PART II TECHNICAL SPECIFICATIONS

DRAINAGE ITEMS

ITEM D-701 PIPE FOR STORM DRAINS AND CULVERTS

DESCRIPTION

701-1.1 This item shall consist of the construction of pipe culverts and storm drains according to these Specifications and in reasonably close conformity with the lines and grades shown on the Plans.

MATERIALS

701-2.1 Materials shall meet the requirements shown on the Plans and specified below.

701-2.2 PIPE. The pipe shall be of the type called for on the Plans and shall be according to the following appropriate requirements.

Metallic Coated Corrugated Steel Pipe (Type I, IR or II)	AASHTO M 36
Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains	ASTM A760
Galvanized Steel Corrugated Structural Plates and Fasteners for Pipe, Pipe-Arches, and Arches	ASTM A761
Polymer Precoated Corrugated Steel Pipe for Sewers and Drains Post-Coated and Lined (Bituminous or Concrete)	ASTM A762
Corrugated Steel Sewer and Drainage Pipe	ASTM A849
Corrugated Aluminum Alloy Culvert Pipe	ASTM B745
Non-Reinforced Concrete Pipe	ASTM C14
Reinforced Concrete Pipe	ASTM C76
Reinforced Concrete D-Load Pipe	ASTM C655
Reinforced Concrete Arch Pipe	ASTM C506
Reinforced Concrete Elliptical Pipe	ASTM C507
Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers	ASTM C1433
Corrugated Polyethylene (PE) Pipe and Fittings	ASTM F667
Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter	ASTM F714
Poly (Vinyl Chloride) Ribbed Drain Pipe & Fittings Based on Controlled Inside Diameter	ASTM F794
Polyethylene (PE) Large Diameter profile Wall Sewer and Drain Pipe	ASTM F894
Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings	ASTM F949
Steel Reinforced Polyethylene (PE) Corrugated Pipe	ASTM F2435
Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage	ASTM F2562
Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe	ASTM F2736
Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications	ASTM F2764
Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications.	ASTM F2881
Bituminous-Coated Corrugated Metal Pipe and Pipe Arches	AASHTO M 190
Bituminous-Coated Corrugated Aluminum Alloy Culvert Pipe	AASHTO M 190 and M 196
Bituminous-Coated Structural Plate Pipe, Pipe Arch, and Arches	AASHTO M 167 and M 243
Aluminum Alloy Structural Plate for Pipe, Pipe Arch, and Arches	AASHTO M 219
Polyvinyl Chloride (PVC) Pipe	ASTM D3034
Corrugated Polyethylene Drainage Tubing	AASHTO M 252
Corrugated Polyethylene Pipe, 300 mm to 1500 mm Diameter	AASHTO M 294
Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings	

701-2.3 CONCRETE. Concrete for pipe cradles shall have a minimum compressive strength of 2,000 pounds per square inch (psi) at 28 days and conform to the requirements of AASHTO M 157.

701-2.4 RUBBER GASKETS. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe and polyethylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the ``RE'' closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 JOINT MORTAR. Pipe joint mortar shall consist of one part by volume of portland cement and two parts sand. The portland cement shall conform to the requirements of AASHTO M 85, Type I. The sand shall conform to the requirements of AASHTO M 45.

701-2.6 JOINT FILLERS. Poured filler for joints shall conform to the requirements of AASHTO M 324.

701-2.7 PLASTIC GASKETS. Plastic gaskets shall conform to the requirements of AASHTO M 198(Type B).

701-2.8. CONTROLLED LOW-STRENGTH MATERIAL (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used all joints shall have gaskets.

701-2.9 CULVERT MARKER POSTS. Provide posts made of durable glass fiber and resin reinforced material flexible to -40°F, resistant to impact and ultraviolet light. “T” in cross section, 3.75 inch wide x 72 inches long, and color blue. Provide Carsonite CUM-375 utility marker or approved equal.

701-2.10 CLASS B BEDDING. Use one of the following materials:

- **a.** Suitable material as defined in specification subsection P-152-2.3, except that 100% of the material will pass a 1 inch sieve.
- **b.** P-299 Aggregate Surface Course (when included in this contract).
- **c.** P-209 Crushed Aggregate Base Course (when included in this contract).

701-2.11 END SECTIONS. End sections for metal pipe must be of the same material as the pipe.

CONSTRUCTION METHODS

701-3.1 EXCAVATION. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 18 inches on each side. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe (whichever is greater) but for no more than 75% of the nominal diameter of the pipe. The width of the excavation shall be at least 1 foot greater than the horizontal outside diameter of the pipe. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved Class B bedding material for the full trench width. The Engineer shall determine the depth of removal necessary. The Class B bedding material shall be compacted to provide adequate support for the pipe.

The excavation for pipes that are placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the Plans.

701-3.2 BEDDING. The pipe bedding shall conform to the class specified on the Plans. When no bedding class is specified or detailed on the Plans, the requirements for Class B bedding shall apply. Compact all bedding to 95% of the maximum density determined by ATM 207 or ATM 212.

a. Rigid Pipe. Class A bedding shall consist of a continuous concrete cradle conforming to the plan details.

Class B bedding shall consist of a bed of granular material having a thickness of at least 6 inches below the bottom of the pipe and extending up around the pipe for a depth of not less than 30% of the pipe's vertical outside diameter. The layer of bedding material shall be shaped to fit the pipe for at least 10% of the pipe's vertical diameter and shall have recesses shaped to receive the bell of bell and spigot pipe.

Class C bedding shall consist of bedding the pipe in its natural foundation material to a depth of not less than 10% of the pipe’s vertical diameter. The bed shall be shaped to fit the pipe and shall have recesses shaped to receive the bell of bell and spigot pipe.

b. Flexible Pipe. For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

Pipe Corrugation Depth, in.	Minimum Bedding Depth, in.
1/2	1
1	2
2	3
2-1/2	3-1/2

c. PVC and Polyethylene Pipe. For PVC and polyethylene pipe, the bedding material shall consist of Class B bedding. The bedding shall have a thickness of at least 6 inches below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 LAYING PIPE. The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

701-3.4 JOINING PIPE. Joints shall be made with (1) portland cement mortar, (2) portland cement grout, (3) rubber gaskets, (4) plastic gaskets, or (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints in order to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

a. Concrete Pipe. Concrete pipe may be either bell and spigot or tongue and groove. The method of joining pipe sections shall be such that the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be thoroughly wetted before mortar or grout is applied.

b. Metal Pipe. Metal pipe shall be firmly joined by form fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M 36 for aluminum pipe.

c. PVC, Polypropylene, and Polyethylene Pipe. Joints for PVC, polypropylene, and polyethylene pipe shall conform to the requirements of ASTM D3212 when water tight joints are required. Joints for PVC and polyethlyene pipe shall conform to the requirements of AASHTO M 304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M 252 or M 294. Fittings for polypropylene pipe shall conform to the requirements of ASTM F2881, ASTM F2736, or ASTM F2764.

