

**SECTION 33 40 00**  
**STORM DRAINAGE UTILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies construction of outside, underground storm sewer systems. The storm sewer systems shall be complete and ready for operation, including all drainage structures, frames, grate and covers, connections to new buildings, structure service lines, existing storm sewer lines and existing drainage structures and all required incidentals.

**1.2 RELATED WORK:**

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

**1.3 QUALITY ASSURANCE:**

- A. Products Criteria:
  - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
  - 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to public storm sewer lines and the extension, and/or modifications to Public Utility systems.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturers' Literature and Data: Submit the following as one package:
  - 1. Piping.
  - 2. Jointing material.
  - 3. Manhole, inlet and catch basin material.
  - 4. Frames and covers.
  - 5. Steps.
- C. One copy of Pennsylvania State Department of Transportation standard details of MANHOLES, INLETS and catch basins.

- D. One copy of Pennsylvania State Department of Transportation specification.

**1.5 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
- A48-03/A48M-03.....Gray Iron Castings
- A536-84(2004).....Ductile Iron Castings
- A615-05/A615M-05.....Deformed and Plain-Billet Steel Bars for  
Concrete Reinforcement
- A655-04e1/A655M-04e1... Reinforced Concrete D-Load Culvert, Storm Drain  
and Sewer Pipe
- A742-03/A742M-03.....Steel Sheet, Metallic Coated and Polymer  
Precoated for Corrugated Steel Pipe
- A760-01a/A760M-01a.....Corrugated Steel Pipe, Metallic-Coated for  
Sewers and Drains
- A762-00/A762M-00.....Corrugated Steel Pipe, Polymer Precoated for  
Sewers and Drains
- A798-01/M798M-01.....Installing Factory-Made Corrugated Steel Pipe  
for Sewers and Other Applications
- A849-00.....Post-Applied Coatings, Pavings, and Linings for  
Corrugated Steel Sewer and Drainage Pipe
- A929-01/A929M-01.....Steel Sheet, Metallic Coated by the Hot Dip  
Process for Corrugated Steel Pipe
- C76-05a/C76M-05a.....Reinforced Concrete Culvert, Storm Drain and  
Sewer Pipe
- C139-03.....Concrete Masonry Units for Construction of Catch  
Basins and Manholes
- C150-04ae1.....Portland Cement
- C443-05/C443M-05.....Joints for Concrete Pipe and Manholes, Using  
Rubber Gaskets
- C478-03a/C478M-03a.....Precast Reinforced Concrete Manhole Sections
- C506-05/C506M-05.....Reinforced Concrete Arch Culvert, Storm Drain  
and Sewer Pipe
- C507-05a/C507M-05a.....Reinforced Concrete Elliptical Culvert, Storm  
Drain and Sewer Pipe
- C655-04e1/C655M-04e1... Reinforced Concrete D-Load Culvert, Storm Drain  
and Sewer Pipe
- C1433-04e1/C1433M-04e1..Precast Reinforced Concrete Box Sections for  
Culverts, Storm Drains and Sewers

C828-03.....Low-Pressure Air Test of Vitrified Clay Pipe  
Lines

C857-95(2001).....Minimum Structural Design Loading for  
Underground Precast Concrete Utility Structures

C923-02/C923M-02.....Resilient Connectors between Reinforced Concrete  
Manhole Structures, Pipes and Materials

C924-02/C924M-02.....Testing Concrete Pipe Sewer Lines by Low  
Pressure Air Test Method

C1103-03/C1103M-03.....Joint Acceptance Testing of Installed Precast  
Concrete Pipe Sewer Lines

D698-00ae1.....Laboratory Compaction Characteristics of Soil  
Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600  
kN-m/m<sup>3</sup>))

D1056-00.....Flexible Cellular Materials-Sponge or Expanded  
Rubber

D2412-02.....Determination of External Loading  
Characteristics of Plastic Pipe by Parallel  
Plate Loading

D2321-04e1.....Underground Installation of Thermoplastic Pipe  
for Sewers and Other Gravity Flow Applications .

D3034-04a.....Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe  
and Fittings

D3212-96a(2003)e1.....Joints for Drain and Sewer Plastic Pipes Using  
Flexible Elastomeric Seals

D3350-04.....Polyethylene Plastics Pipe and Fittings  
Materials

D4101-05a.....Polypropylene Injection and Extrusion Materials

F477-02e1.....Elastomeric Seals (Gaskets) for Joining Plastic  
Pipe

F679-03.....Poly (Vinyl Chloride) (PVC) Large-Diameter  
Plastic Gravity Sewer Pipe and Fittings

F714-05.....Polyethylene (PE) Plastic Pipe (SDR-PR) Based on  
Outside Diameter

F794-03.....Poly (Vinyl Chloride)(PVC) Profile Gravity Sewer  
Pipe and Fittings Based on Controlled Inside  
Diameter

F894-98a.....Polyethylene (PE) Large Diameter Profile Wall  
Sewer and Drain Pipe

F949-03.....Poly (Vinyl Chloride) (PVC) Corrugated Sewer  
Pipe with Smooth Interior

F1417-92(2005).....Installation Acceptance of Plastic Gravity Sewer  
Lines Using Low-Pressure Air

NOTE: ASTM test methods shall be the current version as of the date of  
advertisement of the project.

