

Section 401. CULVERTS

401.01 Description.

- A. **Pipe Culverts.** This work consists of constructing pipe and precast concrete box culverts of the size and class specified and shall include excavation and backfilling. Pipe culverts are divided into six classes as shown in Table 401-1.

When only the size and class of culvert is specified, the Contractor may furnish any of the alternates permitted in Table 401-1.

When a particular type of culvert material is required in lieu of the classes designated in Table 401-1, the type and size of the culvert will be specified in the contract document.

A higher strength or greater thickness of culvert may be substituted for the minimum strength or minimum thickness of culvert specified.

- B. **Precast Box Culverts.** This work shall consist of the design, manufacture, and installation of a precast concrete box culvert including necessary dewatering, maintaining the water flow during construction stages, furnishing and installing gaskets to seal the culvert joints and geotextile fabric pipe wrap material to place over the exterior of the culvert joint surface. The precast concrete box sections and appurtenances shall be constructed in accordance with the details shown in the plans, and as specified herein.

Table 401-1 Pipe Alternates for Culvert Classes

Type of Pipe Depth of Cover in feet (a)	Class A Culvert 0 to 10	Class B Culvert >10 to 16	Class C Culvert >16 to 23	Class D Culvert >23 to 33 (i)	Class E Culvert 0 to 3 (b)	Class F Drive Culvert (c)
Reinforced Concrete Pipe (d)	II	III	IV	V	IV	II
Nonreinforced Concrete Pipe (e)	1	3	No	No	No	1,3 (f)
Corrugated and Spiral Ribbed Al-Alloy Pipe	Yes	Yes	Yes	Yes	No	Yes
Corrugated and Spiral Ribbed Steel Pipe	Yes	Yes	Yes	Yes	No	Yes
Smooth-Lined Corrugated Plastic Pipe (CPE) (g) (h)	Yes	No	No	No	No	Yes

- a. Cover, including the pavement structure is defined as the height of fill above the top of the pipe.
b. Class E culvert applies when the culvert is beneath the influence of proposed pavement and the depth of cover is 3 feet or less.
c. Class F culvert applies for driveway culverts (residential and commercial).
d. Roman numerals refer to class of reinforced concrete pipe, AASHTO M 170.
e. Arabic numerals in Table 401-1 refer to the class of nonreinforced concrete pipe, AASHTO M 86.
f. Nonreinforced concrete pipe class 1 is allowed for Class F culverts with a depth of cover up to 10 feet. Nonreinforced concrete pipe class 3 is allowed for Class F culverts with a depth of cover greater than 10 feet but less than or equal to 16 feet.
g. CPE shall conform to AASHTO M 294, Type S polyethylene pipe.
h. Permitted only for 24-inch diameter pipe and under for CPE pipes. Minimum cover 2 feet (measured from top of pipe to final grade). 30 and 36-inch pipe are approved for selected state projects only and installed according to the contract documents.
i. Special design is required for fill heights greater than 33 feet.

401.02 Materials. Materials shall meet the following requirements.

Concrete, Grade S2	701
Mortar, Type R-2	702
Granular Material Class II, III, IIIA	902
Coarse Aggregate 6A	902
Open-Graded Aggregate 34R	902
Asphaltic Materials	904
Culvert Pipe	909
Precast Concrete Box Culvert	909
Sealers for Culvert Joints	909
Steel Pipe (for jacking-in-place)	909
Drainage Marker Post	909
Geosynthetics	910

Closed-cell rubber extrusion type gasket shall conform to AASHTO M198.

Inserts shall be $\frac{3}{4}$ -inch diameter or approved equal.

The grout for use with jacked-in-place steel pipe shall be a mixture of Portland cement and sand shall not exceed 50 percent sand by volume.

401.03 Construction.

- A. **Design of Precast Box Culverts.** The precast box culvert shall conform to the criteria found in Division I, section 17.7 of the AASHTO Standard Specifications for Highway Bridges and current ASTM C 1433M. The joint design shall be suitable for the joint sealing material as specified herein and shall conform to section 8 of the current ASTM C 1433M Standard Specification.