701-3.5 BACKFILLING. Pipes shall be inspected before any backfill is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense.

Use backfill that is suitable material as defined in subsection P-152-2.3 except that:

a. 100% of the material placed within 1 foot of the pipe will pass a 3 inch sieve.

b. If the pipe is placed in or under the structural section, construct the backfill according to the material and construction requirements of the specifications for the applicable lift of material (P-154, P-299, P-209).

When the top of the pipe is even with or below the top of the trench, the backfill shall be compacted in layers not exceeding 6 inches on both sides of the pipe and shall be brought up 1 foot above the top of the pipe or to natural ground level, whichever is greater. Care shall be exercised to thoroughly compact the backfill material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on both sides of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the backfill shall be compacted in layers not exceeding 6 inches and shall be brought up evenly on both sides of the pipe to 1 foot above the top of the pipe. The width of backfill on each side of the pipe for the portion above the top of the trench shall be equal to twice the pipe's diameter or 12 feet, whichever is less.

For PVC, polypropylene, and polyethylene pipe, the backfill shall be placed in two stages; first to the top of the pipe and then at least 12 inches over the top of the pipe. The backfill material shall meet the requirements of Subsection 701-3.2c.

All backfill shall be compacted to the density required under Item P-152.

It shall be the Contractor’s responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

701-3.6 CULVERT MARKER POSTS. Install culvert marker posts at each culvert inlet and outlet. Drive posts to 18 inches minimum embedment.

METHOD OF MEASUREMENT

701-4.1 PIPE. The length of pipe will be measured in linear feet of pipe in place, completed, and approved. It will be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types and size will be measured separately. All fittings and end sections will be included in the length of the pipe being measured. All trench excavation and backfill associated with pipe installation is subsidiary to item D-701a.

701-4.2 CONCRETE. The volume of concrete for pipe cradles to be paid for will be the number of cubic yards of concrete which is completed in place and accepted.

701-4.3 ROCK. The volume of rock to be paid for will be the number of cubic yards of rock excavated. No payment will be made for the cushion material placed for the bed of the pipe.

701-4.4 CULVERT MARKER POSTS. Culvert marker posts will not be measured for payment.

BASIS OF PAYMENT

701-5.1 Payment will be made at the contract unit price per linear foot for each kind of pipe of the type and size designated; at the contract unit price per cubic yard of concrete for pipe cradles; and at the contract unit price per cubic yard for rock excavation. Culvert marker posts will not be paid for directly, but will be subsidiary to pipe items.

Payment will be made under:

Item D701.010.0018	CS Pipe, 18-inch – per linear foot
Item D701.070.0000	Concrete for Pipe Cradles – per cubic yard
Item D701.080.0000	Rock Excavation – per cubic yard

MATERIAL REQUIREMENTS

AASHTO M 36	Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
AASHTO M 45	Aggregate for Masonry Mortar
AASHTO M 85	Portland Cement
AASHTO M 157	Ready-Mixed Concrete
AASHTO M 190	Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 196	Corrugated Aluminum Alloy Culverts and Underdrains
AASHTO M 198	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 219	Aluminum Alloy Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 243	Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M 252	Corrugated Polyethylene Drainage Tubing
AASHTO M 294	Corrugated Polyethylene Pipe, 300 to 1500 mm Diameter
AASHTO M 304	Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO M 324	Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM A760	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A761	Steel Galvanized, Corrugated Structural Plates and Fasteners for Pipe, Pipe-Arches, and Arches
ASTM A762	Precoated (Polymeric) Galvanized Steel Sewer and Drainage Pipe
ASTM A849	Post-Coated and Lined (Bituminous or Concrete) Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Corrugated Aluminum Alloy Culvert Pipe
ASTM C14	Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C1433	Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers, 3 – 24 in
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe

ASTM C655	Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C700	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM D1056	Flexible Cellular Materials--Sponge or Expanded Rubber
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Corrugated Polyethylene Pipe and Fittings
ASTM F714	Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Poly (Vinyl Chloride) Ribbed Drain Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Polyethylene (PE) Large Diameter profile Wall Sewer and Drain Pipe
ASTM F949	Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
ASTM F2435	Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Polypropylene (PP) Corrugated Singe Wall Pipe and Double Wall Pipe
ASTM F2764	Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

ITEM D-702 SLOTTED DRAINS

DESCRIPTION

702-1.1 This item shall consist of the construction of steel slotted drains according to these Specifications and in reasonably close conformity with the lines and grades shown on the Plans. Typical details shall be shown on the Plans.

MATERIALS

702-2.1 GENERAL. All slotted drains shall meet the requirements shown on the Plans and specified below. All slotted drains shall meet specified hydraulic design requirements and shall support the loadings specified.

Standard details can be found in the American Association of State Highway and Transportation Officials (AASHTO)-AGC-ARTBA publication "A Guide to Standardized Highway Drainage Products." All products used shall meet the most demanding aircraft loading and tire pressure requirements, as well as maintenance and equipment loadings.

702-2.2 PIPE.

a. Steel slotted Drain. Pipe shall be metallic coated (galvanized or aluminized steel type II) corrugated steel type I meeting the requirements of AASHTO M 36. Pipe diameter and gage shall be as shown on the Plans. The corrugated steel pipe shall have a minimum of two rerolled annular ends.

b. Not Used.

702-2.3 GRATES AND CASTINGS.

a. Steel Slotted Drain. Grates shall be manufactured from ASTM A36 or ASTM A1011, Grade 36 steel. Spacers and bearing bars (sides) shall be 3/16-inch material. The spacers shall be welded to each bearing bar with four 1-1/4-inch long by 3/16-inch wide fillet welds on each side of the bearing bar at spacings not exceeding 6 inches. The grates shall be 6 inches high or as shown on the Plans and shall have a maximum 1-3/4-inch opening in the top.

Grates shall be galvanized according to AASHTO M 111 except with a 2 ounces per square foot galvanized coating.

The grates shall be fillet welded to the corrugated steel pipe with a minimum weld 1 inch long on each side of the grate at every other corrugation. Weld areas and the heat affected zones where the slot is welded to the corrugated pipe shall be thoroughly cleaned and painted with a zinc-rich paint according to repair of damaged coatings in AASHTO M 36.

Each 20-foot length of drain delivered to the job site shall be within the following tolerances: vertical bow ± 3/8-inch, horizontal bow ± 5/8-inch, twist ± 1/2-inch.

b. Not used.

702-2.4 CONCRETE. Plain or reinforced concrete used for steel slotted shall conform to the requirements of Section P-610 Concrete for Miscellaneous Structures.

CONSTRUCTION METHODS

702-3.1 EXCAVATION. The width of the trench shall be sufficient to permit satisfactory installation and jointing of the slotted drain and placing of a concrete backfill material under and around the drain, but shall not be less than the external pipe diameter plus 6 inches on each side. The depth of the trench shall be a minimum of 2 inches below the invert for steel slotted drain.

