

**SECTION 02520****PIPE, STRUCTURAL PLATE PIPE AND PIPE ARCH, AND BOX CULVERTS****02520.01 GENERAL****A. Description**

Pipe culvert and storm drain installation shall include, but not necessarily be limited to, furnishing and installing gravity pipe, fittings, and appurtenances of the size and type shown on the Plans, installed on firm foundation true to line and grade in accordance with the Contract Documents.

**B. Related Work Included Elsewhere**

1. Protection of the environment; Section 01500.
2. Trench excavation, backfill, and compaction; Section 02250.
3. Storm drainage structure installation; Section 02530.

**C. Quality Assurance**

1. Materials
  - a. The Engineer will inspect all materials before and/or after installation to ensure compliance with the Contract Documents. When specific materials test are called for in the referenced standards and specifications, the Engineer will have the option of requiring that any or all of these tests be performed for materials furnished for a specific project. When testing is required, it will be specified in the "Special Provisions".
  - b. Corrugated polyethylene drainage tubing, pipe, and fittings shall be homogeneous throughout and free from foreign inclusions, cracks, creases, or uneven pigmentation.
  - c. Class PS 50 polyvinyl chloride (PVC) pipe and fittings shall be homogeneous throughout and free from foreign inclusions, cracks, creases, flaws, or other injurious defects. Pipe and fittings shall be as uniform as commercially practical in color, opacity, and other physical properties.
  - d. Precast reinforced concrete box sections shall be free from fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint; surface defects indicating honeycombed or open texture; defects that indicate imperfect proportioning, mixing, and molding; or damaged or cracked ends where such damage would prevent making a satisfactory joint.

- e. Reinforced concrete culvert and storm drain pipe and fittings and arch and elliptical pipe shall be free from fractures or cracks that extend through the wall of the pipe or fitting; surface defects indicating honeycombed or open texture; defects that indicate imperfect proportioning, mixing, and molding; damaged or cracked ends where such damage would prevent making a satisfactory joint; or any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more.

Materials and finished product testing shall be in accordance with AASHTO M 170, M 206, or M 207 as detailed in AASHTO T 33, and as specified herein. Acceptability of pipe through 54-inch diameter, or with a maximum 54-inch rise, and classes produced in accordance with design tables found in AASHTO M 170, M 206, or M 207, or the modified and special designs permitted therein, shall be determined by results of a three-edge bearing test for a load to produce a 0.01-inch crack. If the load exceeds the requirements before the 0.01-inch crack is reached, the load may be relieved and the pipe accepted for use. For pipe 60-inch diameter, or with a 58-inch rise, and larger, acceptance will be based on materials tests specified in AASHTO M 170, M 206, or M 207.

- f. Corrugated metal culverts, pipe, and pipe arches shall be free from defects due to uneven laps; elliptical shaping; variation from a straight center line; ragged or diagonal sheared edge; loose, unevenly lined or spaced rivets or spot welds; poorly formed rivet heads or lack seams; unfinished ends; illegible brand; lack of rigidity; bruised, scaled, or broken metallic coating; or dents or bends in the metal itself.
- g. Cast iron soil pipe and fittings shall be sound and without defects that might impair its service. Repair of defects by welding or other methods will not be allowed if such repairs adversely affect the serviceability of the pipe or fitting.

## 2. Field Tests

- a. General

No testing will be conducted on pipe, structural plate pipe or pipe arch, or box culverts installed in accordance with this Section; however, the work will be visually inspected.

After installation, storm drains and culverts will be inspected by the Engineer for compliance with these Specifications. Inspections will be conducted at least 15 days after the section of pipeline being inspected has been backfilled in accordance with Section 02250.03

b. Visual Inspection

All equipment necessary for the inspection will be furnished by the County, however, the Contractor shall provide assistance as may be required to enable the County to perform the inspection.

The Engineer will inspect all pipe and culverts for alignment, grade, and condition. The inspection may be conducted by crawling or walking through the pipeline, or using mirrors to reflect light through the pipeline.

