SECTION 817

PIPE CULVERTS, EROSION PIPE, STORM SEWERS, SANITARY SEWERS AND END SECTIONS

817.1 DESCRIPTION

Install the size and type of pipe culvert, erosion pipe, storm sewer, sanitary sewer, end section and concrete headwall specified in the Contract Documents.

Provide materials for, and construct the sanitary sewer system as shown in the Contract Documents.

BID ITEMS	**UNITS**
Entrance Pipe (*) (**) (+) (++) (^) (^^)	Linear Foot
Cross Road Pipe (*) (**) (+) (++) (^) (^^)	Linear Foot
Erosion Pipe (*) (**) (+) (++) (^) (^^)	Linear Foot
Storm Sewer (*) (**) (^) (^^)	Linear Foot
Sanitary Sewer (*) (**)	Linear Foot
End Section (*) (**) (+) (++)	Each
Concrete Headwall	Each
Fly Ash Slurry Grout (xx)	Cubic Yard
Sanitary Sewer System	Lump Sum

*Size
**Type
+Provide Only
++Install Only
xx High Strength or Low Strength
^BC-Bituminous Coated
^^FP-Fully Paved

TYPES OF PIPES

RCP - Round Reinforced Concrete Pipe
RCPA - Reinforced Concrete Pipe-Arch
RCPHE - Reinforced Concrete Pipe Horizontal Elliptical
CSP - Galvanized Round Corrugated Steel Pipe
CSMAC - Galvanized Corrugated Steel - Metal Arch Culvert
ACSP - Aluminized (Type 2) Round Corrugated Steel Pipe
ACSMAC - Aluminized (Type 2) Corrugated Steel - Metal Arch Culvert
CAP - Round Corrugated Aluminum Pipe
CAMAC - Corrugated Aluminum - Metal Arch Culvert
PEP - Polyethylene Pipe
CIP - Cast Iron Pipe
CIPP - Cast Iron Pressure Pipe
CISP - Cast Iron Soil Pipe
PVCP - Polyvinyl Chloride Pipe

TYPES OF END SECTIONS

RC - Round Reinforced Concrete
RCA - Reinforced Concrete Arch
RCHE - Reinforced Concrete Horizontal Elliptical
CS - Galvanized Round Corrugated Steel
CSMA - Galvanized Corrugated Steel - Metal Arch
ACS - Aluminized Corrugated Steel
CA - Round Corrugated Aluminum
ACSMA - Aluminized (Type 2) Corrugated Steel - Metal Arch
CAMA - Corrugated Aluminum - Metal Arch

SIZE DESIGNATIONS FOR ARCH CULVERTS AND HORIZONTAL ELLIPTICAL CULVERTS

Bid item size designations for arch culverts and horizontal elliptical culverts are based on minimum waterway requirements, **TABLE 817-1**. Unless shown otherwise in the Contract Documents, provide CSMAC, ACSMAC, CAMAC, RCPA or RCPHE.

TABLE 817-1: MINIMUM WATERWAY REQUIREMENTS FOR ARCH CULVERTS AND HORIZONTAL ELLIPTICAL CULVERTS

Bid Item Size Designation (minimum Sq. Ft. area of waterway)	CSMAC/ACSMAC/ CAMAC (Sq. Ft. area of waterway)	RCPHE (Sq. Ft. area of waterway)	RCPA (Sq. Ft. area of waterway)
1.0	1.1	1.8	1.7
1.5	1.6	1.8	1.7
2.0	2.2	3.3	2.2
2.5	2.9	3.3	2.8
3.0	4.5	3.3	4.4
4.0	4.5	4.1	4.4
5.0	6.5	5.1	6.4
6.0	6.5	6.3	6.4
7.0	8.9	7.4	8.8
8.5	8.9	8.8	8.8
10.0	11.6/11.7	10.2	11.4
11.0	11.6/11.7	12.9	11.4
12.5	14.7/15.6	12.9	14.3
14.0	14.7/15.6	16.6	14.3
16.5	18.1/19.3	16.6	17.7

a. Pipe Culverts, Erosion Pipe, Storm Sewer and End Sections. Provide the type of pipe specified in the Contract Documents. If the type of pipe and end section is not specified in the proposal or the plans, provide any of the types permitted in **TABLE 1901-1: USES OF PIPES**. Use the same type of pipe base metal (steel) throughout any individual run, installation of pipe or for pipe extensions. Provide end sections of the same type as the pipe, except as follows:

- Provide CS, ACS, CA or RC with PEP or PVCP.

b. Sanitary Sewer. Use cast iron pipe of the bell and spigot type.

c. Reinforced Concrete Box Storm Sewer. Construct reinforced concrete box storm sewer in place as shown in the Contract Documents according to **DIVISION 700**.

817.2 MATERIALS

Provide materials that comply with the applicable requirements.

Pipes, Fittings and End Sections ..... **DIVISION 1900**
Steel Encasement Pipe ..... **DIVISION 1600**
Concrete and Fly Ash Slurry Grout ..... **SECTIONS 401 & 402**
Aggregates for Concrete Not On Grade ..... **SECTION 1102**
Portland Cement ..... **DIVISION 2000**
Water ..... **DIVISION 2400**
Coarse, Fine and Mixed Aggregates ..... **DIVISION 1100**
Reinforcing Steel ..... **DIVISION 1600**
Plastic Joint Compound ..... **DIVISION 1500**
Material for Sealing Joints in Pipes ..... **DIVISION 1500**
Factory Molded Joints ..... **DIVISION 1500**
Flowable Fill ..... **SECTION 843**

Provide materials for the sanitary sewer system as shown in the Contract Documents.

The Engineer will accept the materials for the sanitary sewer system based on catalog cuts, product data (including general bulletins), materials of construction, manufacturer's certifications or affidavits of compliance with specified standards, and visual inspection for compliance with dimensional and other requirements detailed in the Contract Documents.

817.3 CONSTRUCTION REQUIREMENTS

a. General. If PEP or PVCP pipe is used, prior to the pre-construction conference, submit for evaluation by the Engineer, a résumé of experience installing PEP or PVCP. A representative of the manufacturer of PEP or PVCP must attend the pre-construction conference for all projects where the Contractor has minimal or no experience with PEP or PVCP installation, or if no résumé is submitted.

If "Provide Only" is specified, provide and deliver the pipe, coupling bands and end sections to the storage location shown in the Contract Documents.

If "Install Only" is specified, KDOT will provide the pipe, coupling bands and end sections. The location of the materials is shown in the Contract Documents.

If neither "Provide Only" or "Install Only" is designated, provide and install the pipe, coupling band and end sections as shown in the Contract Documents.

Use Grade 3.0 concrete to construct headwalls for erosion pipe. Perform formwork, placing, curing and protection of concrete according to **DIVISION 700**.

If aluminum pipe or aluminized corrugated steel pipe is to come in contact with fresh portland cement concrete or grout, completely cover the contact area of the pipe with an asphaltic paint (approved by the Field Engineer) to prevent corrosion.

b. Excavation.

(1) General. Beginning at the outlet end and proceeding toward the upper end, excavate the bottom of the channel to the line, grade and elevation shown in the Contract Documents. Construct the width of the trench sufficient to lay and backfill the pipe with a minimum width equal to the diameter of the pipe plus 6 inches on each side.

Follow OSHA safety regulations for sloping the sides of excavations. Use shoring and bracing as required.

Do not disturb any railroad, existing street or highway, when tunneling underneath is required (See **SECTION 819** for tunneling, jacking or boring requirements). Methods of tunneling are subject to Engineer approval.

When it is required to remove an existing street or highway surface in constructing the pipe or sewer, replace the surface with an equivalent material at Contractor's expense, unless otherwise shown in the Contract Documents.

