

# SPECIFICATION D-701. PIPE FOR STORM DRAINS AND CULVERTS

## DESCRIPTION

**701-1.1** This Work consists of the construction of pipe culverts and storm drains in accordance with these Specifications and in 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.** Provide the type of pipe specified in the Special Provisions or shown on the Plans in accordance with the following specifications.

Metallic Coated Corrugated Steel Pipe (Type I, IR or II)	ASTM A 760
Galvanized Steel Corrugated Structural Plates and Fasteners for Pipe, Pipe-Arches, and Arches	ASTM A 761
Reinforced Concrete Pipe	ASTM C 76
Reinforced Concrete D-Load Pipe	ASTM C 665
Reinforced Concrete Arch Pipe	ASTM C 506
Reinforced Concrete Elliptical Pipe	ASTM C 507
Precast Reinforced Concrete Box Sections	ASTM C 789 and C 850
Bituminous-Coated Corrugated Metal Pipe and Pipe Arches	AASHTO M 190
Bituminous-Coated Structural Plate Pipe, Pipe Arch, and Arches	AASHTO M 167 and M 243

**701-2.3 CONCRETE.** Concrete for pipe cradles shall have a minimum compressive strength of 2,000 psi (13,790 kPa) at 28 days and conform to the requirements of ASTM C 94.

**701-2.4 GASKETS.** Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C 443. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D 1056, for the "RE" closed cell grades.

**701-2.5 JOINT MORTAR.** Pipe joint mortar consists of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

**701-2.6 PLASTIC GASKETS.** Plastic gaskets shall conform to the requirements of AASHTO M 198 (Type B).

**701-2.7 APRON ENDWALLS.**

**Reinforced Concrete Apron Endwalls.** Reinforced concrete apron endwalls for reinforced concrete pipe shall be manufactured with reinforcement and concrete conforming to the pertinent requirements of ASTM C 76 for Class II, Wall B, reinforced concrete pipe and shall be in accordance with the design, dimensions, and details shown on the Plans.

**Corrugated Steel Apron Endwalls.** Steel apron endwalls for corrugated steel culvert pipe shall be manufactured in accordance with the pertinent requirements specified for corrugated steel pipe under Subsection 701-2.2 and shall conform to the dimensions, thickness, design and details shown on the Plans.

## CONSTRUCTION METHODS

**701-3.1 EXCAVATION.** Make the width of the pipe trench sufficient (but not less than the external horizontal dimension of the pipe plus 6 inches (150 mm) on each side) to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe.

Where rock, hardpan, or other unyielding material is encountered, remove it from below the foundation grade for a depth of at least 12 inches (300 mm) or ½ inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than ¾ of the nominal diameter of the pipe. The width of the excavation shall be at least 1 foot (300 mm) greater than the horizontal outside dimension of the pipe. Backfill the excavation below grade with selected fine compressible material, such as silty clay or loam, and lightly compact it in layers not over 6 inches (150 mm) 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, remove the unstable soil and replace it with approved granular material for the full trench width. The Engineer will determine the depth of removal necessary. Compact the granular material to provide adequate support for the pipe.

Do not excavate for pipes that are to be placed in embankment fill until the embankment has been completed to a height above the top of the pipe.

**701-3.2 BEDDING.** Provide pipe bedding in conformance with the Contract Documents.

**a. Rigid Pipe.** When no bedding class is specified or detailed on the Plans, the requirements for Class B bedding shall apply.

Class A bedding consists of a continuous concrete cradle conforming to the Plan details.

Class B bedding consists of a bed of granular material having a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extending up around the pipe for a depth of not less than 30 percent of the pipe's vertical outside diameter. Shape the layer of bedding material to fit the pipe for at least 10 percent of the pipe's vertical diameter and have recesses shaped to receive the bell of bell and spigot pipe. Use crushed stone chips or crushed gravel for the bedding material, all of which passes a 3/8 inch (9 mm) sieve and not more than 10 percent of which passes a No. 200 (0.075 mm) sieve.

Class C bedding consists of bedding the pipe in its natural foundation to a depth of not less than 10 percent of the pipe's vertical outside diameter. Shape the bed to fit the pipe and have recesses shaped to receive the bell of bell and spigot pipe.

**b. Flexible Pipe.** For flexible pipe, roughly shape the bed to fit the pipe, and provide a bedding blanket of sand or fine granular material as follows:

**TABLE 1. FLEXIBLE PIPE**

<i>Pipe Corrugation Depth</i>		<i>Minimum Bedding Depth</i>	
in.	(mm)	in.	(mm)
1/2	(12.5)	1	(25.0)
1	(25.0)	2	(50.0)
2	(50.0)	3	(75.0)
2-1/2	(62.5)	3-1/2	(87.5)

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

Place paved or partially lined pipe so that the longitudinal center line of the paved segment coincides with the flow line.

Place elliptical and elliptically reinforced pipes with the manufacturer's top of pipe mark within 5 degrees of a vertical plane through the longitudinal axis of the pipe.

Plug laying holes (lift holes) with non-shrink grout. Allow the grout to set and reach strength capable of supporting backfill prior to placing the backfill. Plugs supplied by pipe manufacturers may be used, provided they are mortared in place with non-shrink grout, in a manner to provide a watertight seal.

**701-3.4 JOINING PIPE.**

**a. Concrete Pipe.** Concrete pipe may be either bell and spigot or tongue and groove. Use a method of joining pipe sections so that the ends are fully entered and the inner surfaces are reasonably flush and even. Provide rubber gaskets for pipe joints in accordance with 701-2.4.

**b. Metal Pipe.** Firmly join metal pipe by form fitting bands conforming to the requirements of ASTM A 760 for steel pipe.

**701-3.5 BACKFILLING.** Have pipes inspected before backfill is placed. Remove pipes found to be out of alignment, unduly settled, or damaged and lay it again or replace at the Contractor's expense.

Material for backfill should be fine, readily compactible soil, or granular material selected from the excavation or a source of the Contractor's choosing. It cannot contain frozen lumps, stones that would be retained on a 2-inch (50.0 mm) sieve, chunks of highly plastic clay, or other

objectionable material. No less than 95 percent of a granular backfill material shall pass through a 1/2 inch (12 mm) sieve, and no less than 95 percent of it shall be retained on a No. 4 (4.75 mm) sieve.