- 1) If a mirror test is used, the pipe alignment will be acceptable if it is sufficiently true and straight to allow passage of the reflected light with an image of a “full moon”.
- 2) The pipeline shall be installed on a continuous grade so it does not pond or trap water anywhere along the line.
- 3) The pipeline shall not contain excessive amounts of debris, silt, earth, gravel, rock, or other foreign material.
- 4) Any pipe not properly installed shall be taken up and relaid without additional compensation.

**D. Submittals**

1. Shop Drawings

Shop drawings shall be submitted as specified in the "General Provisions" for the various types of pipe and culverts specified in Section 02520.02. The shop drawings shall include: product information, material strength "type" or “class”, joint type, and storage, handling, and installation recommendations or erection diagrams for structural plate pipes and pipe arches.

2. Certificates of Compliance

Certificates of compliance shall be submitted in accordance with the "General Provisions" for pipe, culverts, and bituminous sealer for concrete pipe specified in Section 02520.02. The certificate shall state that the item furnished has been manufactured in accordance with, and meets the requirements of, the standard referenced.

**02520.02 MATERIALS**

**A. Materials Furnished by the County**

The County will not furnish any materials for drain pipe, structural plate pipe or pipe arch, or box culvert installation.

**B. Contractor's Options**

None.

**C. Detailed Material Requirements**

1. Pipe, structural plate pipe, and pipe arch and box culverts shall meet the requirements of the referenced standards or specifications:
  - a. Corrugated polyethylene drainage tubing, type PS 28 - AASHTO M 252
  - b. Corrugated polyethylene pipe, 12 to 24-inch diameter - AASHTO M 294
  - c. Class PS 50 polyvinyl chloride (PVC) pipe - AASHTO M 278
  - d. Precast reinforced concrete box sections for culverts, storm drains, and sewers with less than 2 feet of cover subject to highway loadings - AASHTO M 273
  - e. Precast reinforced concrete box sections for culverts, storm drains, and sewers - AASHTO M 273
  - f. Reinforced concrete culvert, storm drain and sewer pipe - AASHTO M 170
  - g. Reinforced concrete arch culvert, storm drain, and sewer pipe - AASHTO M 206
  - h. Reinforced concrete elliptical culvert, storm drain, and sewer pipe - AASHTO M 207
  - i. Metallic (zinc or aluminum-zinc alloy) coated corrugated steel culverts and underdrains - AASHTO M 36
  - j. Bituminous coated corrugated metal culvert pipe and pipe arches - AASHTO M 190
  - k. Precoated galvanized steel culverts and underdrains - AASHTO M 245
  - l. Corrugated aluminum alloy culverts and underdrains - AASHTO M 196
  - m. Structural plate for pipe, pipe arches, and arches - AASHTO M 167

- n. Aluminum alloy structural plate for field bolted conduits - AASHTO M 219
- o. Cast iron soil pipe and fittings - ASTM A 74

Class to be specified in the "Special Provisions" or on the Plans, and the material requirements based on the diameter of the pipe. Where no class of pipe is specified, Class III pipe shall be furnished.

- 2. Concrete pipe for culverts and storm drains shall be made with tongue and groove jointing and in not less than four-foot lengths. Other types of joints will be considered by the Engineer for use in the work provided the Contractor furnishes evidence satisfactory to the Engineer that the joints are equal or better than those specified.
- 3. Portland cement concrete shall be the Mix Number specified herein, indicated on the Plans, and/or Standard Details, and meet the requirements specified in Section 03310.
- 4. Mortar for pipe joints shall be as specified in Section 04100.02.
- 5. Bituminous sealer for concrete pipe joints shall be a homogeneous mixture of asphalt, mineral filler and petroleum solvents. When applied by a cold trowel, the sealer shall have adhesive and cohesive properties. Each container shall be legibly marked with a description of the contents, the manufacturer's name and the place of manufacture.

The supplier shall furnish a certified copy of the test results showing that the bituminous sealer meets the following requirements:

<u>Test and Method</u>	<u>Specification Limits</u>
Residue by evaporation nonvolatile matter, ASTM D2939 % min	70
Inorganic filler on ignition, ash content, ASTM D2939 % min	15-45

- 6. Prefomed joint for concrete circular sewer and culvert pipe shall be rubber type gaskets meeting the requirements of AASHTO M198.
- 7. The end section of corrugated metal pipe shall have annular corrugations measuring 2-2/3 inches by 1/2 inch.

