

**CITY OF MEMPHIS – STANDARD CONSTRUCTION SPECIFICATIONS**  
**SECTION 02641 REINFORCED CONCRETE BOX CULVERTS**

**PART 1 – SCOPE**

This work shall consist of the construction of box culverts of the kinds and dimensions shown on the Plans, stipulated in the Contract Documents, or as directed by the Owner. The construction shall be accomplished in accordance with these Specifications and in conformity with the lines, grades, cross-sections, and details shown on the Plans or established by the Owner. The work shall include such labor, material, equipment, bedding, connection to other drainage structures, and all other items as may be necessary to complete the box culverts as shown on the Plans.

**PART 2 – MATERIALS AND EQUIPMENT**

2.01 MATERIAL

A. New Material.

All materials shall be subject to sampling, testing, and approval or rejection by the Owner. Unless otherwise specified, all materials incorporated into the work shall be new and unused in previous construction. Used materials, acceptable to the Owner, may be used for trench bracing, forms, falsework, and similar uses.

B. Manufacturer's Qualifications.

The source of supply for each material to be supplied by the Contractor shall be subject to approval by the Owner before delivery. Precast box culvert sections shall be the standard product of a manufacturer of established, good reputation in the industry and manufactured in a permanent plant adapted to meet the specified design requirements of the culvert.

C. Inspection and Testing.

1. Representative samples of materials intended for incorporation in the work shall be submitted for examination when so specified or requested by the Owner. All materials to be used in the work shall be sampled, inspected, and tested in accordance with current ASTM specifications, or other specified standard specifications. The Contractor shall furnish the Owner with three copies of certified reports from a reputable testing laboratory showing the results of the tests carried out on representative samples of materials delivered and to be used in the project. The performance or cost of all testing is incidental to the work and shall be done at no cost to the City.

2. The Contractor shall notify the Owner in advance of any deliveries of the materials and shall make whatever provisions are necessary, including the furnishing of such labor as may be required to aid the Owner in the examination, inspection and culling of the materials on the site prior to installation in the work.

3. All materials not conforming to the requirements of these Specifications shall be considered as defective and rejected for use and shall be removed from the site of the work.

D. Storage.

The Contractor shall provide such storage facilities and exercise such measures as will insure the preservation of the specified quality and fitness of materials to be incorporated in the work.

E. Concrete.

Box culverts shall be constructed of Class P Concrete as defined in Specification Section 03050.

F. Steel Reinforcement.

Deformed steel reinforcing bar shall conform to ASTM A 615 for Grade 40 or Grade 60 and shall be of the grades, sizes, and dimensions and at the designated spacings and locations shown on the Plans, as per ASTM C 850 for precast culverts, or as directed by the Owner. Welded wire fabric conforming to ASTM A 185 shall have a minimum yield strength of 65,000 psi and fabric conforming to ASTM A 497 shall have a minimum yield strength of 70,000 psi and shall be of the

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size, design, and weight and at the locations shown on the Plans, as per ASTM C 850 for precast culverts, or as directed by the Owner. All steel reinforcement and its storage and handling shall be as specified in Specification Section 03310.

G. Filter Cloth and Fasteners.

1. The filter cloth material for weep hole drainage system shall be pervious sheets of strong, rot-proof plastic fabric meeting the following Specifications:

<u>Physical Property</u>	<u>Test Method</u>	<u>Acceptable Test Results</u>
Tensile Strength, wet, lbs	ASTM D-1682	90 (min)
Elongation, wet, %	ASTM D-1682	40 (min)
Coefficient of Water Permeability, cm/scc	Constant Head	0.10
Puncture Strength, lbs	ASTM D-751	40 (min)
Pore Size – EOS	Corps of Engineers	40 (max)
U.S. Standard Sieve	CW-02215	

2. The Contractor shall furnish a certified laboratory test report from an approved testing laboratory with each shipment of materials. Laboratory test reports shall include actual numerical test data obtained on this product.

3. Pins may be any commercially available pin 6 inches in length capable of retaining a washer.

4. Washers may be any commercially available washer 2 inches in diameter and compatible with the pin.

H. Washed Gravel.

1. Washed gravel for weep hole drainage system shall be crushed stone or washed gravel meeting the quality requirements of ASTM D 692 and one of the following grading requirements:

	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4	No. 8	No. 16
1.	100	95-100	----	25-60	----	0-10	0-5	----
2.	----	100	90-100	20-55	0-15	0-5	----	----
3.	----	----	100	90-100	40-70	0-15	0-5	----
4.	----	----	100	90-100	40-75	5-25	0-10	0-5
5.	----	----	----	100	85-100	10-30	0-10	0-5

I. Weep Hole Drain.

1. Perforated and nonperforated tubing and fittings for weep hole drainage system shall be of the diameter specified on the Design Standards or as directed by the Owner and of only one pipe material for the entire job.