When the precast concrete box culvert carries Interstate (I), United States (US) or Michigan (M) route traffic, or on and off ramps for these routes, it shall be designed to carry AASHTO HS20 Live Loads as prescribed in Table 1 and Interstate Alternate Live Loads as prescribed in Table 2 of ASTM C 1433M, whichever produces the maximum circumferential reinforcement area. As an alternative to using the design Tables, the current version of the FHWA approved BOXCAR program may be used to design the culverts.

The fabricator shall furnish documentation sealed by a Professional Engineer licensed in the State of Michigan showing the adequacy of the design.

- B. **Shop Drawings for Precast Concrete Box Culverts.** The Contractor shall submit shop drawings to the Engineer for review and approval in accordance with subsection 104.02 including the precast box culvert section, and construction details of the joints and connections. The shop drawings shall show inserts and connection details for attachment of the head walls, wing walls, aprons, and curtain walls, as detailed in the plans. The Contractor may submit shop drawings for precast head walls, wing walls, aprons, or curtain walls as an alternative to the cast-in-place end sections shown on the plans. The shop drawings shall be submitted to the Engineer at least fifteen (15) working days prior to

fabrication for review. Fabrication shall not begin until written approval of the shop drawings are received from the reviewing Engineer.

It shall be the Contractor's responsibility to call attention to all deviations from the plans, specifications and/or details. If deviations have not been clearly identified, they will not be considered a part of the shop drawing approval.

- C. **Excavation and Culvert Bedding.** Excavate according to subsection 206.03.A. Culvert bedding shall be constructed using granular material Class IIIA placed in layers not more than 10 inches in thickness and each layer compacted to not less than 95 percent of maximum unit weight for the entire length of the culvert. Where rock or hardpan is encountered, excavate the trench to a minimum of 6 inches below the proposed bottom of the pipe, backfill with granular material Class IIIA and compact.

The limits and the depth of culvert bedding for the proposed box culvert structure shall be as shown on the plans. The materials used for the box culvert bedding shall consist of a minimum depth of 9 inches of coarse aggregate 6A (at least 80 percent crushed) covered with 3 inches of open-graded aggregate 34R. Prior to placing the 34R aggregate, the 6A aggregate shall be compacted using a minimum of three passes with a vibrating plate compactor. The 34R aggregate shall be compacted using a minimum of one pass with a vibrating plate compactor.

- D. **Repair of Damaged Coated Surfaces.** Galvanized culvert surfaces damaged in transporting, handling, or installing the pipe shall be repaired according to subsection 716.03.E at no cost to the Department. Repair of other culvert surfaces shall be as directed by the Engineer.
- E. **Laying and Jointing Pipe.** All culverts shall be laid true to the lines and grades given, bells or grooves up grade, ends fully and closely jointed, and each section shall have a full, firm bearing throughout its length. All pipe sections/joint assemblies for use in culverts shall be selected from the Qualified Products List. A field assembly diagram shall be provided to the Engineer. Pipes with diameters greater than 24 inches shall have the pipe joints wrapped with a geotextile blanket. The geotextile blanket shall have a minimum width of 3 feet and shall be centered on the joint.

Joints for smooth lined corrugated plastic pipe (CPE) shall be provided with homing marks to indicate correct joining of the pipe and joint material during field installation.

The Engineer shall select at least fifty percent of the installed length of each size of smooth lined corrugated plastic pipe to be tested for deformation by the Contractor using a nine point mandrel. The mandrel shall have an effective diameter equal to 95 percent of the nominal pipe diameter. The Contractor shall provide the Engineer with a proving-ring to verify mandrel size. The Contractor shall perform the mandrel testing after the required compaction of the trench backfill has been achieved. Conduct the mandrel testing between 5 and 10 working days prior to pavement surfacing or completion of final grade, except as otherwise approved by the Engineer. Pipe with diameter reduced by 5 percent or more shall be removed and either re-installed, if the pipe is not damaged, or replaced at no cost to the

Department. Such pipe shall not be re-installed without prior approval from the Engineer. The Contractor will be responsible for all expenses and delays due to the replacement of deformed or damaged pipe. Pipe damaged by the Contractor's operations shall be removed, replaced and mandrel tested at the Contractor's expense.