C. American Association of State Highway and Transportation Officials  
(AASHTO):

HB17.....Standard Specifications for Highway Bridges

M190-04.....Bituminous Coated Corrugated Metal Culvert Pipe  
and Pipe Arches

M198-05.....Joints for Circular Concrete Sewer and Culvert  
Pipe Using Flexible Watertight Gaskets

M294-04.....Corrugated Polyethylene Pipe, 300-1500 mm (12 to  
60 inches) Diameter

## PART 2 - PRODUCTS

### 2.1 PIPING:

A. Gravity Lines (Pipe and Appurtenances):

1. High Density Polyethylene (HDPE):

a. Smooth Wall PE Pipe: Shall comply with ASTM F714, DR 21 for pipes  
75 to 600 mm (3 to 24 inches), and SDR 26 for pipes 650 to 1200 mm  
(26 to 48 inches). Pipe shall be produced from PE certified by the  
resin producer as meeting the requirements of ASTM D3350, minimum  
cell class 335434C.

b. Corrugated PE Pipe: Shall comply with AASHTO M294 for pipes 300 to  
1500 mm (12 to 60 inches). Pipe walls shall have following minimum  
properties:

<u>Nominal Size</u>	<u>Minimum Wall Area</u>	<u>Min. Moment of Inertia mm<sup>4</sup>/mm (in<sup>4</sup>/in)</u>
300 mm (12 in)	3200 mm <sup>2</sup> /m (1.50 in <sup>2</sup> /ft)	390 (.024)
375 mm (15 in)	4000 mm <sup>2</sup> /m (1.91 in <sup>2</sup> /ft)	870 (.053)
450 mm (18 in)	4900 mm <sup>2</sup> /m (2.34 in <sup>2</sup> /ft)	1020 (.062)
600 mm (24 in)	6600 mm <sup>2</sup> /m (3.14 in <sup>2</sup> /ft)	1900 (.116)
750 mm (30 in)	8300 mm <sup>2</sup> /m (3.92 in <sup>2</sup> /ft)	2670 (.163)
900 mm (36 in)	9500 mm <sup>2</sup> /m (4.50 in <sup>2</sup> /ft)	3640 (.222)
1050 mm (42 in)	9900 mm <sup>2</sup> /m (4.69 in <sup>2</sup> /ft)	8900 (.543)
1200 mm (48 in)	10900 mm <sup>2</sup> /m (5.15 in <sup>2</sup> /ft)	8900 (.543)
1350 mm (54 in)	12000 mm <sup>2</sup> /m (5.67 in <sup>2</sup> /ft)	13110 (.800)
1500 mm (60 in)	13650 mm <sup>2</sup> /m (6.45 in <sup>2</sup> /ft)	13110 (.800)

- c. Profile Wall PE Pipe: Shall comply with ASTM F894, Class 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, Minimum cell class 334433C. Pipe walls shall have following minimum properties:

<u>Nominal Size</u>	<u>Minimum Wall Area</u>	<u>Min. Moment of Inertia mm<sup>4</sup>/mm (in<sup>4</sup>/in)</u>
450 mm (18 in)	6300 mm <sup>2</sup> /m (2.96 in <sup>2</sup> /ft)	850 (.052)
525 mm (21 in)	8800 mm <sup>2</sup> /m (4.15 in <sup>2</sup> /ft)	1150 (.070)
600 mm (24 in)	9900 mm <sup>2</sup> /m (4.66 in <sup>2</sup> /ft)	1330 (.081)
675 mm (27 in)	12500 mm <sup>2</sup> /m (5.91 in <sup>2</sup> /ft)	2050 (.125)
750 mm (30 in)	12500 mm <sup>2</sup> /m (5.91 in <sup>2</sup> /ft)	2050 (.125)
825 mm (33 in)	14800 mm <sup>2</sup> /m (6.99 in <sup>2</sup> /ft)	2640 (.161)
900 mm (36 in)	17100 mm <sup>2</sup> /m (8.08 in <sup>2</sup> /ft)	3310 (.202)
1050 mm (42 in)	16500 mm <sup>2</sup> /m (7.81 in <sup>2</sup> /ft)	4540 (.277)
1200 mm (48 in)	18700 mm <sup>2</sup> /m (8.82 in <sup>2</sup> /ft)	5540 (.338)

SPEC WRITER NOTE: Spec writer to delete unused corrugated metal pipe options.