When the top of the pipe is even with or below the top of the trench, compact the backfill in layers not exceeding 6 inches (150 mm) on both sides of the pipe and bring up 1 foot (300 mm) above the top of the pipe or to natural ground level, whichever is greater. Be careful to thoroughly compact the backfill material under the haunches of the pipe. Bring material up evenly on both sides of the pipe.

When the top of the pipe is above the top of the trench, compact the backfill in layers not exceeding 6 inches (150 mm) and bring it up evenly on both sides of the pipe to 1 foot (300 mm) 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 must be equal to twice the pipe's diameter, or 12 feet (3.5 m), whichever is less.

Compact all backfill to the density required under Specification P-152.

**701-3.6 APRON ENDWALLS.** Excavate the trench for apron endwalls to the required width and grade. For metal aprons with toe plates, excavate a trench to permit placement of the toe plate against the inner face of the trench when the apron is in its final position. After the apron has been properly secured to the pipe, backfill and firmly compact this trench.

Place reinforced concrete apron endwalls with its tongue (or groove) fully entered in the groove (or tongue) of the pipe.

Backfill for the apron is the same as required for the pipe, unless otherwise directed.

**701-3.7 JOINT TIES.** When shown on the Plans, furnish and install joint ties for concrete pipe in accordance with the details and at locations indicated.

## METHOD OF MEASUREMENT

**701-4.1** Pipe Culverts will be measured in linear feet of pipe in place, completed, and approved. It will be measured along the centerline of the pipe between the points of connection to the apron endwalls, or if there are no apron endwalls, to the ends of the pipe. If a length of culvert pipe ends at a drainage structure, measurement will extend to the centerline of the structure. All fittings will be included in the footage as typical pipe sections in the pipe being measured. Apron endwalls will not be included in the measurement for pipe.

**701-4.2** Storm sewer will be measured by the linear foot in place, completed, and accepted in accordance with the Contract measured along the centerline of the pipe. Measurement will be from the pipe end at a free outlet to the center of the end catch basin, manhole, inlet, junction or other drainage structure; or from center to center of catch basins, end manholes, inlets, other drainage structures or junctions. There will be no deduction from these measured lengths for intermediate catch basins, manholes, inlets, other drainage structures, junctions, or fittings.

**701-4.3** The volume of concrete for pipe cradles will not be measured separately, and the cost shall included in the contract prices for storm sewer or culvert.

**701-4.4** 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.

**701-4.5** Apron endwalls will be measured by the unit per each for the various diameters and materials required on the Plans and Specifications. Materials will be reinforced concrete (RC) or Corrugated Steel (CS) per Subsection 701-2.7.

## BASIS OF PAYMENT

**701-5.1** Payment will be made at the Contract unit price per linear foot for each size and type or each line number or location indicated for Storm Sewer or Culvert Pipe. Payment will be made at the Contract unit price per each for each size and kind of Apron Endwall designated.

These prices will fully compensate the Contractor for furnishing all materials and for all preparation, dewatering, excavation, installation and bedding and backfill of these materials, joint ties (when required), surface restoration; and for all labor, equipment, tools, and incidentals necessary to complete the Work.

Standard Pay Items for Work covered by this Specification are as follows:

Pay Item D70101	Storm Sewer, 12 inch, per linear foot
Pay Item D70102	Storm Sewer, 15 inch, per linear foot
Pay Item D70103	Storm Sewer, 18 inch, per linear foot
Pay Item D70104	Storm Sewer, 21 inch, per linear foot
Pay Item D70105	Storm Sewer, 24 inch, per linear foot
Pay Item D70106	Storm Sewer, 27 inch, per linear foot
Pay Item D70107	Storm Sewer, 30 inch, per linear foot

Pay Item D70108	Storm Sewer, 33 inch, per linear foot
Pay Item D70109	Storm Sewer, 36 inch, per linear foot
Pay Item D70110	Storm Sewer, 42 inch, per linear foot
Pay Item D70111	Storm Sewer, 48 inch, per linear foot
Pay Item D70112	Storm Sewer, 54 inch, per linear foot
Pay Item D70113	Storm Sewer, 60 inch, per linear foot
Pay Item D70114	Storm Sewer, 72 inch, per linear foot
Pay Item D70115	Storm Sewer, ___ inch, per linear foot
Pay Item D70116	Storm Sewer, ___ inch, per linear foot
Pay Item D70117	Storm Sewer, line No. ___, per linear foot
through D70124	
Pay Item D70125	Storm Sewer, ___ inch by ___ inch, ___, per linear foot
through D70130	
Pay Item D70131	Culvert Pipe, 18 inch, RC, per linear foot
Pay Item D70132	Culvert Pipe, 18 inch, CS, per linear foot
Pay Item D70133	Culvert Pipe, 24 inch, RC, per linear foot
Pay Item D70134	Culvert Pipe, 24 inch, CS, per linear foot
Pay Item D70135	Culvert Pipe, 27 inch, RC, per linear foot
Pay Item D70137	Culvert Pipe, 30 inch, RC, per linear foot
Pay Item D70138	Culvert Pipe, 30 inch, CS, per linear foot
Pay Item D70139	Culvert Pipe, 33 inch, RC, per linear foot
Pay Item D70141	Culvert Pipe, 36 inch, RC, per linear foot
Pay Item D70142	Culvert Pipe, 36 inch, CS, per linear foot
Pay Item D70143	Culvert Pipe, 42 inch, RC, per linear foot
Pay Item D70144	Culvert Pipe, 42 inch, CS, per linear foot
Pay Item D70145	Culvert Pipe, 48 inch, RC, per linear foot
Pay Item D70146	Culvert Pipe, 48 inch, CS, per linear foot
Pay Item D70147	Culvert Pipe, ___ inch, ___ per linear foot
through D70152	
Pay Item D70153	Culvert Pipe, Location No. ___, per linear foot
through D70160	
Pay Item D70161	Apron Endwalls, 12 inch, RC, per each
Pay Item D70162	Apron Endwalls, 12 inch, CS, per each
Pay Item D70163	Apron Endwalls, 15 inch, RC, per each
Pay Item D70164	Apron Endwalls, 15 inch, CS, per each
Pay Item D70165	Apron Endwalls, 18 inch, RC, per each
Pay Item D70166	Apron Endwalls, 18 inch, CS, per each
Pay Item D70167	Apron Endwalls, 21 inch, RC, per each
Pay Item D70168	Apron Endwalls, 21 inch, CS, per each
Pay Item D70169	Apron Endwalls, 24 inch, RC, per each
Pay Item D70170	Apron Endwalls, 24 inch, CS, per each
Pay Item D70171	Apron Endwalls, 27 inch, RC, per each
Pay Item D70173	Apron Endwalls, 30 inch, RC, per each
Pay Item D70174	Apron Endwalls, 30 inch, CS, per each
Pay Item D70175	Apron Endwalls, 33 inch, RC, per each
Pay Item D70177	Apron Endwalls, 36 inch, RC, per each
Pay Item D70178	Apron Endwalls, 36 inch, CS, per each
Pay Item D70179	Apron Endwalls, 42 inch, RC, per each
Pay Item D70180	Apron Endwalls, 42 inch, CS, per each
Pay Item D70181	Apron Endwalls, 48 inch, RC, per each
Pay Item D70182	Apron Endwalls, 48 inch, CS, per each
Pay Item D70183	Apron Endwalls, 54 inch, RC, per each
Pay Item D70184	Apron Endwalls, 54 inch, CS, per each
Pay Item D70185	Apron Endwalls, 60 inch, RC, per each
Pay Item D70186	Apron Endwalls, 60 inch, CS, per each
Pay Item D70187	Apron Endwalls, 72 inch, RC, per each
Pay Item D70188	Apron Endwalls, 72 inch, CS, per each
Pay Item D70189	Apron Endwalls, 84 inch, RC, per each
Pay Item D70190	Apron Endwalls, 84 inch, CS, per each
Pay Item D70191	Apron Endwalls, _____ inch by _____ inch, _____, per each
through D70198	
Pay Item D70199	Rock Excavation for Pipe Trench, per cubic yard