Reinforced concrete elliptical pipe shall be installed with the longer axis placed horizontally unless otherwise specified.

Type HE elliptical pipe shall be installed with the longer axis placed within ± 5 degrees of horizontal.

Type VE elliptical pipe shall be installed with the longer axis placed within ± 5 degrees of vertical.

Circular concrete pipe with elliptical reinforcement shall be installed with the lift holes on top of the pipe. The manufacturer's marks designating the top and bottom of the pipe shall not be more than 5 degrees from the vertical plane through the longitudinal axis of the pipe. After the pipe is installed, the lift holes shall be sealed with concrete plugs and waterproofed.

Culvert sections showing signs of settlement or poor alignment, as determined by the Engineer, shall be taken up and relaid at the Contractor's expense.

When extending a pipe culvert, a concrete collar with a minimum thickness of 3 inches extending 6 inches each side of the joint shall be cast around the connection. The connecting joint shall then be wrapped with a 3-foot wide strip of geotextile blanket centered on the joint. An angle bolt dimple band is allowed instead of a concrete collar on the first connection when extending an existing corrugated metal pipe with a corrugated metal pipe if the existing culvert is in good condition and circular in cross section. Other methods of connecting to the existing pipe shall be approved by the Engineer prior to construction. All remaining joints of the extension shall meet the watertight requirements of MTM 723.

Wedge lock dimple bands are not allowed for corrugated metal pipe.

Dissimilar types of base metal (steel or aluminum alloy) or dissimilar types of coatings on steel (zinc or aluminum) shall not be used in a single line of pipe, except zinc coated steel end sections may be used with aluminum coated steel pipe. All coupling bands shall be of the same base metal and coating metal as the pipe.

All joints for precast concrete box culvert sections shall conform to the following requirements: The space between the box culvert joints during placement of box sections is filled with closed-cell rubber extrusion type gaskets conforming to AASHTO M 198. The gasket size and installation methods shall be as recommended by the manufacturer and approved by the Engineer. Every precast concrete box culvert exterior joint shall be treated, after placing the box culvert sections to the required line and grade, with cold applied culvert joint sealer and covered with a 2-foot wide strip of geotextile blanket centered on the joint.

F. Backfilling.

1. **Pipe Culvert.** All culverts within the limits of the roadbed shall be backfilled with granular backfill material Class II, III, or IIIA placed in layers not more than 10 inches in thickness and each layer compacted to not less than 95 percent of maximum unit weight. Culverts or portions of culverts outside the limits of the roadbed shall be backfilled with material approved by the Engineer that can be compacted to not less than 95 percent of maximum unit weight, contains no organic material and has a maximum unit weight of at least 95 pounds per cubic foot. A minimum of 3 feet of cover, except when trimming for final grades, shall be maintained at all times.

The backfill material for smooth lined corrugated plastic pipe shall be granular material Class IIIA to a minimum of one foot above the pipe and as detailed in the plans. Class II backfill may be used one foot above the pipe. The backfill shall be placed in layers not more than 10 inches or $\frac{1}{2}$ the pipe diameter, whichever is least. The backfill shall be placed equally on opposite sides of the pipe at the same time.

Staking or other methods to restrain the pipe may be necessary during the backfilling operation to maintain the line and grade of the culvert.

2. **Box Culvert.** Backfill for precast concrete box culvert shall be granular material Class II placed according to subsection 206.03. Backfill must be placed and compacted on opposite sides of the culvert at the same time.