702-3.2 INSTALLATION. Slotted drains shall be laid in sections joined firmly together with coupling bands or as shown on the Plans. The top of all drains shall be held firmly in place to the proper grade, to preclude movement during the backfilling operation.

702-3.3 JOINING. Slotted steel drain joints shall be firmly joined by modified hugger type bands, or as indicated, to secure the pipe and prevent infiltration of the backfill. When the slotted steel drain is banded together, the adjacent grates shall have a maximum 3-inch gap.

702-3.4 BACKFILLING. Slotted drains shall be inspected before any backfill is placed. Damaged drains shall be aligned or replaced at the expense of the Contractor.

The trench holding the slotted drain assembly shall be backfilled with concrete that will easily flow under and around the drain and the trench wall. The opening in the top of grates shall be covered to prevent unwanted material from entering the drain during the backfilling and subsequent surfacing operations.

METHOD OF MEASUREMENT

702-4.1 The length of slotted drain will be measured in linear feet of slotted drain in place, completed, and approved. It will be measured along the centerline of the drain from end or inside face of structure to the end or inside face of structure, whichever is applicable. The classes, types, and sizes will be measured separately. All fittings will be included in the length as typical pipe sections being measured.

BASIS OF PAYMENT

702-5.1 Payment will be made at the contract unit price per linear foot for each kind of slotted drain type and size designated and at the contract unit price per cubic yard of concrete for backfill.

Payment will be made under:

Item D702.010.0000	Slotted Drain, 18-inch, 14 Gauge Pipe – per linear foot
Item D702.020.0000	Concrete for Backfill – per cubic yard
Item D702.030.0000	Trench Drain – per linear foot

MATERIAL REQUIREMENTS

AASHTO M 36	Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
AASHTO M 111	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A36	Structural Steel
ASTM A1011	Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High Strength Low Alloy with Improved Formability, and Ultra High Strength
Information	*A Guide to Standardized Highway Drainage Products* disseminated under the sponsorship of the American Association of State Highway and Transportation Officials, Associated General Contractors, and the American Road and Transportation Builders Association

ITEM D-705 PIPE UNDERDRAINS FOR AIRPORTS

DESCRIPTION

705-1.1 This item shall consist of the construction of pipe drains according to these Specifications and in reasonably close conformity with the lines and grades shown on the Plans.

MATERIALS

705-2.1 GENERAL. Materials shall meet the requirements shown on the Plans and specified below.

705-2.2 PIPE. The pipe shall be of the type called for on the Plans or in the bid and shall be according to the following appropriate requirements.

Perforated Concrete Pipe	ASTM C444
Porous Concrete Pipe	ASTM C654
Corrugated Steel Pipe, Metallic Coated for Sewers and Drains	ASTM A760
Polymer Precoated Perforated Corrugated Steel Pipe	ASTM A762
Perforated Corrugated Aluminum Alloy Pipe	AASHTO M 196
Smooth-Wall Perforated PVC Pipe	ASTM F758
Poly Vinyl Chloride (PVC) Ribbed Drain Pipe & Fittings Based on Controlled Inside Diameter	ASTM F794
Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings	ASTM F949
Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage	ASTM F2562
Perforated Corrugated Steel Pipe	AASHTO M 36
Bituminous-Coated Perforated Corrugated Aluminum Alloy Pipe	AASHTO M 196 and M 190
Corrugated Polyethylene Drainage Tubing	AASHTO M 252
Corrugated Polyethylene Pipe, 300 to 1500 mm Diameter	AASHTO M 294
Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter	AASHTO M 304
Steel Reinforced Polyethylene (PE) Ribbed Pipe, 12 to 36 inch Diameter	AASHTO MP 20

705-2.3 JOINT MORTAR. Pipe joint mortar shall consist of one part by volume of portland cement and two parts sand. The portland cement shall conform to the requirements of AASHTO M 85, Type I. The sand shall conform to the requirements of AASHTO M 45.

705-2.4 ELASTOMERIC SEALS. Elastomeric seals shall conform to the requirements of ASTM F477.

705-2.5 POROUS BACKFILL. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested according to ATM 304.

TABLE 1. GRADATION OF POROUS BACKFILL

Sieve Designation (square openings)	Percentage by Weight Passing Sieves	
	No. 1	No. 2
1-1/2 in.		100
1 in.		90 - 100
3/8 in.	100	25 - 60
No. 4	95 - 100	5 - 40
No. 8	---	0 - 20
No. 16	45 - 80	---
No. 50	10 - 30	---
No. 100	0 - 10	---

When two courses of porous backfill are specified in the Plans, the finer of the materials shall conform to particle size in Table 1, Gradation of Porous Backfill, for porous backfill No. 1. The coarser granular material shall meet the gradation given in Table 1, Gradation of Porous Backfill, for porous backfill No. 2.

705-2.6. GRANULAR MATERIAL. Granular material used for bedding and backfill shall be fine, readily compactable soil, or granular material selected from the excavation or a source of the Contractor's choosing. It shall not contain frozen lumps, chunks of highly plastic clay, or other objectionable material. Material for backfill shall be 100% passing a 2-inch sieve, 95-100% passing a 1/2-sieve, and 0-5% passing a No. 4 sieve.

705-2.7. FILTER FABRIC. The filter fabric shall conform to the requirements of AASHTO M 288, Class 2, except as modified by Table 2.

TABLE 2. FILTER FABRIC PROPERTIES

Fabric Property	Test Method	Test Requirement
Apparent Opening Size	ASTM D4751	40-100
Permittivity	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

CONSTRUCTION METHODS

705-3.1 EQUIPMENT. All equipment necessary and required for the proper construction of pipe underdrains shall be on the project, in good working condition, and approved by the Engineer before construction is permitted to start.

705-3.2 EXCAVATION. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches. The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The Engineer will determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the Engineer. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the Engineer and compacted to the density of the surrounding material.

The pipe bed shall be so shaped that at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Spaces for the pipe bell shall be excavated to allow the pipe barrel to support the entire weight of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to Federal, state, and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per linear foot for the pipe.

705-3.3 LAYING AND INSTALLING PIPE.

a. Concrete or Clay Pipe. The laying of the pipe in the finished trench shall be started at the lowest point and laid upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the Plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and relaid by the Contractor at no additional expense.

b. Metal and Fiber Pipe. The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands which is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

The sections of bituminized-fiber pipe shall be securely fastened together with suitable fittings. When the fiber couplings are tapered, they shall provide a tight, driven fit.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

c. PVC or Polyethylene Pipe. PVC or polyethylene pipe shall be installed according to the requirements of ASTM D2321 or AASHTO Standard Specification for Highway Bridges Section 30. Perforations shall meet the requirements of AASHTO M 252 or M 294 Class 2, unless otherwise indicated on the Plans. The pipe shall be laid accurately to line and grade.

d. All Types of Pipe. The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the Engineer.

Unless otherwise shown on the Plans, a 4-inch bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the Plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the Plans.

e. Filter Fabric. The filter fabric shall be installed according to the manufacturer's recommendations, or according to AASHTO M 288 APPENDIX, unless otherwise shown on the Plans.