**02520.03 EXECUTION**

**A. General**

- 1. Trench excavation, backfill, and compaction, and pipe bedding and haunching shall be as specified in Section 02250.

2. Pipe shall not be installed by the Contractor until the length called for at each station has been approved by the Engineer.
3. When a pipe, structural plate pipe, or pipe arch is to be laid projecting above existing ground on or in fill, the embankment shall be constructed to a height of at least 9 inches above but not more than 3 feet above the top of pipe and then a trench excavated to receive the pipe.
4. No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when there is danger of ice formation or frost penetration at the bottom of the excavation. In freezing weather, open trench length shall be kept to a minimum and the excavation promptly backfilled after the pipe has been installed.
5. Each pipe shall be bedded on a solid foundation acceptable to the Engineer. Bell holes shall be dug sufficiently large to insure that joints are properly made and the pipe is firmly bedded for the full length of the barrel.
6. All pipe shall be installed in accordance with the recommendations of the pipe manufacturer and as specified herein. These recommendations shall include maximum trench width, if more restrictive than that shown in the Standard Details; bedding requirements; backfill material and compaction, where applicable.

**B. Corrugated and Non-corrugated Plastic Pipe and Tubing**

1. All corrugated polyethylene drainage tubing and pipe shall be installed with coupled joints. Only couplings and fittings supplied or recommended by the tubing or pipe manufacturer shall be used.
2. Class PS50 PVC pipe shall be installed with one or more of the following joint systems as specified or shown on the Plans:
  - a. Elastomeric gasket joints meeting ASTM D 3212
  - b. Belled ends
  - c. Sleeve-type couplings
  - d. Stop-type couplings
  - e. Solvent cement-type joints

**C. Cast Iron and Reinforced Concrete Pipe**

1. All cast iron and reinforced concrete pipe shall be installed with cemented joints. The pipe shall be installed carefully, hubs up grade, spigot ends fully entered into the adjacent hub and true to lines and grades given. Before succeeding sections of pipe are installed, the lower half of the hub of the preceding section shall be plastered on

the inside with the cement mortar of sufficient thickness to bring the inner surfaces of the abutting pipes flush and even. At the same time, the upper half of the spigot of the succeeding pipe shall be similarly plastered with mortar. After the pipe is installed, the remainder of the joints shall be filled with similar material; and sufficient additional material shall be used to form a bead around the joint. The inside of the joint shall be wiped and finished smooth. The mortar on the outside shall be protected from the air and sun for two (2) days or until the back fill is made around the pipe. The use of 8-foot lengths of pipe handled with a single support through a lay hole through the shell of the pipe will be permitted with an approved lifting device. After installation, the lay hole shall be filled in its entirety with mortar.

2. Where indicated on the Plans or directed by the Engineer, pipe shall be encased in a 6-inch jacket of Mix No. 1 Concrete. When required, the Contractor shall furnish cold weather protection for mortar joints and concrete encasements by maintaining a temperature of not less than 40°F for a period of 3 days, or backfill immediately and maintain a temperature of 40°F inside the pipe for a period of 3 days.
3.
  - a. As an alternate to mortared joints for concrete culvert, storm drain, and sewer pipe, bituminous sealer, rubber type gaskets, or resilient type material may be used under the prescribed conditions. Care shall be exercised to insure the proper application of sealer on the underside of all joints.
  - b. Bituminous sealer shall not be applied when the air temperature is less than 35°F unless provision is made to preheat it before use, such as storage at normal room temperature or immersion of the containers in a warm water bath prior to use. Care shall be exercised to insure the proper application of sealer on the underside of all joints.
4. Joints between sections shall be caulked with one or more rings of oakum, jute or hemp. The jointing material shall then be firmly applied into the joint space until flush with the outer rim of the bell or barrel of tongue-and-groove section, after which additional sealer shall be applied to form a bead around the joint.