Measurement and payment will only be made for Pay Items contained in the Schedule of Prices. The cost of all Work required by the Contract Documents shall be included in the Pay Items contained in the Schedule of Prices.

## MATERIAL REQUIREMENTS

ASTM A 760	Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 761	Steel Galvanized, Corrugated Structural Plates and Fasteners for Pipe, Pipe-Arches, and Arches
ASTM C 76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 94	Ready Mixed Concrete
ASTM C 144	Aggregate for Masonry Mortar
ASTM C 150	Portland Cement
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 507	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C 655	Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C 789	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 850	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less than 2 feet of Cover
ASTM D 1056	Flexible Cellular Materials—Sponge or Expanded Rubber
AASHTO M 198	Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
AASHTO M 243	Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

# SPECIFICATION D-705. PIPE UNDERDRAINS FOR AIRPORTS

## DESCRIPTION

**705-1.1** This Work consists of the construction of pipe underdrains in accordance with these Specifications and in conformity with the lines and grades and details shown on the Plans.

## MATERIALS

**705-2.1 GENERAL.** The pipe shall be of the type called for on the Plans and shall be in accordance with the following appropriate requirements. Whenever a type of pipe is not indicated on the Plans or in the Special Provisions, provide pipe in accordance with one of the following standards.

Polymer Precoated Perforated Corrugated Steel Pipe	ASTM A 762
Smooth-Wall Perforated PVC Pipe	ASTM F 758
Poly (Vinyl Chloride)(PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings	ASTM F 949
Corrugated Polyethylene Drainage Tubing	AASHTO M 252
Corrugated Polyethylene Pipe	AASHTO M 294

**705-2.2 ELASTOMERIC SEALS.** Elastomeric seals shall conform to the requirements of ASTM F 477.

**705-2.3 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 in accordance with ASTM C 136.

**TABLE 1. GRADATION OF POROUS BACKFILL**

<i>Sieve Designations (square openings)</i>	<i>Percentage by Weight Passing Sieves</i>	
	<i>Porous Material No. 1</i>	<i>Porous Material No. 2</i>
1-1/2 inch		100
1 inch (225.0 mm)		90-100
3/8 (9.5 mm)	100	25-60
No. 4 (4.75 mm)	95-100	5-40
No. 8 (2.36 mm)		0-20
No. 16 (1.18 mm)	45-80	
No. 50 (0.30 mm)	10-30	
No. 100 (0.15 mm)	0-10	

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

**705-2.4 GEOTEXTILE FABRIC.** Provide Type DF, Geotextile Fabric in accordance with Specification P-635.

**705-2.5 CONCRETE.** Portland cement concrete for end sections, concrete collars, and other uses shall conform to Specification P-610.

## CONSTRUCTION METHODS

**705-3.1 EQUIPMENT.** Before construction is permitted to start, provide equipment necessary and required for the proper construction of pipe underdrains on the project, in first-class working condition, and approved by the Engineer.

**705-3.2 EXCAVATION.** The width of the pipe trench shall be sufficient (but not less than the external diameter of the pipe plus 6 inches (150 mm) on each side) to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe.

Remove rock, hardpan, or other unyielding material that is encountered, below the foundation grade for a depth of at least 4 inches (100 mm). Backfill the excavation grade with selected fine compressible material, such as silty clay or loam, and lightly compact it in layers not over 6 inches (150 mm) 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, remove the unstable soil and replace it with approved granular material for the full trench width. The Engineer will determine the depth of removal necessary. Compact the granular material to provide adequate support for the pipe.

Dispose of excavated material that is not required or acceptable for backfill as directed by the Engineer. Do not carry the excavation below the required depth. If this is done, backfill the trench at the Contractor's expense with material approved by the Engineer and compacted to the density of the surrounding earth material.

Shape the bed for the pipe so that at least the lower quarter of the pipe is in continuous contact with the bottom of the trench. Excavate spaces for the pipe bell accurately to size to clear the bell so that the barrel supports the entire weight of the pipe.

Trench brace, sheath, or shore as necessary to perform and protect the excavation as required for safety and conformance to governing laws. Unless otherwise provided, remove the bracing, sheathing, or shoring after the completion of the backfill to at least 12 inches (300 mm) over the top of the pipe. Pull the sheathing or shoring as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. Include the cost of bracing, sheathing, or shoring, and the removal of it in the unit price bid for the pipe.