The Contractor shall submit to the Engineer the manufacturer's minimum fill depth required for construction traffic over the culvert. The Contractor is responsible for any construction traffic on the culvert. Construction traffic loads shall not exceed the specified design loads. The Contractor shall replace damaged units at no additional cost to the Department.

- G. Headwalls and End Sections.** The ends of the culvert shall be protected by headwalls or end sections constructed according to details on the plans. Headwalls shall be constructed according to applicable requirements in section 706.

Precast concrete end sections shall be used on concrete culverts. Footings, when required, for precast end sections may be either precast or cast-in-place concrete construction. They shall be formed or placed at the locations and to the elevations required by the plans.

The wing walls and apron for precast concrete box culverts shall be constructed with a positive connection to the adjoining precast section using $\frac{3}{4}$ inch diameter threaded bars or as shown on the plans. The inside edges between the wing walls and sidewalls and top slab and face of the headwall shall be formed with a radius as shown on the plans. The box culvert sections shall be laid in stages to coincide with maintaining traffic, dewatering, temporary pumping and part width construction sequence and as approved by the Engineer. Precast wing walls, headwalls, and aprons are acceptable alternatives for cast-in-place wing walls, headwalls, and aprons.

Metal end sections shall be used on corrugated metal pipe culverts. Metal end sections shall be attached to the ends of corrugated metal pipe by means of standard metal bands or other connecting devices as detailed on the plans or as approved by the Engineer. Toe plates shall be furnished and installed on the metal end sections when called for on the plans.

End sections for use with corrugated plastic pipe shall be either precast concrete or metal end sections. Plastic end sections are not allowed. End sections shall be fastened securely to the pipe as recommended by the pipe manufacturer or as directed by the Engineer. The Contractor may elect to furnish a metal end section that is one size larger in diameter than the corrugated plastic pipe. The end section shall be slipped over the end of the pipe and securely fastened, making sure that the portion of the plastic pipe left exposed is less than 3 inches. If a concrete end section is used, the joint will be wrapped with a strip of geotextile blanket 3 feet wide and centered on the joint.

End section grates for culvert end sections shall be furnished and installed on designated culvert end sections. Grates shall be fabricated from any grade of weldable hot-rolled steel bars, plain or deformed, of the diameter and configuration specified on the plans. They shall be securely fastened to the concrete end sections as called for on the plans.

Salvaged end sections shall be placed according to the specifications for placing new end sections.

- H. **Drainage Marker Posts.** Drainage marker posts shall be placed at headwalls and culvert end sections on culverts 36 inches in diameter or less and at all outlet endings.
- I. **Pipe Culverts Jacked-in-Place.** This work consists of jacking into place a pipe culvert of the size and type detailed on the plans.

The culvert shall be jacked into place to the line and grade shown on the plans or as established by the Engineer.

Excavation ahead of the pipe shall be minimized to prevent caving of the earth. A steel cutting edge or shield may be attached to the front section of pipe to form and cut the required opening for the pipe.

The approach trench shall be large enough to accommodate at least one section of pipe, jacks, and blocking. Two rails or sills shall be laid in the bottom of the trench to keep the pipe at the established line and grade. When jacking pipe under railroad tracks, sheeting and bracing plans for the jacking pits shall be submitted through the Engineer for approval by the railroad company. Excavation of the jacking pit shall not start until the approval has been received.

Voids between the excavation and the pipe shall be filled using materials and placing methods, as approved by the Engineer.

