locations shown on the Plans, storm sewers and pipe culverts shall be connected to existing drainage pipe. The Contractor shall repair any damage to the ends of the existing storm drainage pipe so the new storm sewer pipe extension may be properly and securely connected. The repair when complete shall be zinc coated in accordance with requirements as set forth herein. The connection shall be made in such a manner to provide a secure and watertight connection.

5. **BACKFILL:** All trenches, channels, and excavation shall be backfilled with suitable material in a manner that will not disturb the pipe.
- 5.1 The trenches or excavation for all pipe culverts, storm sewer, and/or box culverts that lie within the roadbed, or beneath entrances, side roads, and other intersecting traveled ways, or which are so designated on the Plans and for those pipe culverts and storm sewer pipes which lie outside the traveled ways, roadway, entrances, drives and side roads, shall all be backfilled to the required grade in layers not to exceed six (6) inches in thickness, and each layer shall be compacted to ninety-five (95) percent of standard compaction as defined in the SECTION: EARTHWORK.
- 5.2 All culverts and storm sewer pipes shall be backfilled in accordance with the following requirements, regardless of whether or not compaction of earthwork is required by the Plans. Only approved materials that will produce a dense, well-compacted backfill shall be used for backfilling. Materials such as sod, frozen soil, debris, and soil containing organic matter shall not be used. Rocks may be used in the backfill only with the express permission of the City and only when voids between the rocks are filled with fines and properly densified.
- 5.3 No backfilling shall be placed against any culvert and storm sewer without permission of the City. Backfill, placed around culverts and storm sewers, shall be deposited on both sides to approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the pipe. The slopes bounding the excavation shall be stepped when necessary to prevent such wedge action.
- 5.4 Jettings of fills, or other hydraulic methods, involving or likely to involve liquid or semiliquid pressure shall be prohibited.
- 5.5 The material shall be placed in layers and compacted by means of suitable equipment, exclusive of track-laying equipment, or by tamping with mechanical tampers or hand tampers. Each layer shall be compacted to a density equal to or greater than ninety-five (95) percent of the Standard Compaction of the soil. Each successive layer shall contain only that amount of material which will insure proper compaction, but in no case shall any layer be greater than six (6) inches (loose measurement) in

depth. The moisture content of the soil to be used for backfill shall be uniform and shall be within the moisture designated on the Plans for the embankment adjacent to the pipe. If no moisture range is designated, the moisture content of the soil to be used shall be uniform and shall be adjusted as necessary in the judgement of the City, to permit proper consolidation; but not to exceed option plus three percent (OMC+3% max). Excess material shall be disposed of and the area involved shall be left in a neat and presentable condition.

- 5.6 The Contractor shall complete the backfill around culverts and storm sewer pipes as outlined above to the level of the original ground line for the full width of the excavation area. If the top of the culvert and storm sewer pipe extends above the original ground line, the Contractor shall continue the compacted backfill to the top of the pipes for a width of one and one-half (1 1/2) times the maximum external width of the pipes on each side of the center line of the pipes for the full width of the roadway embankment.
- 5.7 After the culverts and storm sewer pipes have been bedded, the backfill must be placed and compacted for the width and as described above to a height above the top of the pipes equal to the maximum external width of the pipes. The earth material in the prism directly over the pipes shall then be excavated and the trench backfilled with earth material deposited in the loosest possible condition. The construction of the embankment will then proceed in accordance with the standard methods as set out in this Specification.

6. QUALITY CONTROL: In-place field density tests shall be performed on the backfill materials placed alongside the pipe culverts. The density tests shall be performed in accordance with the provisions of SECTION: EARTHWORK, except the minimum number of representative tests obtained shall be two per section between curb inlets and/or two per culvert location, one on each side of the pipe, with additional tests obtained when there is reason to suspect that the compaction does not meet the specified requirements.

7. METHOD OF MEASUREMENT: Pipe culverts and storm sewer pipe shall be measured by the linear foot of the various sizes and types of pipe as denoted on the Plans. Measurements shall be along the center line of the pipe complete in place from end to end of pipe or to the inside face of walls of drainage structures.

8. AASHTO REFERENCES

- 8.1 AASHTO M36 – Corrugated Steel Culverts and Underdrains.
- 8.2 AASHTO M190 – Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Inserts.

9. ASTM REFERENCES

- 9.1 ASTM A48 – Standard Specification for Gray Iron Castings.
- 9.2 ASTM A536 – Standard Specification for Ductile Iron Castings.
- 9.3 ASTM C150 – Standard Specification for Portland Cement.
- 9.4 ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections.
- 9.5 ASTM C923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
- 9.6 ASTM D1227 – Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
- 9.7 ASTM D4022 – Standard Specification for Coal Tar Roof Cement, Asbestos Containing.

END OF SECTION