**705-3.3 LAYING AND INSTALLING PIPE.** Start laying the pipe in the finished trench at the lowest point and lay it upgrade. When bell and spigot pipe is used, lay the bells upgrade. If tongue and groove pipe is used, lay the groove end upgrade. Place holes in perforated pipe down, unless otherwise shown on the Plans. Firmly and accurately set the pipe to line and grade shown on the Plans so that the invert will be smooth and uniform. Do not lay pipe on frozen ground.

Take up and relay pipe which is not true in alignment, or which shows settlement after laying without extra compensation.

Install PVC pipe in accordance with the requirements of ASTM D 2321.

Plug or cap the upgrade end of pipelines, not terminating in a structure, as approved by the Engineer.

Unless otherwise shown on the Plans, spread a 4-inch (100 mm) bed of granular backfill material in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Construct pipe outlets for the underdrains when required or shown on the Plans. Lay the pipe with tight-fitting joints. When shown on Plans, porous backfill is not required around or over pipe outlets for underdrains. Make all connections to other drainage pipes or structures with manufactured fittings and connections, or as shown on the Plans. If connections are not made to other pipes or structures, protect the pipe outlets and construct them as shown on the Plans.

**705-3.4 POROUS BACKFILL BEDDING.** Install bedding and geotextile fabric as shown on Plans.

Wrap the geotextile fabric securely around porous backfill material as shown on Plans along its entire length so that no water can enter the porous material without first passing through the fabric.

Furnish geotextile fabric in a cover that protects the fabric from exposure to sunlight and abrasion due to shipping and hauling. Do not expose the fabric to the direct rays of the sun for more than 48 hours prior to covering.

Cover torn or punctured fabric with a suitable geotextile fabric extending at least 12 inches (305 mm) in any direction from the edge of the damaged fabric.

Overlap all joints or splices a minimum of 18 inches (460 mm).

### **705-3.5 BACKFILLING.**

**Earth.** Backfill trenches and excavations within a reasonable time after the pipes are installed, unless other protection of the pipe is directed. The backfill material shall be as shown on the Plan, or if not shown, shall be selected material from excavation or borrow. Material which is placed within a nominal pipe diameter distance of the sides of the pipe and 1 foot (305 mm) over the top shall be material which can be readily compacted. It cannot contain stones retained on a 3-inch (75 mm) sieve, frozen lumps, chunks of highly plastic clay, or other material that is objectionable to the Engineer. Moisten or dry the material, if necessary to be compacted by the method in use. Backfill material must be approved by the Engineer. Take special care in placing the backfill. Use great care to obtain thorough compaction under the haunches and along the sides to the top of the pipe.

Place the backfill in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe, and not exceeding 8 inches (200 mm) over the pipe. Add successive layers and thoroughly compact them by hand and pneumatic tampers, approved by the Engineer, until the trench is completely filled and brought to the proper elevation. Backfill in a manner to avoid injurious top or side pressures on the pipe.

In embankments and for other areas outside of pavements, compact the backfill to the density required for embankments in unpaved areas under Specification P-152. Under paved areas, compact the subgrade and any backfill to the density required for embankments for paved areas under Specification P-152.

**Granular Material.** When granular backfill is required, place it in the trench and about the pipe as shown on the Plans. Take special care in placing the backfill. The granular backfill cannot contain a damaging amount of foreign matter, nor can earth from the sides of the trench or from the windrow be allowed to filter into the backfill. When required by the Engineer, use a template to properly place and keep separate the two sizes of backfill. Place the backfill in loose layers not exceeding 6 inches (150 mm) in depth and compact it by hand and pneumatic tampers to the requirements as given for earth backfill. Backfill in a manner to avoid injurious top or side pressure on the pipe. Make the granular backfill to the elevation of the trench, as shown on the Plans.

When perforated pipe is specified, place granular backfill material along the full length of the pipe. Position the granular material as shown on the Plans.

When placing porous backfill in paved or adjacent areas prior to the completion of grading or subgrade operations, place the backfill material immediately after laying the pipe. The depth of this granular backfill cannot be less than 12 inches (305 mm), measured from the top of the underdrain. During subsequent construction operations, do not disturb this minimum backfill of 12 inches (305 mm) of depth until completion of the underdrains. When completing the underdrains, remove the unsuitable material until the porous backfill is exposed. Remove and replace that part of the porous backfill that contains objectionable material with suitable material. The cost of removing and replacing unsuitable material shall be borne by the Contractor.

Whenever using a granular subbase blanket course under pavements that extend several feet beyond the edge of paving to the outside edge of the underdrain trench, place the granular backfill material over the underdrains in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to placing the granular subbase blanket course, 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. Remove and replace unsuitable material that remains over the underdrain trench. Place the subbase material to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

**705-3.6 END SECTIONS.** Construct underdrain end sections in accordance with the details and at the location shown on the Plans.

**705-3.7 RISERS.** Construct underdrain risers in accordance with the details and at the locations shown on the Plans.

**705-3.8 CONNECTIONS.** When the Plans call for connections to existing or proposed pipe or structures, these connections must be watertight and made so that a smooth uniform flow line will be obtained throughout the drainage system.

**705-3.9 CLEANING AND RESTORATION OF SITE.** After the backfill is completed, dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Engineer. Except for paved areas of the airport, restore all disturbed areas to their original condition unless indicated otherwise on the Plans or in the Special Provisions.

## 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. Fittings will be included in the footage 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 on typical trench sections indicating the placement of porous backfill. Quantities outside the typical trench sections shown will not be measured for payment.

**705-4.3** Airport Underdrain Risers and End Sections will be measured on the basis of the amount per each installed and accepted.

## BASIS OF PAYMENT

**705-5.1** Payment will be made at the Contract unit price per linear foot for Airport Underdrain of the size designated; at the Contract unit price per cubic yard for Porous Backfill No. 1; and at the Contract unit price per cubic yard for Porous Backfill No. 2; and at the Contract unit price per each for Airport Underdrain Riser and Airport Underdrain End Sections. These prices will be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, bedding, backfill, site restoration, and for all labor, equipment, tools, and incidentals necessary to complete the Work. The cost of geotextile fabric shall be included in a separate item for geotextile fabric.