- J. **Steel Pipe Jacked-in-Place.** This work shall consist of jacking steel pipe in place to serve as a carrier pipe or a casing for a carrier pipe. Steel pipes shall be jacked in place as specified in subsection 401.03.
- K. **Steel Casing Pipe.** Steel casing pipe installed in a trench shall meet the requirements as detailed on the plans. Steel casing pipes placed for future use shall be provided with a temporary bulkhead at each end to prevent infiltration into the pipe.
- L. **Corrugated Steel Culvert.** Dissimilar type of base metal (steel or aluminum alloy) or dissimilar types of coatings on steel (zinc or aluminum) shall not be used in a single line of pipe.
- M. **Disposal of Surplus Material.** Disposal of surplus material shall be as specified in subsection 205.03.P.
- N. **Cleanout.** All culverts installed on the project shall be maintained and shall be free of silt, debris, and other foreign matter above the existing flow line of the drainage course at the time of final acceptance.
- O. **Video Inspection.** Video inspection of culverts shall be completed as described for sewers in subsection 402.03.K. Video inspection is not required for extension of existing catch basin leads of less than 20 feet and sewers 36 inches in diameter or greater.
- P. **Dewatering and Maintaining Stream Flow During Construction.** All dewatering or pumping and temporary drainage for maintaining stream flow during construction shall be done so as to avoid damage to adjacent property or structures and without interfering with the rights of the public, owners of adjacent properties, vehicular traffic or the work of other contractors. Dewatering or temporary pumping shall be done in such a manner that the soil under and adjacent to existing structures is not disturbed.

All water from dewatering operations or from maintaining stream flow must be directed to a filter bag before discharging to an existing drainage facility. Overloading or obstructing existing drainage facilities will not be permitted.

401.04 Measurement and Payment.

Contract Item (Pay Item)	Pay Unit
Culv, CI <u> </u> , <u> </u> inch	Foot
Culv, CI <u> </u> , (<u>material</u>), <u> </u> inch	Foot
Culv, Precast Conc Box, (<u>span</u>) foot by (<u>rise</u>) foot	Foot
Culv, Reinf Conc Ellip, CI <u> </u> , (<u>rise</u>), inch by (<u>span</u>) inch	Foot
Culv, CSP Arch, CI <u> </u> , (<u>span</u>) inch by (<u>rise</u>) inch	Foot
Culv Bedding	Cubic Yard
Culv Bedding, Box Culv	Cubic Yard
Culv, Slp End Sec, (<u>Slope</u>), <u> </u> inch, Longit	Each
Culv, Slp End Sec, (<u>Slope</u>), <u> </u> inch, Transv	Each
Culv, Slp End Sec, Arch Pipe, (<u>Slope</u>), <u> </u> (<u>span</u>) inch by (<u>rise</u>) inch, Longit	Each

Culv, Slp End Sec, Arch Pipe, (Slope), (span) inch by (rise) inch, Transv	Each
Culv, Slp End Sec, Ellip Pipe, (Slope), (rise) inch by (span) inch, Longit	Each
Culv, Slp End Sec, Ellip Pipe, (Slope), (rise) inch by (span) inch, Transv	Each
Culv End Sec, (material), — inch	Each
Culv End Sec, — inch	Each
Culv End Sec, — , — inch	Each
Culv End Sect, Footing	Each
Culv End Sec, Grate	Pound
Culv, Cl — , — inch, Jacked-in-Place	Foot
Steel Casing Pipe, — inch, Jacked-in-Place	Foot
Steel Casing Pipe, ___ inch, Trench Det	Foot
Dr Marker Post	Each
Culv End Sec, Salv, 30-inch or less	Each
Culv End Sec, Salv, over 30-inch	Each

A. Pipe Culvert.

1. **Culvert** of the diameter, class and/or material specified will be measured by length in feet excluding the length of end section as detailed on the plans. Payment for culverts includes excavating the material down to grade or to the culvert bedding bottom elevation, dewatering and maintaining the stream flow during construction stages, disposing of excess material, furnishing and placing the culvert and geotextile strip, mandrel testing when required, and furnishing, placing, and compacting the backfill. The cost of providing temporary cover and restraining the pipe to maintain line and grade shall be included in the item of work.
2. **Culv, Jacked-in-Place** of the size and type specified, will be measured by length which shall be determined by multiplying the number of units actually jacked by their commercial laying length. Payment includes all items necessary to complete the work including the pit, sheeting, bracing, jacking equipment, drainage, safety devices, and all other items associated with the operation.