2. Perforated and nonperforated polyethylene corrugated tubing and fittings shall meet the requirements of AASHTO M252 and M294.

2.02 EQUIPMENT

All equipment required for the satisfactory performance of the work shall be on the project and approved before work will be permitted to begin.

**PART 3 – CONSTRUCTION REQUIREMENTS**

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3.01 CAST-IN-PLACE CONSTRUCTION.

A. General.

The requirements for concrete formwork, falsework, reinforcement, placing concrete, removal of forms and falsework, removal of defective concrete, and curing and protection of concrete as defined in Specification Section 03310, "Concrete Structures" shall apply to the construction of cast-in-place reinforced concrete box culverts except as modified in this section of the Specifications. Concrete materials, proportioning, mixing, and delivery shall conform to Specification Section 03050, "Portland Cement Concrete". The subgrade shall be carefully shaped to the culvert section and grades shown on the Plans and compacted to provide a firm foundation for the structure in conformance with Specification Section 02631.

B. Bedding.

Bedding for reinforced concrete box culvert when required by the Owner or on the Plans shall consist of 12 inch thickness of washed gravel shaped and compacted to conform to the shape of the bottom of the culvert and extended a minimum of 6 inches beyond the outside face of the culvert walls on each side.

C. Construction Joints.

Sidewalls and top slabs for box culverts shall be constructed monolithically. Using this method of construction, any necessary construction joints shall be vertical at right angles to the axis of the culvert. Unless otherwise specified on the Plans, transverse contraction joints in box culverts shall be plain butt joints and longitudinal reinforcement shall extend across the joint. Contraction joints shall be spaced at intervals of 30 to 40 feet. The location of joints shall be predetermined, and when practical, shall be placed at changes in the box section. These joints will be located parallel to the main reinforcing steel in the slab and not necessarily perpendicular to the axis of the box culvert.

D. Finish.

Sidewalls and bottom of top slabs shall be given a Class 1, ordinary surface finish and the bottom slab and top of slab, unless otherwise specified on the Plans, shall be given a Class 3, float finish as defined in Specification Section 03310 Paragraph 3.11.

E. Invert.

The bottom slab of box culverts shall be constructed with a "V" shaped invert as shown on the Plans and Design Standard.

F. Connecting Storm Drains.

Existing and new storm drains intercepted by box culverts shall be formed into sidewalls and cut off flush and smooth with the inside face of the wall so as to not leave an obstruction along the wall. Walls shall be poured monolithically around pipe. Intercepted drains shall be oriented at right angles to the wall or skewed in the direction of flow. Existing pipes 12 inches in diameter or smaller intercepted by the box culvert shall be extended as required for proper connection at no additional compensation. Existing pipes larger than 12 inches in diameter shall be extended as required for proper connection and paid for at the appropriate price per linear foot for the pipe. Pipe extensions shall be of the same material as the existing pipe to which it is connected, except for pipe larger than 12 inches in diameter which shall be reinforced concrete pipe unless otherwise directed by the Owner.

G. Weep Holes Drainage System.

1. Weep holes when shown on the Plans shall be constructed along the culvert walls at the locations and intervals shown on the Design Standard or as directed by the Owner. Weep holes shall be constructed of 4 inch diameter tubing. Weep hole tubing shall be cut off smoothly and flush with the interior surface of the culvert wall.

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2. The weep hole drainage system when shown on the Plans or Design Standards shall consist of a 4 inch diameter perforated drain tubing surrounded by a continuous gravel drain, and wrapped in filter cloth. A weep hole drain shall be constructed along the entire length of both culvert walls as shown on the Design Standard or as directed by the Owner. The perforated drain pipe shall be connected to a weep hole at no greater than 30 foot intervals.
3. The weep hole drain shall be at the grade shown on the Plans but shall not be less than 0.40 percent. The filter cloth shall be placed with the long dimension parallel to the centerline of the culvert and shall be laid loosely without wrinkles or creases. The filter cloth shall be installed in such a manner that all splice joints perpendicular to the culvert are provided with a minimum overlap of 3 feet. The cloth shall be placed such that the upstream strip overlaps the downstream strip.
4. The cloth shall be protected at all times during construction from contamination by surface runoff, and any cloth so contaminated shall be removed and replaced with uncontaminated cloth at the Contractor's expense. Any damage to the cloth during its installation shall be replaced by the Contractor at his own expense. Gravel overlaying the cloth shall not be dropped on the cloth from a height greater than 3 feet.
5. After the filter cloth has been properly placed, a layer of washed gravel shall be spread on the bottom of the drain and brought to a uniform grade at the flowline elevation of the drain pipe. Care shall be taken during the gravel placement operation as well as the pipe installation to prevent damage to the filter cloth. To repair a torn, punctured, or otherwise damaged section, a piece of filter cloth is cut large enough to cover the damaged area and overlap all around the damaged area a minimum of 12 inches and sewn to the cloth.
6. Perforated pipe shall be laid with the flow sector and perforations at the bottom.
7. The underdrain pipe shall be connected to the weep hole by means of a split tee of the same material as the pipe.
8. After the pipe has been laid and inspected, the backfilling shall be carefully done so that the pipe will not become displaced. The backfilling around the pipe shall be with the washed gravel specified. Unless otherwise designated on the Plans, the gravel backfill shall be a minimum of 4 inches on each side of the pipe and 12 inches over the pipe.
9. The overlap of the filter cloth closure at the top of the drain system shall be at least 12 inches and secured with mechanical ties.