Standard Pay Items for Work covered by this Specification are as follows:

Pay Item D70501	Airport Underdrain, 6 inch, per linear foot
Pay Item D70502	Airport Underdrain, 8 inch, per linear foot
Pay Item D70503	Airport Underdrain, 10 inch, per linear foot
Pay Item D70504	Airport Underdrain, 12 inch, per linear foot
Pay Item D70510	Porous Backfill No. 1, per cubic yard
Pay Item D70511	Porous Backfill No. 2, per cubic yard
Pay Item D70512	Airport Underdrain Riser, per each
Pay Item D70513	Airport Underdrain End Section, per each.
Pay Item D70514	Airport Underdrain Unperforated, 6 inch, per linear foot
Pay Item D70515	Airport Underdrain, Unperforated, 8 inch, per linear foot
Pay Item D70516	Airport Underdrain, Unperforated, 10 inch, per linear foot
Pay Item D70517	Airport Underdrain, Unperforated, 12 inch, per linear foot

Measurement and payment will only be made for Pay Items contained in the Schedule of Prices. The cost of all Work required by the Contract Documents shall be included in the Pay Items contained in the Schedule of Prices.

## **MATERIAL REQUIREMENTS**

ASTM A 762	Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C 136	Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C 144	Aggregate for Masonry Mortar
ASTM C 150	Portland Cement
ASTM D 2321	Underground Installation of Flexible Thermoplastic Sewer Pipe
ASTM D 3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F 477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 758	Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F 949	Poly (Vinyl Chloride)(PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
AASHTO M 252	Corrugated Polyethylene Drainage Tubing
AASHTO M 294	Corrugated Polyethylene Pipe, 12 to 24 in. diameter

## **TESTING REQUIREMENTS**

# SPECIFICATION D-751. MANHOLES, CATCH BASINS, AND INLETS

## DESCRIPTION

**751-1.1** This Work consists of construction of manholes, catch basins and inlets, in accordance with 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.** Brick shall conform to the requirements of ASTM C 32, Grade SM.

**751-2.2 MORTAR.** Mortar consists of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144.

**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 Specification P-610.

**751-2.4 PRECAST REINFORCED CONCRETE MANHOLE SECTIONS.** Precast reinforced concrete manhole sections shall conform to the requirements of ASTM C 478. Unless otherwise specified or shown on the Plans, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (0.90 m).

**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 A 48.
- b. Malleable iron castings shall meet the requirements of ASTM A 47.
- c. Structural steel for grates and frames shall conform to the requirements of ASTM A 283, Grade D.
- d. Ductile iron castings shall conform to the requirements of ASTM A 536.

All castings or structural steel units shall conform to the dimensions shown on the Plans and shall be designed to support the loadings specified.

Provide frame and cover or grate units (castings) with fastening members to prevent dislodging due to traffic but which will allow easy removal for access to the structure.

Castings shall be thoroughly cleaned and given two coats of approved bituminous paint. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A 123.

**751-2.7 STEPS.** Steps or ladder bars shall be gray or malleable cast iron steps or steps constructed utilizing steel reinforcing rod encapsulated in copolymer polypropylene. Steps shall conform to ASTM C 478. Steps shall be the size, length, and shape shown on the Plans and given a coat of bituminous paint.

**751-2.8 PREFORMED FLEXIBLE JOINT SEALANT.** Provide preformed flexible joint sealant in accordance with ASTM C 990.

## CONSTRUCTION METHODS

**751-3.1 UNCLASSIFIED EXCAVATION.**

a. Excavate for structures and structure footings to the lines and grades or elevations shown on the Plans, or as staked by the Engineer. Excavate to sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

b. Remove boulders, logs, or other objectionable material encountered in excavation. Clean rock or other hard foundation material of loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. Clean or grout seams or crevices. Remove loose and disintegrated rock and thin strata. When concrete is to rest on a surface other than rock, take special care not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before placing the concrete or reinforcing.

c. 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. Unless otherwise provided, remove bracing, sheathing, or shoring involved in the construction of structures after the completion of the structure. The removal should not disturb or mar finished masonry. Include the cost of removal in the unit price bid for the structure.

e. Notify the Engineer after each excavation is completed, and place concrete or reinforcing steel after the Engineer has approved the depth of the excavation and the character of the foundation material.

### 751-3.2 BRICK STRUCTURES.

a. **Foundations.** Place a prepared foundation 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 in accordance with the requirements of Specification P-610.

b. **Laying Brick.** Brick must be clean and thoroughly wet before laying so that it will not absorb any appreciable amount of additional water at the time it is laid. Lay brick in freshly made mortar. Discard mortar that is not used within 45 minutes after water has been added. Retempering of mortar is not permitted. Spread an ample layer of mortar on the beds and make a shallow furrow in it which can be readily closed by the laying of the brick. Fill bed and head joints solid with mortar. Fully butter end joints of stretchers and side or cross joints of headers with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Remove, clean, and relay bricks with fresh mortar that may be loosened after the mortar has taken its set. Do not use broken or chipped brick in the face, and do not use spalls or bats except where necessary to shape around irregular openings or edges; in which case, place full bricks at ends or corners where possible, and place the bats used in the interior of the course. In making closures, do not use a piece of brick shorter than the width of a whole brick; and wherever practicable, use and lay whole brick as headers.

c. **Joints.** Slush joints with mortar at every course, but slushing alone will not be considered adequate for making an acceptable joint. Lay up exterior faces in advance of backing. Back plaster or parget exterior faces with a coat of mortar not less than 3/8-inch (9 mm) thick before the backing is laid up. Prior to pargeting, cut all joints flush on the back of face courses. Unless otherwise noted, joints shall be not less than 1/4-inch (6 mm) nor more than 1/2-inch (12 mm) wide and whatever width is adopted shall be maintained uniform throughout the Work.

d. **Pointing.** Neatly strike face joints, using the weather joint. Finish joints properly as the laying of the brick progresses. When nails or line pins are used immediately plug holes with mortar and point when the nail or pin is removed.

e. **Cleaning.** Upon completion of the Work, thoroughly clean exterior surfaces by scrubbing and washing down with water and, if necessary to produce satisfactory results, clean with a 5 percent solution of muriatic acid which is then rinsed off with liberal quantities of clean fresh water.

f. **Curing and Cold Weather Protection.** In hot or dry weather, or when directed by the Engineer, protect the brick masonry and keep moist for at least 48 hours after laying the brick. Brick masonry work or pointing should not be done when there is frost in the brick or when the air temperature is below 50°F (10°C) 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 (15°C) for the duration of the curing period.