705-3.4 MORTAR. The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 JOINTS IN CLAY OR CONCRETE PIPE. When open or partly open joints are required or specified, they shall be constructed as indicated on the Plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the Plans. This backfill shall be placed so its thickness will be not less than 3 inches nor more than 6 inches, unless otherwise shown on the Plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2, as shown on the Plans or as directed by the Engineer.

When the original material excavated from the trench is previous and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the Plans or as directed by the Engineer.

705-3.6 BACKFILLING.

a. Earth. All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The backfill material shall be selected material from excavation or borrow and shall be approved by the Engineer. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and 1 foot over the top of the pipe and shall be readily compacted. It shall not contain stones retained on a 3-inch sieve, frozen lumps, chunks of highly plastic clay, or any other material which is objectionable to the Engineer. The material shall be moistened or dried, as required to aid compaction. Placement of the backfill shall not cause displacement of the pipe. Special care shall be taken in placing the backfill. Great care shall be used to obtain thorough compaction under the haunches and along the sides to the top of the pipe.

The backfill shall be placed in loose layers not exceeding 6 inches in depth under and around the pipe, and not exceeding 8 inches over the pipe. Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the Engineer, until the trench is completely filled and brought to the proper elevation. Backfilling shall be done to avoid damaging top or side pressures on the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

b. Granular Material. When granular backfill is required, its placement in the trench and about the pipe shall be as shown on the Plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the windrow be allowed to filter into the granular backfill. When required by the Engineer, a template shall be used to properly place and keep separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench, as shown on the Plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the Plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the granular backfill shall be not less than 12 inches, measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is to be used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material which remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

c. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153.

d. Deflection Testing. The Engineer may at any time, notwithstanding previous material acceptance, reject or require re-installation of pipe that exceeds 5% deflection when measured according to ASTM D2321, including Appendices.

705-3.7 CONNECTIONS. When the Plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made so that a smooth uniform flow line will be obtained throughout the drainage system.

705-3.8 CLEANING AND RESTORATION OF SITE. After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the Engineer. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

METHOD OF MEASUREMENT

705-4.1 The length of pipe to be paid for will be the number of linear feet of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes will be measured separately. All fittings will be included in the length as typical pipe sections in the pipeline being measured.

705-4.2 The quantity of porous backfill to be paid for will be the number of cubic yards of porous backfill No. 1 and No. 2, complete in place and accepted, and will be determined from the dimensions given on the Plans by typical trench sections indicating the placement of porous backfill or dimensions ordered by the Engineer.

705-4.3 The quantity of filter fabric to be paid for will be the number of square yards of filter fabric in place, completed, and approved; and will be determined from the dimensions given on the Plans by typical trench sections indicating the placement of filter fabric or dimensions directed by the Engineer.

BASIS OF PAYMENT

705-5.1 Payment will be made at the contract unit price per linear foot for pipe underdrains of the type, class, and size designated.

705-5.2 POROUS BACKFILL.

a. Porous backfill No. 1 shall be made at the contract unit price per cubic yard.

b. Porous Backfill No. 2 shall be made at the contract unit price per cubic yard.

705-5.3 FILTER FABRIC. Filter fabric shall be made at the contract unit price per square yard (square meter) for filter fabric.

705-5.4 PIPE UNDERDRAINS, COMPLETE. Pipe underdrains, complete (including porous backfill and filter fabric) shall be made at the contract unit price per linear foot.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D705.010.0004	Underdrain, HDPE, 4-inch – per linear foot
Item D705.030.0000	Porous Backfill No. 1 – per cubic yard
Item D705.040.0000	Porous Backfill No. 2 – per cubic yard
Item D705.050.0000	Filter Fabric – per square yard

TESTING REQUIREMENTS

ATM 304	Sieve Analysis of Aggregates & Soils
AASHTO MP 20	Steel Reinforced Polyethylene (PE) Ribbed Pipe, 12 – 36 in Diameter

MATERIAL REQUIREMENTS

AASHTO M 36	Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
AASHTO M 45	Aggregate for Masonry Mortar
AASHTO M 85	Portland Cement
AASHTO M 190	Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M 196	Corrugated Aluminum Alloy Culverts and Underdrains
AASHTO M 252	Corrugated Polyethylene Drainage Tubing
AASHTO M 288	Geotextile Specification for Highway Applications
AASHTO M 294	Corrugated Polyethylene Pipe, 300 to 1500 mm Diameter
AASHTO M 304	Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO	*Standard Specifications for Highway Bridges*
ASTM A760	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A762	Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C444	Perforated Concrete Pipe
ASTM C654	Porous Concrete Pipe
ASTM D2321	Underground Installation of Flexible Thermoplastic Sewer Pipe

ASTM D3034	Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Smooth-Wall Poly Vinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F949	Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

ITEM D-751 MANHOLES, CATCH BASINS, INLETS, AND INSPECTION HOLES

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, according to these Specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the Plans or required by the Engineer.

MATERIALS

751-2.1 BRICK. The brick shall conform to the requirements of ASTM C32, Grade MS.

751-2.2 MORTAR. Mortar shall consist of one part by volume portland cement and two parts sand. The portland cement shall conform to the requirements of AASHTO M 85, Type I. The sand shall conform to the requirements of AASHTO M 45.

751-2.3 CONCRETE. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

751-2.4 PRECAST CONCRETE PIPE MANHOLE RINGS. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches nor more than 48 inches. There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

751-2.5 CORRUGATED METAL. Corrugated metal shall conform to the requirements of AASHTO M 36.

751-2.6 FRAMES, COVERS, AND GRATES. The castings shall conform to one of the following requirements:

- **a.** Gray iron castings shall meet the requirements of ASTM A48, Class 30B and 35B.
- **b.** Malleable iron castings shall meet the requirements of ASTM A47.
- **c.** Steel castings shall meet the requirements of AASHTO M 103.
- **d.** Structural steel for grates and frames shall conform to the requirements of ASTM A283, Grade D.
- **e.** Ductile iron castings shall conform to the requirements of ASTM A536.
- **f.** Austempered ductile iron castings shall conform to the requirements of ASTM A897.

All castings or structural steel units shall conform to the dimensions shown on the Plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of AASHTO M 111.

751-2.7 STEPS. The steps or ladder bars shall be gray or malleable cast iron, injection-molded polypropylene, or galvanized steel. The steps shall be the size, length, and shape shown on the Plans and those steps that are not galvanized shall be given a coat of asphalt paint, when directed.

751-2.8 PRECAST INLET STRUCTURES. Manufactured in accordance with and conforming to ASTM C913.

CONSTRUCTION METHODS

751-3.1 UNCLASSIFIED EXCAVATION.

a. Limits of Excavation. The Contractor shall excavate for structures and structure footings to the lines and grades or elevations, shown on the Plans, or as staked by the Engineer. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the Plans, shall be considered as approximately only; and the Engineer may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

b. Excavation. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed, and excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

c. Shoring. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. Shoring Removal. All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not damage or disturb finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. Engineer's Approval. After excavation is completed for each structure, the Contractor shall notify the Engineer. No concrete or reinforcing steel shall be placed after the Engineer has approved the depth of the excavation and the character of the foundation material.