B. Box Culvert.

1. Payment for **Culv, Precast Conc Box**, shall include all work required to design, manufacture, and install the precast elements. This contract item shall include cold applied culvert joint sealer, closed-cell rubber extrusion type gaskets, geotextile pipe wrap for box culvert joints, inserts for the size of bars specified, dewatering and maintaining the stream flow during construction stages. Excavation and backfill will be paid for separately.
2. **Culv Bedding** shall be compacted in place to the depth, length, and width as shown on the plans or directed by the Engineer to provide a stable foundation for the culvert.

Payment for **Culv Bedding, Box Culv**, shall include all labor, equipment, and material necessary to place and compact the Coarse Aggregate 6A and Open Graded Aggregate 34R.

If precast wing walls, head walls, aprons, or curtain walls are used in lieu of cast-in-place wing walls, head walls, aprons, and curtain walls, they shall be paid for as the corresponding pay items for the cast-in-place wing walls, head walls, aprons, and curtain walls as detailed in the contract plans.

- C. **Culv Bedding** and **Culv Bedding, Box Culv** will be measured by volume in cubic yards compacted in place to the depth, length, and width directed by the Engineer as necessary to provide a stable foundation for the culvert. Payment for **Culvert Bedding** includes the cost of excavating and disposing of the unsuitable material and furnishing, placing, and compacting the bedding material. When rock excavation is required, it will be paid for separately according to subsection 205.04.

D. **Culvert End Sections.**

1. **Culv, Slp End Sec** of the size and shape specified includes furnishing and placing the end section including the longitudinal and cross tubes.
2. **Culv End Sec, (Material)** of the size and type required includes furnishing and placing the end section. Riprap required will be paid for according to subsection 813.04.
3. Metal end sections will be paid for as **Culv End Sect, Metal** of the size required. The length of culvert represented by the "c" dimension, which is detailed on the plans, is included in the length of **Culv End Sec, Metal**. Payment includes the cost of furnishing and placing the end section and a toe plate, if specified on the plans.
4. Footings required for precast concrete end sections will be paid for as **Culv End Sec, Footing**. Payment for the work includes all excavation, forming, furnishing and placing the steel reinforcement, and furnishing, placing, finishing, and curing the concrete for the footing according to the plans.
5. When corrugated plastic pipe is furnished, the end section will be paid for as **Culv End Sec** of the diameter specified for the culvert, even when the Contractor furnishes a metal end section larger than the nominal diameter of the pipe. The cost of fastening the end section to the pipe is included in the payment for the end section.
6. Payment for **Culv End Sec, Salv** of the diameter specified, shall include removing the existing end section, salvaging and storing, and re-installing as required. **Culv End Sec Grates** will be measured by weight in pounds as indicated on the plans for the size of grate specified.
7. End sections which become damaged during salvaging or replacing shall be replaced with the same size of end section as the original and all costs of replacement shall be borne by the Contractor.

- E. Headwalls will be measured and paid as steel reinforcement and concrete, Grade S2, according to subsection 706.04. If precast wing walls, headwalls, and aprons are used in lieu of cast-in-place wing walls, headwalls, and aprons, they shall be paid for as the corresponding pay items for the cast-in-place wing walls, headwalls, and aprons as detailed in the contract documents.
- F. Whenever steel pipe is jacked in place to act as a casing at the option of the Contractor, it will not be paid for separately and any required grouting between the carrier and casing pipes will be included in payment for the carrier pipe.
- G. Payment for **Steel Casing Pipe** of the size and trench detail shown shall include all excavation and backfill necessary to complete the item. Payment for pipe inserted into the casing shall be paid for at the unit price for pipe installed in trench. Payment shall include casing chocks, inserting the pipe, and grouting as required to install the carrier pipe.
- H. **Video Taping Sewer and Culvert Pipe** will be measured and paid for according to Subsection 402.04.