**751-3.3 CONCRETE STRUCTURES.** Build concrete structures on prepared foundations, conforming to the dimensions and form indicated on the Plans. The construction shall conform to the requirements specified in Specification P-610. Required reinforcement shall be placed as indicated on the Plans and will be approved by the Engineer before concrete is poured.

Construct and shape invert channels accurately so as to be smooth, uniform, and cause minimum resistance to flowing water. Slope the interior bottom downward toward the outlet.

**751-3.4 PRECAST REINFORCED CONCRETE STRUCTURES.** Construct precast reinforced concrete structures with an integral base or on prepared or previously placed slab foundations and that conform to the dimensions and locations shown on the Plans. Furnish precast reinforced concrete sections necessary to build a completed structure. The different sections should fit together readily, and all jointing and connections must be watertight. Form and dimension the top of the uppermost precast concrete section to receive the metal frame and cover or grate, or other cap, as required. Seal joints between concrete sections with preformed flexible joint sealant installed in accordance with applicable requirements of ASTM C 990 and manufacturer's instructions. Provide provisions for connections for lateral pipe, including drops and leads that may be installed in the structure. Connections should be made with mortar joints. Form flow lines with concrete that will be smooth, uniform, and cause minimum resistance to flow. Install steps or ladders as shown on the Plans.

**751-3.5 CORRUGATED METAL STRUCTURES.** Construct corrugated metal structures on prepared foundations, conforming to the dimensions and locations as shown on the Plans. Use prefabricated structures. Furnish standard or special fittings to provide pipe connections or branches of correct dimensions. The connections or branches should be long enough to accommodate connecting bands. Weld the fittings in place to the metal structures. When indicated, place the structures on a reinforced concrete base. Design the top of the metal structure so that

either a concrete slab or metal collar may be attached to which then can be fastened a standard metal frame and grate or cover. Furnish steps or ladders as shown on the Plans.

**751-3.6 INLET AND OUTLET PIPES.** Extend inlet and outlet pipes through the walls of the structures for a sufficient distance beyond the outside surface to allow for connections but cut off flush with the wall on the inside surface. For concrete or brick structures, place the mortar around these pipes so as to form a tight, neat connection.

**751-3.7 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES, AND FITTINGS.** Place castings, frames, and fittings for manhole and inlet covers in the positions indicated on the Plans or as directed by the Engineer, and set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, place and position all anchors or bolts before the concrete or mortar is placed. Do not disturb the unit until the mortar or concrete has set.

When frames or fittings are to be placed upon previously constructed masonry, bring the bearing surface or masonry true to line and grade and present an even bearing surface in order that the entire face or back of the unit will come in contact with the masonry. Set the unit in mortar beds and anchor to the masonry as indicated on the Plans or as directed and approved by the Engineer. Set firm and secure all units.

After the frames or fittings have been set in final position and the concrete or mortar has been allowed to harden for 7 days, place and fasten down the grates or covers.

**751-3.8 INSTALLATION OF STEPS.** Install the steps as indicated on the Plans or as directed by the Engineer. When setting the steps in concrete, place and secure them in position before the concrete is poured. When the steps are installed in brick masonry, place them as the masonry is being built. Do not disturb or use the steps until the concrete or mortar has hardened for at least 7 days. After this period has elapsed, clean and paint the steps, unless they have been galvanized.

When steps are required with precast reinforced concrete structures, cast them into the sides of the pipe at the time the pipe sections are manufactured or set in place after the structure is erected. This is done by drilling holes in the concrete and cementing the steps in place or installing in accordance with the manufacturer's instructions.

When steps are required with corrugated metal structures, weld them into aligned position at a vertical spacing of 12 inches (300 mm).

Instead of steps, prefabricated ladders may be installed. In the case of brick or concrete structures, hold the ladder in place by grouting the supports in drilled holes. In the case of metal structures, secure the ladder by welding the top support and grouting the bottom support into drilled holes in the foundation or as directed.

### **751-3.9 BACKFILLING.**

**a.** After a structure has been completed, fill the area around it with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Specification P-152 for the location where the structure is located or as shown on the Plans. Deposit each layer all around the structure to approximately the same elevation. The top of the fill must meet the elevation shown on the Plans or as directed by the Engineer.

**b.** Do not place backfill against structures until the structure can support the loads imposed by the backfill. In the case of concrete structures, the concrete shall be in place 7 days, or until tests made by a laboratory establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding pressure created by the backfill or the placement methods.

**c.** Backfill shall 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 the structure involved.

**751-3.10 CLEANING AND RESTORATION OF SITE.** After the backfill is completed, dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Engineer. Restore all disturbed areas to their original condition.

After all Work is completed, remove all tools and equipment, leaving the entire site free, clear, and in good condition.

## **METHOD OF MEASUREMENT**

**751-4.1** Manholes, catch basins, inlets, manhole covers, inlet covers, and adjusting covers will be measured by the unit per each complete in-place.

## **BASIS OF PAYMENT**

**751-5.1 MANHOLES, CATCH BASINS, AND INLETS.** The accepted quantities of manholes, catch basins, and inlets will be paid for at the Contract unit price per each, complete and in place. This price will be full compensation for furnishing all materials (including steps but not

covers) and for all preparation, excavation, dewatering, site restoration, backfilling and placing of the materials; for furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the Work as shown on the Plans; and for all materials, labor, equipment, steps, tools and incidentals necessary to complete the structure.

**Manhole Covers and Inlet Covers.** Work under the Pay Items of Manhole Covers (Type) and Inlet Covers (Type), measured as provided above, will be paid for at the Contract unit price each, which price will be full compensation for removing and salvaging the existing covers; for furnishing new covers, including frames, grates or lids, and all other required materials; and for all labor, tools, equipment and incidentals necessary for adjusting and installing each cover complete. Old covers removed shall remain the property of the Airport.

**Adjusting Covers.** Work under the Pay Item of Adjusting Covers, measured as provided above, will be paid for a the Contract unit price each, which price will be full compensation for furnishing all required materials, exclusive of frames, grates or lids available and designated for adjusting; for removing, reinstalling and adjusting the covers on manholes, inlets, or catch basins; and for all labor, tools, equipment and incidentals necessary for adjusting each cover. Covers to be adjusted and which are rendered unfit for use by the Contractor through the Contractor's operations shall be replaced by the Contractor at the Contractor's own cost and expense.