751-3.2 BRICK STRUCTURES.

a. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed according to the requirements of Item P-610.

b. Laying Brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it which can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and relaid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. Joints. All joints shall be filled with mortar at every course. Exterior faces shall be laid up in advance of backing. Exterior faces shall be plastered or parged with a coat of mortar not less than 3/8 inch thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4 inch nor more than 1/2 inch wide and the selected joint width shall be maintained uniform throughout the work.

d. Pointing. Face joints shall be neatly struck, using the weather struck joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing with water. If necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of water.

f. Curing and Cold Weather Protection. The brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost on the brick or when the air temperature is below 50 °F unless the Contractor has on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60 °F for the duration of the curing period.

751-3.3 CONCRETE STRUCTURES. Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the Plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the Plans and shall be approved by the Engineer before the concrete is placed.

All invert channels shall be constructed and shaped accurately so as to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

751-3.4 PRECAST CONCRETE STRUCTURES. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another third party certification program approved by the Engineer.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the Plans. All precast concrete pipe sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall (1) be full-bedded in cement mortar or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal, injection molded polypropylene, or metal encapsulated steps which are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 CORRUGATED METAL STRUCTURES. Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base.

751-3.6 INLET AND OUTLET PIPES. Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes so as to form a tight, neat connection.

751-3.7 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES, AND FITTINGS. All castings, frames, and fittings shall be placed in the positions indicated on the Plans or as directed by the Engineer, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface in order so the entire face

or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the Plans or as directed by the Engineer. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for 7 days, before the grates or covers are placed and fastened down.

751-3.8 INSTALLATION OF STEPS. The steps shall be installed as indicated on the Plans or as directed by the Engineer. When the steps are to be set in concrete, they shall meet the requirements of ASTM C478. The steps shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least 7 days. After 7 days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete pipe structures, they shall be cast into the sides of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches.

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the Engineer.

751-3.9 BACKFILLING. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the Plans or as directed by the Engineer.

Backfill shall not be placed against any structure until approved by the Engineer. For concrete structures, approval shall not be given until the concrete has been in place 7 days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

METHOD OF MEASUREMENT

751-4.1 Manholes, catch basins, inlets, and inspection holes will be measured by the unit.

BASIS OF PAYMENT

751-5.1 The accepted quantities of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each, complete and in place. This price shall be full compensation for furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the Plans.

All excavation and backfill required to complete the items of this section shall not be measured for payment, and shall be considered as a subsidiary obligation of the Contractor, included in the contract unit price for the structure involved.

Payment will be made under:

ItemD751.010.0048	Manholes Type I, 48-inch - per each
ItemD751.020.0000	Catch Basins - per each
ItemD751.030.0000	Inlets - per each
ItemD751.040.0000	Inspection Holes - per each

MATERIAL REQUIREMENT

AASHTO M 36	Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Underdrains
AASHTO M 45	Aggregate for Masonry Mortar
AASHTO M 85	Portland Cement
AASHTO M 103	Steel Castings, Carbon, for General Application
AASHTO M 111	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A47	Malleable Iron Castings
ASTM A48	Gray Iron Castings
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM A536	Ductile Iron Castings
ASTM A897	Austempered Ductile Iron Castings
ASTM C32	Sewer and Manhole Brick
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
ASTM C478	Precast Reinforced Concrete Manhole Sections
ASTM C913	Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers

ITEM D-752 CONCRETE CULVERTS, HEADWALLS, AND MISCELLANEOUS DRAINAGE STRUCTURES

DESCRIPTION

752-1.1 This item shall consist of plain or reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed according to these Specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the Plans or required by the Engineer.

MATERIALS

752-2.1 CONCRETE. Concrete shall meet the requirements of Item P-610.

CONSTRUCTION METHODS

752-3.1 UNCLASSIFIED EXCAVATION.

a. Trenches and foundation pits for structures or structure footings shall be excavated to the lines and grades or elevations shown on the Plans. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the Plans, shall be considered as approximate only; and the Engineer may order, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until immediately before the concrete or reinforcing steel is to be placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to perform and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for excavation.

d. All bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or mar finished concrete. The cost of removal shall be included in the unit price bid for excavation.

e. After each excavation is completed, the Contractor shall notify the Engineer. No concrete or reinforcing steel shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.

752-3.2 BACKFILLING.

a. After a structure has been completed, backfill with approved material, in horizontal layers not to exceed 8 inches in loose depth, and compact. The field density of the compacted material shall be at least 95% of the maximum density. The maximum density shall be determined according to ATM 207 or ATM 212. The field density and moisture content shall be determined according to ATM 213.

b. No backfilling shall be placed against any structure until approved by the Engineer. For concrete, approval shall not be given until the concrete has been in place 7 days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill or the placement method.

c. Fill placed around concrete culverts shall be deposited on each side at the same time and to approximately the same elevation. All slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent wedge action against the structure.

d. Backfill will not be measured for direct payment. Performance of this work shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for "unclassified excavation for structures."

752-3.3 WEEP HOLES. Weep holes shall be constructed as shown on the Plans.

752-3.4 NOT USED.

METHOD OF MEASUREMENT

752-4.1 Unclassified excavation for structures will be measured in original position, between vertical planes 18 inches outside of and parallel to the neat lines of the footings.

752-4.2 Concrete will be measured by the dimensions shown on the Plans or approved by the Engineer, complete in place and accepted. No measurements or other allowances will be made for forms, false work, cofferdams, pumping, bracing, expansion joints, or finishing of the concrete. No deductions will be made for the volumes of reinforcing steel or embedded items.

752-4.3 Reinforcing steel will be measured by the theoretical weight shown on the Plans, complete in place and accepted. The unit weight used for deformed bars will be the weight of plain square or round bars, as the case may be, of equal nominal size.

BASIS OF PAYMENT

752-5.1 Payment will be made at the contract unit price per cubic yard for unclassified excavation for structures; at the contract unit price per cubic yard for concrete for the structures; and at the contract unit price per pound for reinforcing steel.

Payment will be made under:

Item D752.010.0000	Unclassified Excavation for Structures – per cubic yard
Item D752.020.0000	Structural Concrete – per cubic yard
Item D752.030.0000	Reinforcing Steel – per pound
Item D752.040.0000	Trench Drain – per linear foot

TESTING REQUIREMENTS

ATM 212	Standard Density of Coarse Granular Materials Using the Vibratory Compactor
ATM 207	Moisture-Density Relations of Soils
ATM 213	In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods

ITEM D-754 CONCRETE GUTTERS, DITCHES, AND FLUMES

DESCRIPTION

754-1.1 This item shall consist of portland cement concrete gutters, ditches, and flumes constructed according to these Specifications at the specified locations according to the dimensions, lines, and grades as shown on the Plans.