Firm the foundation in the trench to prevent subsequent settlement. Remove soft, unstable materials and replace with suitable materials. If the foundation is on firm earth, pare or mold the earth to give full support to each pipe for a depth a minimum of ¼ the external diameter of the pipe. When bell and spigot pipe is used, cut notches to receive the bell.

The Contractor may undercut the trench and backfill with sand or other suitable material to obtain proper, uniform bearing of the pipe at no additional cost to KDOT.

If rock is encountered, remove the rock to an elevation 12 inches below the elevation shown in the Contract Documents for the bottom of the channel. If blasting is used to remove rock, take the precautions to protect the previously placed portions of the structure. Backfill and compact the bottom 12 inches of the excavation with soil from the roadway excavation. If the foundation is in rock, place an equalizing bed a minimum of 6 inches thick of well-compacted sand or similar material upon the rock.

When shown in the Contract Documents, or ordered in writing by the Engineer, place a concrete cradle or encasement under or around the pipe to provide a suitable foundation for the pipe. Use the dimensions and grade of concrete as shown in the Contract Documents, or as directed by the Engineer.

(2) Pipes and Culverts 3 feet or less in diameter. While excavating, use a template to shape the bottom of the channel so that at least 10% of the overall height of the pipe or culvert is in contact with the bottom of the channel. Excavate recesses into the channel to accept all protrusions from the perimeter of the pipe or culvert.

Alternate methods of bedding the pipe or culvert:

- Place a bed of granular material (4 inch minimum thickness) on the bottom of the channel, and then use a template to shape the granular material to accept the culvert.
- Place the pipe or culvert on the bottom of the channel, then place and tamp granular material (4 inch minimum thickness) under the haunch area of the pipe or culvert.

(3) Pipes and Culverts greater than 3 feet in diameter. Excavate recesses into the channel to accept all protrusions from the perimeter of the pipe or culvert. After the pipe or culvert is placed on the bottom of the channel, place and tamp granular material under the haunch area of the pipe or culvert so that 20% of the overall height of the pipe or culvert is bedded in the granular material.

An alternate method of bedding the pipe or culvert is to place and compact a bed of granular material (approximately half the total quantity needed) on the bottom of the channel, then use a template to shape the granular material to accept the pipe or culvert. Place and tamp the remainder of the granular material after the pipe or culvert is placed so that 20% of the overall height of the pipe or culvert is bedded in the granular material.

(4) Polyethylene (PEP) and Polyvinyl Chloride (PVCP) Pipe. Excavate and form a bed for PEP and PVCP according to **subsections 817.3b.(1)** thru **(3)** and the following additions and exceptions:

- The minimum trench width = (1 ½ x pipe diameter) + 12 inches.
- The space between the pipe and the trench wall shall be wider than the compaction equipment used in the pipe zone.
- The trench width in unsupported, unstable soils will depend on the size of the pipe, the stiffness of the backfill and insitu soil, and the depth of cover.
- Place a 6 inch (minimum) equalizing bed of pipe backfill (PB) upon the foundation as specified in **SECTION 1107**.

c. Laying. Do not lay pipe until the Engineer approves the foundation bed.

(1) General. When placing 2 or more pipe culverts adjacent to each other, separate the pipe culverts by a distance equal to a minimum of ½ the diameter of the pipe. The minimum distance for pipe culverts is 18 inches, and the minimum distance for metal arch culverts is 24 inches.

Before installing corrugated steel pipe, repair any damage to the metallic coating on the pipe. Clean the damaged area to bright metal by blast cleaning, power disk sanding or wire brushing. Apply zinc-rich paint over the cleaned area. Use zinc-rich paint to repair both aluminized and galvanized coatings.

Before installing asphalt coated pipe, repair any damage to the asphalt coating on the pipe. Use material that is compatible with the original asphalt coating. The repaired area shall have the same thickness as the original asphalt coating. For erosion pipe, weld any bends or angles prior to applying the asphalt coating.