**D. Corrugated Metal Pipe**

1. When any type of corrugated metal pipe sections are connected on the work, the ends shall be butted together and the sections joined with a standard band, which shall be bolted firmly in place. Pipe sections or fittings shall not be cut with a torch.
2. Spiral corrugated metal pipe sections shall be butted together and joined with an approved metal band.

**E. Pipe Connections**

Where shown on the Plans, pipe connections shall be constructed. These connections shall be for any pipe size, type or alignment and shall be of two basic types.

1. Prefabricated Pipe Connection. This type connection shall be prefabricated by the pipe manufacturer and delivered to the project for installation. It shall include reinforced concrete pipe, corrugated metal pipe, structural plate pipe, pipe arches, and box culverts.
2. Field Pipe Connection. This type shall be fabricated at the site during the installation of the pertinent pipe culverts. It shall include connections of new pipe culverts to existing pipe culverts when specified. A field connection shall include cutting a hole in one pipe, inserting and trimming the connecting pipe and pouring a concrete collar at the connection. In the case of corrugated metal pipes, a welded connection may be substituted for the concrete collar. Backfill may be placed immediately after installing pipe, provided the mortar joints are protected with building paper or other approved material.

**F. End Treatments**

The following requirements apply to all types of pipe culverts except structural plate pipes and structural plate pipe arches:

1. The ends of pipe culverts placed askew shall be cut off flush with the end wall.
2. Endwalls on the inlet ends of pipe, when built to grade and visible from the roadway, shall be constructed parallel to the roadway; askew pipe shall protrude through the endwall.
3. Endwalls on the inlet ends of pipes, when not built to grade and not visible from the roadway, shall be constructed normal to the centerline of the pipe. Embankment slope faces, in case of askew pipes, will not be warped. The area between endwall and normal slope will be filled to 3 inches below top of endwall and the area sloped to drain.
4. Endwalls on the outlet end of pipes, when used, shall be constructed as noted above.

**G. Structural Plate Pipes and Pipe Arches**

This paragraph is intended to describe structural plate pipes and pipe arches, which structures differ from pipe culverts hereinbefore mentioned, in that they are usually of greater size and are composed of curved plates usually bolted together in the field. The plates must be shop fabricated to required dimensions and having all required holes and be shipped complete with proper markings and including all necessary connection devices, such as bolts, nuts, washers, etc. Culvert structures with beveled or skewed ends shall be detailed by the producer and the detailed drawings submitted to the Engineer. An erection diagram shall be submitted to the



Engineer for all structural plate pipes and pipe arches. No fabrication shall be performed until shop drawings are reviewed and approved by the Engineer.

1. Plates

Plates shall consist of structural units of galvanized corrugated metal. Single plates shall be furnished in standard sizes to permit structure length increments of 2 feet. (Plates have approximately a 2-inch lip beyond each end crest, which results in the actual length of a given structure being approximately 4 inches longer than the nominal length, except when skewed or beveled).

2. Gages

The gages for plates will be specified in the Contract Documents for each location. The plate configurations shall have radii and curvature in accordance with AASHTO requirements. When bottom plates are specified to be thicker than top and side plates, the thicker plates for circular pipes shall cover at least 25% of periphery of the circle. For pipe arches, the thicker plates shall include corner plates as well as bottom plates.

3. Erection

The plates at longitudinal and circumferential seams shall be connected by bolts. Joints shall be staggered so that not more than three plates come together at any one point. Each plate shall be curved to one or more circular arcs.

- a. Plates shall be formed to provide lap joints. The boltholes shall be punched so that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross sectional dimensions of the finished structure shall be as indicated on the Plans or as specified.
- b. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be staggered in rows 2 inches apart, with one row in the valley and one in the crest of the corrugations. Boltholes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12 inches. The minimum distance from center of hole to edge of the plate shall be not less than one and three quarter times the diameter of the bolt. The diameter of the boltholes in the longitudinal seams shall not exceed the diameter of the bolt by more than 1/8 inch.
- c. Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs, shall present a workmanlike finish. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

- d. The method of erection will vary with the size of the structure. The structural plates shall be assembled in accordance with the recommendations of the manufacturer and/or reviewed and accepted detailed shop drawings. The structures may be partially assembled and then placed on the prepared foundations. If the structures are to be preassembled other than at the job site, the materials and construction procedure shall be in strict accordance with the specification requirements contained herein. Whenever two or more sections of the structure are to be assembled at the job site, care shall be exercised to insure proper matching and aligning of joints. Where such procedure is allowed, the length of the assembly shall not exceed that which permits lifting, moving, and depositing of the section without any bending or distortion or stress being induced therein.