MATERIALS

754-2.1 CONCRETE. Plain and reinforced concrete shall meet the requirements of Item P-610.

754-2.2 JOINTS. Joint filler materials and premolded joint material shall conform to Item P-610.

CONSTRUCTION METHODS

754-3.1 PREPARING SUBGRADE. Excavation shall be made to the required width and depth, and the subgrade upon which the item is to be built shall be compacted to a firm uniform grade. All soft and unsuitable material shall be removed and replaced with suitable approved material. When required, a layer of approved granular material, compacted to the thickness indicated on the Plans, shall be placed to form a subbase. The underlying course shall be checked and accepted by the Engineer before placing and spreading operations are started.

754-3.2 PLACING. The forms and the mixing, placing, finishing, and curing of concrete shall conform to the requirements of Item P-610 and the following requirements.

The concrete shall be tamped until it is consolidated and mortar covers the top surface. The surface of the concrete shall be floated smooth and the edges rounded to the radii shown on the Plans. Before the concrete is given the final finishing, the surface shall be tested with a 12-foot straightedge, and any irregularities of more than 1/4 inch in 12 feet shall be eliminated.

The concrete shall be placed with dummy-grooved joints not to exceed 25 feet apart, and no section shall be less than 4 feet long.

Expansion joints of the type called for in the Plans shall be constructed to replace a dummy groove at spacings of approximately 100 feet. When the gutter is placed next to concrete pavement, expansion joints in the gutter shall be located opposite expansion joints in the pavement. When a gutter abuts a pavement or other structure, an expansion joint shall be placed between the gutter and the other structure.

Forms shall not be removed within 24 hours after the concrete has been placed. Minor defects shall be repaired with mortar containing 1 part cement and 2 parts fine aggregate.

Depositing, compacting, and finishing the item shall be conducted to build a satisfactory structure. If any section of concrete is found to be porous, or is otherwise defective, it shall be removed and replaced by the Contractor without additional compensation.

754-3.3 BACKFILLING. After the concrete has set sufficiently, the spaces adjacent to the structure shall be refilled to the required elevation with material specified on the Plans and compacted by mechanical equipment to at least 90 percent of the maximum density as determined by ATM 207 or ATM 212, except that base course for adjacent paved surfaces will be compacted as specified in Item P-209. The in-place density and moisture content shall be determined according to ATM 213.

METHOD OF MEASUREMENT

754-4.1 Concrete will be measured by the dimensions shown on the Plans or ordered by the Engineer. No deductions will be made for the volume occupied by reinforcing steel, anchors, conduits, weep holes, or piling.

754-4.2 Reinforcing steel will be measured by the theoretical weight shown on the Plans or ordered by the Engineer. No allowance will be made for clips, wire, or other material used for fastening reinforcement in place.

BASIS OF PAYMENT

754-5.1 The accepted quantities of structural concrete will be paid for at the contract unit price per cubic yard, complete in place.

754-5.2 The accepted quantities of reinforcing steel will be paid for at the contract price per pound, complete in place.

Payment will be made under:

Item D754.010.0000	Structural Concrete – per cubic yard
Item D754.020.0000	Reinforcing Steel – per pound

TESTING REQUIREMENTS

ATM 212	Standard Density of Coarse Granular Materials Using the Vibratory Compactor
ATM 207	Moisture-Density Relations of Soils
ATM 213	In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods

ITEM D-760 THAW PIPE AND THAW WIRES

DESCRIPTION

760-1.1 Furnish, fabricate, and install thaw pipes or electric thaw wire.

MATERIALS

760-2.1 THAW PIPE. Use materials that conform to the following:

Pipe	ASTM A53, galvanized per AASHTO M 111
Fittings	ASTM A234, galvanized according to AASHTO M 111
Pipe Hangers	ASTM A47, galvanized per AASHTO M 111
Braces for Standpipe	ASTM A36, galvanized per AASHTO M 111
Bolts and Nuts	ASTM A307, galvanized per AASHTO M 232

760-2.2 THAW WIRE. Provide materials, devices, fittings, and hardware meeting NEMA standards and bearing the approval of a third party certification, meeting ANSI Z 34.1.

Deliver all warranties and guarantees provided by the manufacturer to the Engineer before acceptance of this work.

a. Conduit and Fittings.

(1) Use conduit, couplings, elbows, and nipples that are rigid, hot-dip galvanized steel meeting ANSI C80.1. Install them as indicated on the applicable drawings. Use threaded type couplings, elbows, and nipples.

(2) Use fittings and miscellaneous conduit hardware that are vapor-proof, galvanized cast iron or steel meeting ANSI/NEMA FB-1 and are compatible with the rigid conduit furnished and installed. Use threaded type fittings.

b. Heat Cable. Use heat cable that meets the following standards:

(1) Parallel-circuit, 120, 208, or 240 Volts of Alternating Current (VAC,), 16 American Wire Gauge (AWG) minimum copper bus wire, with self-limiting conductive core.

(2) Modified polyolefin inner jacket, tinned copper or nickel-clad metallic braid, and fluoropolymer overjacket.

(3) Rated in conduit at the Watts per foot (W/ft) output as specified on the drawings. If heat trace cable output is not specified, use 8 W/ft. at 50 °F.

(4) Underwriters Laboratories (UL) Listed or Factory Mutual (FM) approved specifically as a culvert deicing system in conduit.

All connection components shall be rated for the areas in which they are installed. Use power connections and seals specifically designed for use with the particular type and size of heat cable.

c. Controls.

(1) Use a thermostat that is heavy duty, single stage, line voltage type. Operating temperature range: 25 to +125 °F. Provide capillary bulb for remote sensing.

(2) Use a contactor that is electrically held, 30 Amperes rated, lighting type.

(3) Use a switch that is heavy duty hand-off-auto type with a gloved hand selector switch knob.

(4) Components listed in this section shall be provided in enclosures of the types specified on the drawings. If enclosure types are not specified on the drawings, provide enclosures rated for the areas in which the components are to be installed. Reference NEMA enclosure types and NEC Table 110.28.

d. Conductors. Use copper conductors with insulation rated for 300 Volt minimum where the impressed voltage is 100 Volts or less and 600 Volt where the impressed voltage is between 100 and 600 Volts. 75°C -rated conductor insulation shall be used if indicated on the drawings.

(1) Service and Feeder Cables. Use No. 8 AWG, or larger, with type USE, THWN, THHN, or XHHW insulation.

(2) Underground Wire. Use No. 6 AWG with type XHHW or USE insulation where buried in conduit.

(3) Branch Circuit Wire. Use No. 12 AWG with type USE or XHHW insulation.

(4) Control Wire. Use No. 16 AWG with stranded conductor with type SIS insulation within control panels.

(5) Splices for Copper Conductors. Use solderless, preinsulated, compression set type only with heat-shrink tubing jacket. When making splices between power leads and heat cable cold leads, use splicing kits designed specifically for that purpose.