## 2.2 JOINTING MATERIAL:

### A. PE Plastic Pipe:

1. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion as recommended by the manufacturer.
2. Corrugated PE Plastic Pipe: Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to requirements in AASHTO HB-17, Division II, for soil tightness and shall be as recommended by the manufacturer.
3. Profile Wall PE Plastic Pipe: Joints shall be gasket or thermal weld type with integral bell in accordance with ASTM F894.

## 2.3 MANHOLES, INLETS AND CATCH BASINS:

- ### A. Manholes, inlets and catch basins shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. Manholes, inlets and catch basins shall be in accordance with Pennsylvania State Department of Transportation standard details, and the following VA requirements, in case of variance, VA requirements supersede:

1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6 m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6 m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
4. Flat top manhole tops shall be reinforced concrete as detailed on the drawings.
5. Precast Catch Basins: Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C-857.
6. Mortar:
  - a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, 1/4 part lime hydrate, and 3 parts sand.
  - b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21L (5-1/2 gallons) per sack of cement.
7. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M-198B.
8. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "storm sewer". The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm

(3/4 inch) vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.

9. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 250 mm (10 inches) wide and project a minimum of 125 mm (5 inches) away from the wall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.
10. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 9 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7 inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).

#### **2.4 PRECAST REINFORCED CONCRETE BOX.**

Precast Reinforced Concrete Box: For highway loadings with 600 mm (2 feet) of cover or more subjected to dead load only, conform to ASTM C1433; For less than 600 mm (2 feet) of cover subjected to highway loading, conform to ASTM C1433.

#### **2.5 WARNING TAPE:**

Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, purple with black letters, and imprinted with "CAUTION BURIED STORM SEWER BELOW".

### **PART 3 - EXECUTION**

#### **3.1 EXCAVATION FOR STORM DRAINS AND DRAINAGE STRUCTURES:**

Excavation of trenches and for appurtenances and backfilling for storm drains, shall be in accordance with the applicable portions of Section 31 20 00, EARTH MOVING.

#### **3.2 PIPE BEDDING:**

The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic

pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

### **3.3 GENERAL PIPING INSTALLATION:**

- A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade.
- B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or other utility.
- H. Do not walk on pipe in trenches until covered by layers of shading to a depth of 300 mm (12 inches) over the crown of the pipe.
- I. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
  - 1. Reinforced Concrete Pipe: Comply with manufacturer's recommendations with gasketed joints.
  - 2. Polyvinyl Chloride (PVC) Piping: ASTM D2321.
  - 3. High Density Polyethylene (HDPE) Piping: Comply with manufacturer's recommendations with gaskets with fused joints.
  - 4. Corrugated Metal Pipe: ASTM A798.
- J. Warning tape shall be continuously placed 300 mm (12 inches) above storm sewer piping.

### **3.4 REGRADING:**

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.

- B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.
- C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

### **3.5 CONNECTIONS TO EXISTING VA-OWNED MANHOLES AND INLETS:**

Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping

### **3.6 MANHOLES, INLETS AND CATCH BASINS:**

#### A. General:

##### 1. Circular Structures:

- a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
- b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
- c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

##### 2. Rectangular Structures:

- a. Reinforced concrete structures shall be installed in accordance with Division 03, CONCRETE of these specifications.
- b. Precast concrete structures shall be placed on a 200 mm (8 inch) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on a 200 mm (8 inches) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D 698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.

- 3. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.

4. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
  - a. Forming directly in concrete base of structure.
  - b. Building up with brick and mortar.
5. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (25mm per 300mm, 1-inch per foot) nor more than 1:6 (50mm per 300mm, 2 inches per foot). Bottom slab and benches shall be concrete.
6. The wall that supports access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
7. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
8. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

### **3.7 CURB INLETS, CATCH BASINS, AND AREA DRAINS:**

Reinforced concrete as shown or precast concrete.

### **3.8 INSPECTION OF SEWERS:**

Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp between structures and show full bore indicating sewer is true to line and grade. Lip at joints on inside of sewer is prohibited.

### **3.9 TESTING OF STORM SEWERS:**

A. Gravity Sewers (Select one of the following):

1. Air Test: Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.
2. Exfiltration Test:
  - a. Subject pipe to hydrostatic pressure produced by head of water at depth of 900 mm (3 feet) above invert of sewer at upper manhole under test. In areas where ground water exists, head of water

shall be 900 mm (3 feet) above existing water table. Maintain head of water for one hour for full absorption by pipe body before testing. During 1 hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 11L (3.0 gallons) per hour per 30 m (100 feet).

- b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.

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