H. Access Shaft.

Access shafts provided with standard manhole rim and cover shall be constructed at locations shown on the Plans or as directed by the Owner in conjunction with the box culvert with openings provided in top slab. Shafts shall be constructed such that one inside face of the shaft is flush with the inside face of cone culvert wall. The shaft shall be constructed of brick or concrete at the Contractor's option. All shafts shall be provided with steps spaced and staggered in accordance with Specification Section 02640 Paragraph 3.02.A. Access will be paid for separately. Rim and cover will be paid for as provided in Specification Section 02640.

I. Test Specimens.

The Contractor shall furnish the concrete necessary for casting test specimens in the field. The City will supply all molds and labor necessary to cast and test the specimens. The Owner will designate the frequency of sampling the fresh concrete. The method of making and curing test specimens will be in accordance with AASHTO Designation T 23. Test cores shall be drilled by the Contractor at his expense if required by the Owner at locations selected by the Owner.

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J. Backfilling.

Backfill shall not be placed until representative test samples of the concrete used in the culvert attain the compressive strength required on the Plans. In addition, the concrete shall have been placed a minimum of 7 days (not counting days of 24 hours each when the temperature is below 40 degrees F.) or 21 calendar days whichever comes first. Backfill shall be carried up simultaneously behind the sidewalls to maintain uniform loading. Backfill above and around the filter cloth closure shall be of suitable nonporous material. Placement and compaction of the backfill and final cleanup shall be in accordance with Specification Section 02631.

3.02 PRECAST CONCRETE BOX CULVERTS.

A. General.

When indicated on the Plans or authorized by the Owner, the Contractor may substitute Precast Box Sections for the cast-in-place design presented in the Plans. When so authorized, the Contractor will be required to furnish design criteria, drawings, calculations, designs, details, and other documentation which the Owner may require before approval to proceed. Precast box culvert sections must meet all requirements of ASTM C 850 as applicable and shall be constructed with a "V" shaped invert in the bottom slab. Transitions in box culvert size shall be cast-in-place construction.

B. Bedding.

When precast box sections are approved, trench excavation shall be deepened to provide for a 12 inch bed of washed gravel on which the culvert will be placed. This bedding shall extend a minimum of 6 inches beyond the outside face of the walls and be thoroughly compacted and graded to a smooth surface to receive the units.

C. Laying and Joining.

Precast units shall be laid in accordance with manufacturer's recommendations. Joints between units shall be plastic or butyl joints constructed in accordance with Specification Section 02632 Paragraph 3.02.D. No composition or asphalt base joint material shall be used to seal joints. The Contractor shall have the necessary equipment to properly place and join the units without damage to the structure.

D. Multiple Barrel Installation.

When two or more precast culverts are constructed side by side, a 2 inch width of mortar shall be placed between barrels for their full depth. Diversion walls shall be constructed of Class A concrete at either end of the structure.

E. Precast Openings.

1. Precast box culvert sections must be cast with openings for connecting storm drains, weep hole drainage system, and access shafts. Annular space between the culvert walls and connecting storm drain will be filled with nonshrinking grout for the full wall thickness.
2. Construction of connecting storm drains, weep holes, and access shafts shall be as specified for cast-in-place culverts in this Section of the Specifications.

F. Wingwalls and Headwalls.

End sections, wingwalls, and headwalls shall be poured in place with Class A concrete reinforced as required. The Contractor shall submit detailed plans of the end treatment designed to meet plan conditions at the upstream and downstream ends of the structure.

G. Backfill.

Backfill for precast box culverts shall be placed and compacted as specified for cast-in-place culverts in this Section of the Specifications.