(6) Terminations. Use compression set or bolted type.

e. Device, Junction, and Pull Boxes.

(1) Boxes Installed Above Grade. Use boxes that are hot dipped galvanized cast iron or corrosion resistant alloy complete with conduit hubs. Use boxes designed for damp or wet locations.

(2) Boxes Installed below Grade (exposed to earth). Use concrete boxes as required or shown in the drawings. Provide covers constructed of ribbed cast metal alloy.

(3) Cast Thermoplastic or Fiberglass Boxes. Use where indicated in the drawings.

f. Receptacles, Remote Power. Use remote power receptacles that are 2-pole, 3-wire grounding, male, 30 Amperes, 120 or 240 VAC, NEMA L6-30.

g. Circuit Breakers. Provide 1- or 2-pole circuit breakers as scheduled in the drawings. Multiple breakers must operate all poles simultaneously. Use circuit breakers that operate manually for normal ON-OFF switching and automatically for overload and short-circuit conditions. Ensure that the operating mechanism will not prevent trip action when held in the ON position. Provide 10,000-Ampere symmetrical interrupting capacity minimum. Provide breakers with higher symmetrical interrupting capacity ratings if indicated on the drawings. Provide bolt-in type with a molded case.

Use Ground Fault Interrupter (GFI) circuit breakers that sense ground fault current, that trip at 30±1 milliamperes within 2 cycles, and that have the following:

(1) Internal circuitry to prevent nuisance tripping caused by voltage spikes, radio frequency interference, and electromagnetic interference.

(2) A 'TEST' button that provides approximately 30 milliamperes of simulated ground fault current to verify the operation of the sensing and tripping devices. The button must reset the trip unit within the circuit breaker.

(3) Type b auxiliary contacts to close when the circuit breaker is tripped or shutoff.

h. Grounding.

(1) Electrodes. Use electrodes that are copper-clad steel rods with a minimum diameter of 5/8 inch Increase diameter as required to drive to the necessary depth without being damaged.

(2) Splices and Connections. Use an exothermic weld for all connections and joints in inaccessible locations. Use standard clamps and connectors in accessible locations.

i. Terminal Posts. Use terminal posts that are 6-inch by 8-inch treated wood posts 8 feet long.

j. Branch Circuit Panelboard. Use panelboards that meet the following:

(1) Sized and rated according to the panel schedules in the drawings

(2) Have multiple lugs (as required), a neutral terminal bar, and a ground terminal bar if ground conductors are terminated in the panelboard

(3) Use panelboards that are braced for 10,000 Root-Mean-Square (RMS) Amperes minimum, or higher if specified on the drawings.

(4) With copper or aluminum bus bars

CONSTRUCTION REQUIREMENTS

760-3.1 THAW PIPE.

a. Pipe Hangers. Drill or field punch the bolt holes and then ream them. Ensure that the diameter of the hole does not exceed the diameter of the bolt by more than 1/8 inch. Draw the bolt heads and nuts tightly against the pipe.

b. Pipe Jointing. Remove all scale from the pipe. After cutting, ream all pipe. Assemble all pipe and fittings using an application of pipe compound.

c. Installation. Prevent dirt or other foreign matter from entering the pipe. After the thaw pipe is fully assembled and installed, flush it thoroughly with water.

Repair damage to galvanized coatings per AASHTO M 36.

760-3.2 THAW WIRE. Meet all applicable requirements and recommendations of the NEC and the NESC.

Furnish the Engineer with circuit and wiring diagrams.

When required on the plans, install a post and meter combination for each individual thaw wire or a single post and meter combination for any group of thaw wires as specified and paid for under Item L-160.

a. Conduit and Fittings.

(1) Use Galvanized Rigid Steel (GRS) conduit for direct burial at depths required by NEC Articles 300 and 426, unless noted otherwise. Repair damage to galvanized coatings per AASHTO M 36. Unless otherwise specified on the drawings, route power conductors to each heat trace circuit in minimum 2-inch conduit.

(2) Provide bituminous asphalt coating for all ferrous conduit installed directly in earth. Apply 2 coats after conduit is completely assembled. Use conduit with factory-applied protective coating in lieu of asphalt if suitable touch-up materials are used to seal couplings and repair injuries to the factory-applied coat.

(3) Cut and ream all conduit squarely at the ends. Make fittings tight.

(4) Route concealed conduit in a direct path with a minimum number of bends. Use bends of long radii where possible.

(5) Keep all bends free from dents or flattening.

(6) Install conduit mechanically and electrically continuous from termination to termination. Connect securely to cabinets, junction boxes, and device boxes using a locknut on the outside and a grounding bushing on the inside. Bushings and locknuts are not required where conduits are screwed into threaded connections.

(7) Before the installation of conductors, use caps or corks to keep foreign material out of open conduits.

b. Heat Cable. Install per manufacturer's instructions and as indicated on the electrical plans. Install in GRS conduit as indicated on the electrical plans. Use conduit size as specified on the drawings. If size is not specified, use a minimum of 3/4 inch and a maximum of 1-1/2 inches, ensuring conduit fill does not exceed the fill allowed by the NEC. Do not splice heat cable. Do not exceed the manufacturer's published maximum heat trace cable length per circuit.

c. Controls. Install the controls in the load center along with the panelboard as indicated on the electrical plans. Refer to the detail drawings.

d. Conductors.

(1) Install all conductors in conduit.

(2) Clean all conduit before installing conductors.

(3) Install conductors continuously from box to box. Splice only at device or junction boxes.

(4) Circuit all feeder and branch circuits as shown in the drawings.

(5) Install all conductors in a single raceway at one time so that conductors do not cross one another while being pulled into place. Leave sufficient conductor length at all fittings and boxes.

(6) Stay within the pulling tensions specified by the manufacturer or as noted elsewhere in this division.

(7) Maintain bending radii in excess of those allowed by the manufacturer.

(8) Use lubricants according to UL, the conductor, and raceway manufacturers' requirements.

(9) Neatly bundle and form conductors to fan into terminals at regular intervals inside panels.

(10) Coordinate conductor insulation temperature rating and ampacity rating with the temperature and ampacity rating of the circuit protection devices.

(11) Unless otherwise specified on the drawings, the heat trace power conductors shall be sized to limit the voltage drop on the branch circuit conductors to no more than 3%, or to limit the total voltage drop on the feeder and branch circuit conductors to no more than 5%.

e. Color Coding.

(1) Color all conductors #6 AWG and smaller continuously. Conductors larger than #6 may be either continuously colored or marked at each end and at every accessible point with appropriately colored paint, tape, or adhesive labels.

(2) Mark or color grounding conductors according to the NEC.

(3) Mark or color grounded conductors according to paragraph d. and according to the NEC.

(4) Mark or color ungrounded conductors according to the following convention:

Nominal Voltage/Phase	Grounded	Ungrounded
120 or 208-Volt, single phase, 2 wire	White	Black
120/240-Volt, single phase 3 wire	White	Black/Red

f. Device, Junction, and Pull Boxes.