4. Foundation Preparation

- a. Excavation and bedding shall be in accordance with Section 02520.03, Article A. It is very important that templates be set at convenient intervals and the foundation screeded to be coincidental with the exact shape of the bottom plates. Screeding shall be done immediately prior to erection.
- b. In some cases, the prepared foundation must be cambered to allow for possible settlement of underlying strata supporting the foundation because the part of the structure under the deepest fill will deflect greater than under the slopes. Therefore, before preparing any foundation, the Contractor is responsible for conferring with the Engineer to ascertain anticipated need for camber, as well as the amount thereof.

5. Bolting

All bolting and tightening of nuts shall be done with impact wrenches. Each nut and bolt shall be tightened to a minimum of 100 foot-pounds and not to exceed a maximum of 200 foot-pounds of torque. The impact wrenches shall be equipped with a device to assure that the number of foot-pounds of torque applied is between these minimum and maximum limits.

- a. The plates composing the bottom of the structures may be bolted together in positions outside of the permanent one. In this case, the bottom sections may be bolted in lengths as limited above and placed on the prepared foundation. Plates composing sides and tops shall then be erected and bolted. In any event, all plates (bottom, etc.) must be in their proper positions. Bolts shall be placed in all holes, unless otherwise specified.
- b. Where washers are specified or required, they shall be placed under the nuts. In preliminary assembly, the bolts shall first be scattered or distributed over the section being assembled and holes made to align by shifting the plates; and the nuts shall not be drawn tight until the section is assembled and ready

for placing. For bottom plates, the nuts may be inside the structure, if necessary. After placing and before backfilling or coating, all nuts shall be finally tightened and tested to assure compliance with torque requirements.

**6. Backfilling**

- a. Backfilling shall be as specified in Section 02250.03 with additional precaution that backfills are elevated uniformly along each side of the structure. For structures without headwalls, backfill shall be commenced in the center of the structure. If the structure includes headwalls or spandrel walls, backfilling operation may commence at one wall and extend toward the opposite side, care being taken in all cases to bring embankment or sections thereof up evenly on each side to a height of not less than 18 inches above top of the structural plate pipe structure.
- b. No trucks or construction equipment shall be allowed to pass over any part of a structural plate pipe structure until the backfill has been completed and tamped up to a height of not less than 18 inches above the structure. In all cases, the fill material shall be thoroughly but not excessively tamped.

**7. Strutting**

Where specified, structural plate pipe structures shall be strutted with timber posts. In such cases, the table for strutting will be shown on the Plans. If no strutting table is shown, it shall be the Contractor's responsibility to prepare a suggested table of strutting sizes and spacings which is subject to approval by the Engineer before strutting begins. The strutting shall be done in combination with the use of approved jacks so the structure's rise is changed by the proper amount. When strutting is specified, it shall be uniform from end to end. Struts shall be left in place until backfills are completed, unless their removal is otherwise permitted by the Engineer. All removal of struts shall be done by the contractor, and the Contractor shall receive and dispose of all removed materials.

**8. Concreting**

When specified on the Plans or in the "Special Provisions", the invert of structural plate pipe or pipe arch shall be paved using Mix No. 2 concrete. The dimensions of the invert paving will be detailed on the Plans.

The concrete shall be cured in accordance with the requirements of Section 03300.03 using burlap. Cold weather protection shall be performed in accordance with the requirements of Section 03300.03.