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**PART 4 – MEASUREMENT**

**4.01 CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERTS.**

Cast-in-place reinforced concrete box culverts will be measured for payment per linear foot measured along the centerline of the culvert for the various inside width, height and invert dimensions specified in the Contract Documents. Transitions from one culvert size to another will be measured for payment per linear foot for the larger culvert size. Headwalls, wingwalls, aprons, and parapet walls shall be measured and paid for in accordance with Specification Section 02640 Part 4.

**4.02 PRECAST REINFORCED CONCRETE BOX CULVERTS.**

Precast reinforced concrete box culverts will be measured for payment per linear foot measured along the centerline of the culvert for the various inside width and height and invert dimensions specified in the Contract Documents. Headwalls, wingwalls, access shafts, and aprons when required shall be measured and paid in accordance with Specification Section 02640 Part 4. Diversion walls for multiple barrel installations will not be measured for payment.

**4.03 STANDARD DEPTH ACCESS SHAFTS.**

Standard depth access shafts will be measured per each, for the various sizes and types less rim and cover. Standard depth is defined as an access shaft between 0 and 6 feet as measured vertically from the top of the rim to the top of the culvert.

**4.04 EXTRA DEPTH ACCESS SHAFT**

Extra depth access shaft will be measured per vertical foot from a point 6.0 feet from the top of the rim to the top of the culvert for the various sizes and types. Only access shafts greater than 6.0 feet in depth will be considered for extra depth measurement.

**PART 5 – PAYMENT**

**5.01 CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERTS.**

The accepted quantities of cast-in-place reinforced concrete box culverts will be paid for a the contract unit price per linear foot complete in place for the various sizes which price will be full compensation for excavation, foundation preparation and bedding, utility protection, materials and materials' testing, forming, steel reinforcement, concrete placement, form removal, finishing, curing, drain connections 12 inches in diameter and smaller, weep hole drainage system, backfilling and all other material, labor and equipment necessary to complete the item.

**5.02 PRECAST REINFORCED CONCRETE BOX CULVERTS.**

The accepted quantities of precast reinforced concrete box culverts will be paid for a the contract unit price per linear foot complete in place for the various sizes which price will be full compensation for excavation, foundation preparation and bedding, utility protection, furnishing and installing precast sections including jointing, diversion walls, drain connections 12 inches in diameter and smaller, weep hole drainage system, backfilling and all other material, labor and equipment necessary to complete the item.

**5.03 STANDARD DEPTH ACCESS SHAFTS.**

The accepted quantities of standard depth access shafts will be paid for at the contract unit price per each complete in place for the various sizes and types less rim and cover which price will be full compensation for materials and materials' testing; excavation; special protection; placing, protection and curing of concrete; laying, plastering, protection and curing of brick work; placing and jointing precast sections; construction of steps; cleaning and inspection; and backfilling.

**5.04 EXTRA DEPTH ACCESS SHAFTS.**

The accepted quantities of extra depth access shafts will be paid for at the contract unit price per vertical foot complete in place which price will be full compensation for materials and materials' testing; excavation; special protection; placing, protection and curing of concrete; laying, plastering, protection

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and curing of brick work; placing and jointing precast sections; construction of steps; cleaning and inspection, and backfilling.

5.05 PAYMENT WILL BE MADE UNDER:

<u>Item No.</u>	<u>Pay Item</u>	<u>Pay Unit</u>
02641-01	CAST-IN-PLACE REINFORCED CONCRETE BOX CULVERTS	Linear Foot
02640-01.____.____	H / I x W Cast-In-Place Box Culvert	Linear Foot
<u>Item No.</u>	<u>Pay Item</u>	<u>Pay Unit</u>
02641-02	PRECAST REINFORCED CONCRETE BOX CULVERTS	Linear Foot
02641-02.____.____	H / I x W Precast Box Culvert	Linear Foot
02640-03	STANDARD DEPTH ACCESS SHAFTS	Each
02640-03.01.____.____	____' x ____' Standard Depth Cast-in-Place Access Shaft (0' – 6' Deep) Less Rim and Cover	Each
02640-03.02.____.____	____' x ____' Standard Depth Brick Access Shaft (0' – 6' Deep) Less Rim and Cover	Each
02640-03.03.____.____	____' x ____' Standard Depth Precast Concrete Access Shaft (0' – 6' Deep) Less Rim and Cover	Each
02641-04	EXTRA DEPTH ACCESS SHAFTS	Vertical Foot
02640-04.01.____.____	____' x ____' Extra Depth Cast-in-Place Access Shaft	Vertical Foot
02640-04.02.____.____	____' x ____' Extra Depth Brick Access Shaft	Vertical Foot
02640-04.03.____.____	____' x ____' Extra Depth Precast Concrete Access Shaft	Vertical Foot

**END OF SECTION 02641**