The adjusting of covers, when designated on the Plan or in the Contract and when not covered by a Contract Pay Item, will be considered as Work incidental to other Contract Pay Items and no separate or extra compensation will be allowed.

Required adjusting of covers, when not designated on the Plans or when the Contract does not contain a Pay Item for adjusting covers, will be considered and paid for as Extra Work.

Standard Pay Items for Work covered by this Specification are as follows:

Pay Item D75101	Storm Water Manholes, Type 1, per each
Pay Item D75102	Storm Water Manhole, Type 2, per each
Pay Item D75103	Storm Water Manhole, Type 3, per each
Pay Item D75104	Storm Water Manhole, Type 5, per each
Pay Item D75105	Storm Water Manhole, Type 6, per each
Pay Item D75110	Storm Water Catch Basin, Type 1, per each
Pay Item D75111	Storm Water Catch Basin, Type 2, per each
Pay Item D75112	Storm Water Catch Basin, Type 3, per each
Pay Item D75113	Storm Water Catch Basin, Type 5, per each
Pay Item D75120	Storm Water Inlet, Type 1, per each
Pay Item D75121	Storm Water Inlet, Type 2, per each
Pay Item D75122	Storm Water Inlet, Type 3, per each
Pay Item D75123	Storm Water Inlet, Type 4, per each
Pay Item D75124	Storm Water Inlet, Type 8, per each
Pay Item D75125	Storm Water Inlet, Type 9, per each
Pay Item D75126	Storm Water Inlet, Type 10, per each
Pay Item D75127	Storm Water Inlet, Type 11, per each
Pay Item D75140	Manhole Cover, Type J, per each
Pay Item D75141	Manhole Cover, Type K, per each
Pay Item D75142	Manhole Cover, Type L, per each
Pay Item D75143	Manhole Cover, Type M, per each
Pay Item D75150	Inlet Cover, Type H-S, per each
Pay Item D75151	Inlet Cover, Type A-S, per each
Pay Item D75152	Inlet Cover, Type B-A, per each
Pay Item D75153	Inlet Cover, Type MS-A, per each
Pay Item D75154	Inlet Cover, Type HM-S, per each
Pay Item D75155	Inlet Cover, Type A, per each
Pay Item D75156	Inlet Cover, Type B, per each
Pay Item D75157	Inlet Cover, Type C, per each
Pay Item D75158	Inlet Cover, Type F, per each
Pay Item D75159	Inlet Cover, Type H, per each
Pay Item D75160	Inlet Cover, Type Z, per each
Pay Item D75161	Inlet Cover, Type GM-A, per each
Pay Item D75162	Inlet Cover, Type MS, per each
Pay Item D75163	Inlet Cover, Type WM, per each
Pay Item D75164	Inlet Cover, Type W, per each
Pay Item D75165	Inlet Cover, Type X, per each

Pay Item D75166	Inlet Cover, Type V, per each
Pay Item D75167	Inlet Cover, Type R, per each
Pay Item D75168	Inlet Cover, Type GM, per each
Pay Item D75169	Inlet Cover, Type S, per each
Pay Item D75170	Inlet Cover, Type HM, per each
Pay Item D75180	Adjusting Cover, per each

Measurement and payment will only be made for Pay Items contained in the Schedule of Prices. The cost of all Work required by the Contract Documents shall be included in the Pay Items contained in the Schedule of Prices.

## MATERIAL REQUIREMENT

ASTM A 27	Mild to Medium–Strength Carbon–Steel Castings for General Application
ASTM A 47	Malleable Iron Castings
ASTM A 48	
ASTM A 123	
ASTM A 283	Zinc (Hot–Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip
ASTM A 536	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars
ASTM C 32	Sewer and Manhole Brick
ASTM C 94	Ready Mixed Concrete
ASTM C 144	Aggregate for Masonry Mortar
ASTM C 150	Portland Cement
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 822	Standard Definitions and Terms Relating to Concrete Pipe and Related Products
ASTM C 990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
AASHTO M 36	Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Underdrains

# SPECIFICATION D-752. CONCRETE CULVERTS, HEADWALLS, AND MISCELLANEOUS DRAINAGE STRUCTURES

## DESCRIPTION

**752-1.1** This Work consists of reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed in accordance with 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.** Reinforced concrete shall meet the requirements of Specification P-610.

## CONSTRUCTION METHODS

### **752-3.1 UNCLASSIFIED EXCAVATION.**

**a.** Excavate trenches and foundation pits for structures or structure footings 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.

**b.** Remove boulders, logs, or other objectionable material encountered in excavation. Clean rock or other hard foundation material of loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. Clean out and grout seams or crevices. Remove loose and disintegrated rock and thin strata. When concrete is to rest on a surface other than rock, take special care not to disturb the bottom of the excavation, and do not excavate to final grade until just before the concrete or reinforcing steel is to be placed.

**c.** 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. Include the cost of bracing, sheathing, or shoring in the unit price bid for excavation.

**d.** Unless otherwise provided, remove any involved bracing, sheathing, or shoring after the completion of the structure. Remove in a manner which will not disturb or mar finished concrete. Include the cost of removal in the unit price bid for Unclassified Excavation for Drainage Structures.

**e.** Notify the Engineer after each excavation is completed, and place concrete or reinforcing steel after 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, accomplish backfilling with approved material by applying the fill in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted. The field density of the compacted material must be at least 90 percent of the maximum density for cohesive soils and 95 percent of the maximum density for noncohesive soils. Determine the maximum density in accordance with ASTM D 698. Determine the field density in accordance with ASTM D 1556 or ASTM D 2167.

**b.** Do not place backfill against any structure until the concrete has been in place 7 days, or until tests made by an approved laboratory establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

**c.** Deposit fill (placed around concrete culverts) on both sides at the same time and to approximately the same elevation. Take care to prevent any wedging action against the structure. Step or serrate all slopes bounding or within the areas to be backfilled to prevent wedge action.

**d.** Backfill will not be measured for direct payment. Performance of this Work under the Contract is not payable directly but 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.** Construct weep holes as shown on the Plans.

**752-3.4 RESTORATION OF SITE.** After the backfill is completed, dispose of surplus material, dirt, and rubbish from the site. Deposit surplus dirt in embankment, shoulders, or as ordered by the Engineer. Restore all disturbed areas to their original condition.