(1) Anchor device boxes to structural members so there is no apparent movement when the device is operated.

(2) Install junction and pull boxes in permanently accessible locations only. Size boxes according to NEC, Article 314.

(3) Mount all boxes square and plumb.

g. Grounding.

(1) General. Create an equipotential ground plane for the installation as shown on the drawing and as required at the service meter/disconnect cabinet. Connect the following items to the service entrance ground bar:

(a) The grounded neutral conductor for the utility service.

(b) Ground electrode(s).

(c) All non-current-carrying electrical equipment, conduit, and enclosures.

(d) Metal culvert and/or end sections.

(e) Heat cable metal sheath.

(2) Resistance. Ensure that the resistance between the service entrance ground electrode and earth ground, as measured using a multiple ground rod method and a ground resistance tester, is as close to zero as possible with the design shown in the drawings. Give the resistance measurement to the Engineer in writing. Include the environmental conditions during testing. Ground resistance testing shall be performed per IEEE 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

(3) Conductors. Size conductors according to the drawings or, if not shown on drawings, as required by NEC Article 250. Grounding electrode conductors shall be sized per Table 250.66 and equipment grounding conductors shall be sized per Table 250.122. Protect conductors from physical damage.

(4) Electrodes. The grounding electrode system installation shall comply with NEC Article 250.50. Drive ground rods at least 8 feet deep.

h. Controls. Install the controls in the load center along with the panelboard as indicated on the electrical plans. Refer to the detail drawings.

i. Branch Circuit Panelboard.

(1) Mounting. Mount panelboard interiors inside load center cabinet after the enclosure has been installed as shown on the plans and as described under Item L-160.

(2) Circuit Breakers. Install circuit breakers in the order specified in the drawing panelboard schedules. Type the circuit directory with circuit descriptions as they are shown in the drawing panelboard schedules. Make the directory configuration identical to the circuit breaker configuration.

METHOD OF MEASUREMENT

760-4.1 The length of thaw pipe to be paid for will be the number of linear feet of thaw pipe in place, completed and approved; measured along the line and grade of the pipe, or by each complete and approved unit.

760-4.2 The length of thaw wire installation to be paid for will be the number of linear feet of heated sections in place, completed and approved, or by each complete and approved unit.

BASIS OF PAYMENT

760-5.1 All fittings, including standpipes, are subsidiary.

Payment will be made under:

Item D760.010.0010	Thaw Pipe, 0.5-inch – per linear foot
Item D760.020.0010	Thaw Pipe, 0.5-inch – per each
Item D760.030.0000	Thaw Wire Installation – per linear foot
Item D760.040.0000	Thaw Wire Installation – per each

MATERIAL REQUIREMENTS

AASHTO M 36	Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
AASHTO M 111	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
AASHTO M 232	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A36	Carbon Structural Steel
ASTM A47	Ferritic Malleable Iron
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ANSI C80.1	Rigid Steel Conduit, Zinc Coated (GRC)
ANSI Z 34.1	Third-Party Certification Programs for Products, Processes, and Services
ANSI/NEMA FB-1	Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable

ITEM D-765 EDGE DRAINS

DESCRIPTION

765-1.1 This item consists of the construction of edge drain and outlet pipes in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

765-2.1 Use AKWADRAIN™ Highway Edge Drain from American Wick Corporation, DRAIN AWAY™ Highway Edge Drain from Drainage Products, Inc., or an approved equal meeting the following requirements:

a. FABRIC. Use fabric that conforms to the following.

Grab Tensile Strength	110 lbs	ASTM D4632
Puncture Strength	65 lbs	ASTM D4833
Mullen Burst Strength	215 psi	ASTM D3786
Elongation at Break	60%	ASTM D4632
AOS	70-100 sieve	ASTM D4751
Permeability	0.2-0.3 cm/sec	ASTM D4491
Flow Rate	150-170 gal/min/ft^2	ASTM D4491
UV Resistance, (after 500 hrs.)	70%	ASTM D355

b. CORE. Use core material that conforms to the following.

Thickness	1-inch	ASTM D1777
Inplane Flow Capacity*	21 gal/min/ft width	ASTM D4716
Compressive Strength	6,000-9,000 lbs/ft^2	ASTM D1621(mod.)
Shear Strength	6,000-9,000 lbs/ft^2	ASTM D1621(mod.)
Peel Strength	38 lbs/ft^2	ASTM D1876
Fungus Resistance (Core)	No Growth	ASTM G21

* Hydraulic gradient = 0.1, loading = 10 psi

c. PIPE. Use pipe in accordance with the plans and in conformance with the following.

Corrugated Polyethylene Drainage Tubing	AASHTO M 252

CONSTRUCTION METHODS

765-3.1 EXCAVATION. Excavate a trench of sufficient width to permit satisfactory jointing of the edge drain, outlet pipes and thorough tamping of the material under and around the edge drain and pipe. Excavate to form trench walls that are approximately vertical. Do not excavate until the embankment has been completed to a height above the top of the edge drain as shown on the plans.

765-3.2 BACKFILLING & COMPACTION. Use the material removed during trenching for backfill. Place the first layer of backfill to a depth no more than one half of the structures depth, and to hold the edge drain tightly against the side of the trench. Compact this layer before placement of the second layer without causing damage to the structure. Place the second layer of backfill to a depth that, when compacted, is 2 inches below the top edge of the drainage structure. Perform operations in a manner that prevents damage to the structure by surface equipment.

765-3.3 OUTLET PIPE. Splice the outlet pipes into the core material per manufacturer recommendations. Locate pipes and extend pipes past the toe of the embankment to prevent erosion as shown on the plans or as directed by the Engineer.

765-3.4 JOINING PIPE. Use coupling bands to join pipes as per manufacturer recommendations or as directed by the Engineer.

METHOD OF MEASUREMENT

765-4.1 EDGE DRAIN. The length of edge drain will be measured by the linear foot in place, completed, and approved. It will be measured along the centerline of the drain from end of structure to the end of structure. All fittings, outlet pipes and associated hardware will be included in the length of the pipe being measured.

BASIS OF PAYMENT

765-5.1 Payment will be made at the contract unit price per linear foot.

Payment will be made under:

Item D765.010.0000	Edge Drain – per linear foot
Item D765.020.0000	Conduit Drain – per linear foot
Item D765.030.0000	Dry Well – per each

MATERIAL REQUIREMENTS

AASHTO M 252	Corrugated Polyethylene Drainage Tubing
ASTM D1621	Compressive Properties Of Rigid Cellular Plastics
ASTM D1876	Peel Resistance of Adhesives (T-Peel Test)
ASTM D3786	Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
ASTM D4355	Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
ASTM D4491	Water Permeability of Geotextiles by Permittivity
ASTM D4632	Grab Breaking Load and Elongation of Geotextiles
ASTM D4716	Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4751	Determining Apparent Opening Size of a Geotextile
ASTM D4833	Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM G21	Determining Resistance of Synthetic Polymeric Materials to Fungi