In finished trenches, start laying pipe at the outlet end so the spigot ends (when bell and spigot pipe is used) point to the direction of flow. Install all pipes true to line and grade, with ends abutting. When using multiple sections of pipe in an individual run, place the longest section at the upstream end, the next longest section at the outlet end, and shorter sections in the middle of the run. When installing spiral, corrugated pipe, rotate the sections during installation so that the corrugations on the end of one section match those on the end of the adjoining section. Lay pipe in the bed so the lower portion of each pipe is supported for its entire length to a depth a minimum of ¼ the external diameter of the pipe. When laid in the trench, fit and match pipes to form a smooth, uniform invert. Carefully clean bell ends before pipes are lowered into the trenches. Avoid unnecessary handling in the trench when lowering.

Place sections of corrugated metal pipe with the ends abutting and join with the manufacturer's coupling bands. Install and tighten the coupling bands according to the manufacturer's recommendations.

Cement joints of pipe over 24 inches in diameter with a cement mortar or plastic joint compound. Use cement mortar composed of 1 part portland cement and 3 parts fine aggregate mixed with sufficient water to form a plastic mortar. As each section of pipe is laid, clean the bell or hub of the preceding pipe and fill the bottom portion with mortar. After the pipe is placed, fill the remaining portion of the joint. Smooth finish and wipe clean the inside of the joint. After the initial set, protect the mortar on the outside from the sun using soil or other approved covering. Prepare and apply plastic joint compound according to the manufacturer's recommendations.

On 24 inch or smaller RCP's, use plastic joint compound to join the sections.

(2) Polyethylene (PEP) and Polyvinyl Chloride (PVCP) Pipe. Install PE and PVC pipes according to **subsection 817.3c.** and the following additions and exceptions:

- Assemble PEP and PVCP according to the manufacturer's instructions, starting at the downstream end.
- Properly assemble the gasketed bell and spigot joints to prevent the infiltration of soil fines.

- The maximum allowable opening is 1 inch.
- If the opening is greater than ⅛-inch, the bell channel length shall be 4 times the size of the opening.

d. Concrete Headwalls. Construct headwalls for erosion pipe with Grade 3.0 concrete. Formwork, placing, curing and protection of the concrete shall comply with **DIVISION 700**. Place reinforcing steel as shown in the Contract Documents.

e. Backfilling.

(1) General. Do not begin backfilling the pipe until the Engineer approves the pipe installation. Backfill all trenches and excavated areas with suitable material without disturbing or damaging the pipe. Dispose of excess material and leave the area in a neat presentable condition.

Backfill trenches within the embankment or beneath entrances, side roads, sidewalks, other intersecting traveled ways, or those designated in the Contract Documents to the required grade in layers 6 inches (maximum, compacted thickness). Compact to Type A compaction according to **SECTION 205**.

If the top of a pipe or culvert extends above the original ground line, continue the compacted backfill to the top of the pipe culvert. Place the backfill 1½ times the external diameter of the pipe on each side of the culvert for the full width of the roadway embankment. Take the necessary precautions to prevent distortion of the pipe or culvert while backfilling.

When approved by the Engineer, granular material (of sufficient moisture content and that may be adequately rolled or tamped in place) may be used for backfill material. Place granular material in uniform layers a maximum of 12 inches thick. When deemed necessary by the Engineer, terminate the granular backfill material a minimum of 8 inches below the subgrade or ground level, and use suitable soil to backfill the remaining portion.

If it is necessary for construction equipment to travel over CAP, CSP, PE or PVC before the backfill is completed above the top of the culvert, place additional backfill over the top of the pipe. Use **TABLE 204-1** as a guide.