After all Work is completed, remove all tools and equipment, leaving the entire site free, clear, and in good condition.

## METHOD OF MEASUREMENT

**752-4.1** The quantity of Unclassified Excavation for Drainage Structures to be paid for will be the number of cubic yards, measured in original position, of material excavated in accordance with the Plans, or as directed by the Engineer; but in no case shall yardage be included in the measurement for payment which is outside of a volume bounded by vertical planes 18 inches (450 mm) outside of and parallel to the neat lines of the footings. The quantity of Unclassified Excavation for Drainage Structures will only be measured for payment for structures constructed under this Specification.

**752-4.2** Structural Concrete for Drainage Structures will be measured by the number of cubic yards of concrete, complete in place and accepted. In computing the yardage of concrete for payment, the dimensions used will be those shown on the Plans or ordered by the Engineer. No measurements or other allowances will be made for forms, false work, cofferdams, pumping, bracing, expansion joints, or finishing of the concrete. No deductions in yardage will be made for the volumes of reinforcing steel or embedded items.

**752-4.3** The quantity of Reinforcing Steel for Drainage Structures to be paid for will be the calculated theoretical number of pounds placed as shown on the Plans, complete in place and accepted. The unit weight used for deformed bars shall 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 Structural Concrete for Drainage Structures; and at the Contract unit price per pound for Reinforcing Steel for Drainage Structures. These prices will be full compensation for furnishing and placing all materials, and for all preparation, excavation, dewatering, backfill, restoration, temporary sheathing and shoring, and for all labor, materials, equipment, tools, and incidentals necessary to complete the structure as specified and shown on the Plans.

Standard Pay Items for Work covered by this Specification are as follows:

Pay Item D75201	Unclassified Excavation for Drainage Structures, per cubic yard
Pay Item D75202	Structural Concrete for Drainage Structures, per cubic yard
Pay Item D75203	Reinforcing Steel for Drainage Structures, per pound

Measurement and payment will only be made for Pay Items contained in the Schedule of Prices. The cost of all Work required by the Contract Documents shall be included in the Pay Items contained in the Schedule of Prices.

## TESTING REQUIREMENTS

ASTM D 698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12-in (305 mm) Drop
ASTM D 1556	Density of Soil in Place by the Sand-Cone Method
ASTM D 2167	Density of Soil in Place by the Rubber-Balloon Method

## SPECIFICATION D-754. CONCRETE GUTTERS, DITCHES, AND FLUMES

### DESCRIPTION

**754-1.1** This Work consists of Portland cement concrete gutters, ditches, and flumes constructed in accordance with these Specifications at the specified locations in accordance with the dimensions, lines, and grades as shown on the Plans.

### MATERIALS

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

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

### CONSTRUCTION METHODS

**754-3.1 PREPARING SUBGRADE.** Excavate to the required width and depth, and compact the subgrade upon which the item is to be built to a firm uniform grade. Remove soft and unsuitable material and replace it with suitable approved material. When required, place a layer of approved granular material, compacted to the thickness indicated on the Plans, to form a subbase. The underlying course will be checked and accepted by the Engineer before placing and spreading operations are started.

**754-3.2 PLACING.** The forms for and the mixing, placing, finishing, and curing of concrete shall conform to the requirements of Specification P-610 and shall be in accordance with the following requirements.

Tamp and spade the concrete until it is consolidated and mortar entirely covers and forms the top surface. The surface of the concrete should be floated smooth and the edges rounded to the radii shown on the Plans. Before the concrete is given the final finishing, test the surface with a 10-foot (3-m) straightedge, and eliminate irregularities of more than 1/4 inch (6 mm) in 10 feet (3 m).

Place the concrete with dummy-grooved joints not to exceed 25 feet (7.5 m) apart, except where shorter lengths are necessary for closures. No section should be less than 4 feet (1.20 m) long.

Construct expansion joints of the type called for in the Plans to replace a dummy groove at spacings of approximately 100 feet (30 m). When the gutter is placed next to concrete pavement, locate expansion joints in the gutter opposite expansion joints in the pavement. When a gutter abuts a pavement or other structure, place an expansion joint between the gutter and the other structure.

Do not remove forms within 24 hours after the concrete has been placed. Repair minor defects with mortar containing 1 part cement and 2 parts fine aggregate.

Conduct the operations of depositing, compacting, and finishing to build a satisfactory structure. Sections of concrete found to be porous (other than minor defects which may be plastered) shall be removed and replaced by the Contractor without additional compensation.

**754-3.3 BACKFILLING.** After the concrete has set sufficiently, refill the spaces adjacent to the structure 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 ASTM D 698. Determine the in-place density in accordance with ASTM D 1556 or ASTM D 2167.

**754-3.4 CLEANING AND RESTORATION OF SITE.** After the backfill is completed, dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as ordered by the Engineer. Restore all disturbed areas to their original condition.

After all Work is completed, remove all tools and equipment, leaving the entire site free, clear and in good condition.

Performance of the Work described in this section is not payable directly but shall be considered as a subsidiary obligation of the Contractor, covered under the Contract unit price for the structure.

### METHOD OF MEASUREMENT

**754-4.1** Concrete gutters, ditches, and flumes will be measured by the cubic yard, the square yard, or linear foot in accordance with 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.

## **BASIS OF PAYMENT**

**754-5.1** Payment will be made at the Contract unit price, which will be full compensation for furnishing all materials, preparation, excavation, construction, joints, finishing, backfilling, and all labor, materials, equipment, tools, and incidentals necessary to complete the Work in accordance with this specification.

Standard Pay Items for Work covered by this Specification are as follows:

Pay Item D75401	Concrete Gutter, per cubic yard
Pay Item D75402	Concrete Gutter, per square yard
Pay Item D75403	Concrete Flume, per cubic yard
Pay Item D75404	Concrete Flume, per square yard
Pay Item D75405	Concrete Curb and Gutter, per linear foot

Measurement and Payment will only be made for Pay Items contained in the Schedule of Prices. The cost of all Work required by the Contract Documents shall be included in the Pay Items contained in the Schedule of Prices.

## **TESTING REQUIREMENTS**

ASTM D 698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb (2.49 kg) Rammer and 12-inch (300 mm) Drop
ASTM D 1556	Density of Soil in Place by the Sand-Cone Method
ASTM D 2167	Density of Soil in Place by the Rubber-Balloon Method