**9. Multi-cell Installations**

Where batteries or multi-cell installations of structural plate pipe structures are specified, the foregoing provisions shall be used with extra requirements as follows:

- a. In backfilling, backfills between cells shall be elevated equally on each side of each cell.
- b. Individual cells may be erected for their full length before beginning another cell, or the entire structure may be erected in sections so that the total length of the total structure is completed at approximately the same time.
- c. Structural plate pipe structures shall have at their termini cutoff walls, endwalls, headwalls, or slope protection. The details and type of end protection shall be as shown on the Plans, and construction shall be in accordance with the pertinent item.

**10. End Treatment**

- a. Ends of structural plate pipe arches shall be shop fabricated on a bevel to fit and be flush with the slope and alignment of the surface through which they protrude, except that where an endwall or masonry slope protection is specified the ends of the structural plates shall then be shop fabricated to fit that construction. Beveled ends shall not be used on skews of 70° or less angle (between center line of stream and center line of road). The ends of all structural plate pipes and pipe arches which require an end treatment (endwall or slope protection) shall contain hook bolts for anchorage into the concrete.
- b. Endwalls for structural plate pipes and pipe arches, unless otherwise specified, shall be constructed parallel to the alignment of the edge of the adjacent road shoulder.

**H. Box Culverts**

1. The precast reinforced concrete box sections shall be produced with male and female ends. The ends shall be of such design and the ends of the box sections so formed that when the sections are laid together they will make a continuous line of box sections with a smooth interior free of appreciable irregularities in the flow line.
2. Box section shall be installed with mortared joints, bituminous sealer, rubber type gaskets, or resilient type material. The inner surfaces of the abutting sections shall be flush and even. Mortared joints shall be protected from the air, sun, and freezing, and bituminous sealer protected from cold temperatures as specified in Section 02520.03, Article B.

**I. Connections to Existing Structures**

1. Holes for installing new pipes in existing structures shall be carefully cored, drilled, or cut in such a manner to minimize damage to the structure. Any damage to the existing structure shall be promptly repaired to the satisfaction of the Engineer or the structure replaced. Reinforcing steel in precast manholes and inlets shall be cut only to the extent necessary to accommodate the new pipe.
2. The new pipe shall be roughly centered in the hole and the pipe end set flush with the inside wall. The entire space between the pipe and the wall shall be filled with brick and mortar so as to make it watertight.

**02520.04 METHOD OF MEASUREMENT**

**A. Pipe and Box Culverts**

The number of linear feet of pipe and box culverts installed will be determined by measurement of pipe, pipe arch, or box culvert installed in place, completed and accepted, which measurement will be along the centerline of the conduit from end to end of each completed pipe line without deduction for manholes, structures, or fittings.

**B. Structural Plate Pipe Structures**

Structural plate pipe structures will be measured in linear feet as follows: measure top length and bottom length. The average of these two lengths will be the pay length for each pipe in the structure. Such lengths of all pipes will be totaled to obtain the total pay length.

**C. Portland Cement Concrete**

Measurement for furnishing and installing concrete for encasements will be made in cubic yards of concrete placed to the limits indicated in the Standard Details or as directed.

**02520.05 BASIS OF PAYMENT**

**A. General**

1. Payments will be made at the unit and/or lump sum prices bid. The prices bid shall include furnishing all labor, tools, equipment, and materials necessary to complete the work as shown, and specified in strict accordance with the Contract Documents, and accepted by the Engineer.
2. The prices bid for furnishing and installing pipe, structural plate pipe and pipe arch, and box culverts shall include the following:

- a. Trench excavation, backfill, compaction, and incidental items as specified in Section 02250.
  - b. Furnishing and installing granular pipe bedding materials as shown on the Standard Details and as required elsewhere in the Contract Documents.
3. Payment will be made for contingent items when ordered by the Engineer. Payment will be as specified in Sections 02951, 02952, 02953, 02954, 02955, 02956, and 02957.

**B. Pipe, Structural Plate Pipe and Pipe Arch, and Box Culverts**

Payment for furnishing and installing pipe, structural plate pipe and pipe arch structures, and box culverts will be made per linear foot for the particular type of completed conduit specified on the Plans or as directed by the Engineer. The price bid shall include all galvanizing, invert paving, connecting to existing structures, cut-in pipe connections, and bends.