TABLE 204-1: APPROXIMATE MINIMUM COVER OVER THE TOP OF THE PIPE

Size (inches)	Approx. Min. Cover Required for Axle Load of 18 to 50 Kip (feet)	Approx. Min. Cover Required for Axle Load of 50 to 75 Kip (feet)	Approx. Min. Cover Required for Axle Load of 75 to 110 Kip (feet)	Approx. Min. Cover Required for Axle Load of 110 to 150 Kip (feet)
CAP and CSP				
12 to 42	2.0	2.5	3.0	3.0
48 to 72	3.0	3.0	3.5	4.0
78 to 120	3.0	3.5	4.0	4.0
PE and PVC				
12 to 36	2.0	2.5	3.0	3.0
42 to 48	3.0	3.0	3.5	4.0
54 to 60	3.0	3.0	3.5	4.0

(2) Sewers. On all sewers which do not meet the requirements of **subsection 817.3e.(1), second paragraph**, carefully deposit and satisfactorily tamp the material in uniform layers a maximum of 6 inches thick until the backfill reaches the top of pipe. Backfill and tamp the remainder of the trench either in uniform layers a maximum of 12 inches thick, or completely fill the trench and settle by satisfactory methods of jetting or flushing. Continue operations until the backfill is slightly above ground level.

(3) Erosion Pipe. Install cover over the erosion pipe according to the Contract Documents. Place the cover in lifts l8 inches (maximum, loose measurement), and compact each lift to Type A compaction, **SECTION 205**. On projects where Type B compaction is required on the adjacent roadway, compact the cover according to Type B compaction, **SECTION 205**. Use hand or mechanical tampers or rollers to achieve compaction.

(4) Structural Plate Structures and Metal Pipes Greater than 60 inches. Backfill structural plate structures and metal pipes greater than 60 inches in diameter with granular backfill. Use deflection control measures, including hand tamping, to maintain the original shape of the structure.

(5) Reinforced Concrete Pipe. If the height of fill over the top of a reinforced concrete pipe is greater than 27.5 feet, place the backfill using the imperfect trench method in this manner:

- Place the reinforced concrete pipe in the excavation, as specified.

- Place and compact the earthen backfill to a height above the top of the pipe equal to the external width of the pipe.
- After the backfill is placed and compacted as specified, excavate the compacted earth from the prism directly over the pipe.
- Backfill the resulting trench with earth placed in the loosest possible condition.
- After the trench is filled with loose earth, construct the remainder of the embankment as specified in the Contract Documents.

(6) Polyethylene (PEP) and Polyvinyl Chloride (PVCP) Pipe. Backfill PEP and PVCP with either granular backfill or flowable fill, according to **subsection 817.3e.**, with these additions and exceptions:

- If the fill from the top of pipe to the top of the subgrade is 3 feet or less, backfill with granular material to the top of the subgrade.
- If the fill from the top of pipe to the top of the subgrade is greater than 3 feet, backfill with granular material to a point 1 foot above the top of the pipe.
- Prevent damaging or floating the pipe during the backfilling operations. Do not deform or damage the pipe while compacting the granular backfill. Hand tamping may be necessary adjacent to the pipe to prevent distortion.
- The maximum barrel deflection of the pipe (reduction of the barrel nominal base inside diameter) shall not exceed 5%. Use a mandrel to measure the barrel deflection of the pipe. Take the measurement at least 30 days after the installation and backfilling. If oversized diameter pipes are installed, actual inside pipe diameters may need to be considered. Remove, reinstall or replace any pipes deformed more than 5%.

A minimum of 30 days following the installation and backfilling, measure the barrel deflection of each pipe run.

Measure the deflection using a mandrel or any other device (approved by the Engineer) that can physically verify the dimensions of the pipe and is not limited by poor lighting, water-flow, pipe length or other limiting conditions of the installed environment. Measure the deflection in the presence of the Engineer.

Pipes larger than 24 inches may be entered and deflection levels measured directly. Take a measurement once every 10 feet for the length of the pipe.

If a mandrel is used for the deflection test, use a 9 (or greater odd number) arm mandrel, sized to the actual inside diameter of the pipe installed, and inspected by the Engineer prior to testing. Use a properly sized proving ring to check or test the mandrel for accuracy. Pull the mandrel through the pipe by hand with a rope or cable. When applicable, incorporate pulleys into the system to change the direction of pull so that inspection personnel need not physically enter the pipe or manhole.

If any pipes deform between 5% and 7.5%, conduct an evaluation (by a licensed Professional Engineer) and submit to the Engineer for review and approval. In the evaluation consider the severity of the deflection, structural integrity, environmental conditions and the design service life of the pipe. The Engineer may require removal, reinstallation or replacement of the pipe where the evaluation indicates that the deflection could be problematic.

The maximum barrel deflection of the pipe (reduction of the barrel based on the actual inside diameter) is 7.5%. Remove and reinstall or replace, as directed by the Engineer, any pipes deformed more than 7.5%.

c. Cast Iron Pressure Pipes for Sanitary Sewers. Handle according to this specification with the following additions and exceptions.

(1) Handling. Do not injure the pipe or pipe coating. Do not place any pipe or material inside of a pipe or fitting after the coating is applied.

(2) Cutting. Cut the pipe without damaging.

(3) Placing and Laying. While suspended in the sling and before lowering into the trench, the Engineer will inspect the pipe for defects by tapping lightly with a hammer. Damaged pipe will be rejected. Carefully embed the pipe with bell holes excavated so each pipe will rest firmly upon its bed for the full length. After placing a length of pipe in the trench, hold the packing material for the joint around the bottom of the spigot so the packing enters the bell as the pipe is pushed into position. Center the spigot in the bell and push the pipe into position in the required alignment. Lay pipe with the bells facing the direction of laying, except where necessary in making connections with other lines. Position a minimum of 2 lengths of pipe ahead of each joint, with packing installed and earth fill tamped alongside the pipe before the joint is poured, except at closures.

(4) Joints. Before jointing bell and spigot pipe, remove all lumps, blisters, excess coating materials, oil and grease from the bell and spigot ends of the pipe. Rub with a wire brush, wipe clean and dry the outside spigot and inside of the bell. Carefully place the packing, and tightly caulk to a uniform thickness. No loose or frayed ends of fiber may protrude into the space to be filled with joint filler. Carefully inspect each joint and check for proper depth before the joint runner is attached. The depth of load in lead filled joints shall be a minimum of 2 ¼ inches back of the face of the bell. In a melting pot near the joint to be poured, heat lead to the proper temperature so that when stirred the surface will show a rapid change in color. Before pouring lead, remove all scum. On the outside of the pipe, dam the pouring gate with clay to fill the joint even with the top of the bell. Make each joint with 1 pour completely filling the joint space. Caulk toward the joint gate to secure tight joints without overstraining the bells. If the packing has been insufficiently caulked, permitting the lead to be driven to a depth more than ¼ inch from the face of the bell at any point during caulking, remove the lead and remake the joint.

d. Sanitary Sewer System. Install the sanitary sewer system as shown in the Contract Documents. Make all service connections unless specified otherwise in the Contract Documents.

Use Grade 3.5 concrete that complies with **SECTION 401** unless specified otherwise in the Contract Documents.

817.4 MEASUREMENT AND PAYMENT

The Engineer will measure all types of pipe by the linear foot, along the centerline of the pipe. Gain in pipe length due to the fit of the pipe sections at the coupling bands or joints is not measured for payment.

The Engineer will measure each end section, concrete headwall and sanitary sewer system.

The Engineer will measure fly ash slurry grout by the cubic yard.

The Engineer will not measure excavation for separate payment.

Payment for "Entrance Pipe", "Cross Road Pipe", "Erosion Pipe", "Storm Sewer", "Sanitary Sewer", "End Section", "Concrete Headwall", "Fly Ash Slurry Grout" and "Sanitary Sewer System" at the contract unit prices is full compensation for the specified work.