

ITEM 603 PIPE CULVERTS, SEWERS, AND DRAINS

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603.01 Description. This work consists of constructing or reconstructing long span structures, pipe culverts, sewers, and drains (referred to below as Type A, Type D, Type E, and Type F conduit).

Use removed or excavated materials in the Work when the material conforms to the specifications; if not, then recycle or dispose of the material according to 105.16 and 105.19.

603.02 Materials. Furnish materials conforming to:

- Soil and granular embankment 203.02.R
- Structural backfill, Types 1 and 2..... 703.11

The Engineer will allow Type 3 structural backfill, conforming to 703.11, to be used as bedding below the pipe only when pumping operations do not control severe ground water problems. Place at least 12 inches (300 mm) of Type 1 structural backfill on top of the Type 3 structural backfill to prevent piping.

- Embankment 203.02.R
- Concrete for collars and encasement,
Class C 499 and 511
- Concrete for field paving using
aggregate No. 7, 8, or 78, Class C 499 and 511
- Reinforcing steel (collars and encasement)..... 509.02
- Mortar 602
- Non-shrink mortar..... 705.22
- Bituminous pipe joint filler..... 706.10
- Resilient and flexible gasket joints for:
Concrete culvert 706.11
Vitrified clay, B & S 706.12
- Preformed butyl rubber joint filler..... 706.14
- 4x4 - W1.4 x W1.4 galvanized
welded wire fabric for field paving..... 709.08
- Type 2 membrane waterproofing 711.25

Type 3 membrane waterproofing	711.29
Fabric wrap, Type	712.09
Joint wrap	ASTM C 877
Buried Liner Waterproofing Membrane.....	711.22

Furnish pipe of the size and kind specified in the Proposal and conforming to applicable subsections of 706 and 707. The metric equivalent pipe size may vary with material type for the same English size pipe. The difference in sizes shall not be construed as an exclusion of a material type. The kinds of pipe allowed for each of the designated types of conduit are as follows:

Type A Conduits - Culverts:

Non-reinforced concrete pipe, Class 3	706.01
Reinforced concrete pipe	706.02
Reinforced concrete pipe, epoxy coated.....	706.03
Reinforced concrete elliptical pipe	706.04
Precast reinforced concrete box sections.....	706.05
Precast reinforced concrete 3-sided flat topped culverts	706.051
Precast reinforced concrete arch sections	706.052
Vitrified clay pipe (extra strength only)	706.08
Corrugated steel conduits	707.01 or 707.02
Structural plate corrugated steel structures	707.03
Precoated, galvanized steel culverts	707.04
Bituminous coated corrugated steel pipe and pipe arches with paved invert	707.05 or 707.07
Corrugated aluminum alloy pipe	707.21 or 707.22
Aluminum alloy structural plate conduits.....	707.23

Type B Conduits - Not Used

Type C Conduits - Not Used

Type D Conduits - Drive pipes and bikeways:

Non-reinforced concrete pipe, Class 3	706.01
Reinforced concrete pipe	706.02
Reinforced concrete elliptical pipe	706.04
Vitrified clay pipe (extra strength only)	706.08
Corrugated steel conduits	707.01 or 707.02
Structural plate corrugated steel structures	707.03
Corrugated aluminum alloy pipe	707.21 or 707.22
Aluminum alloy structural	

603.03

plate conduits..... 707.23
Corrugated polyethylene
smooth lined pipe 720.12
Polyvinyl chloride corrugated
smooth interior pipe 720.10
Polyvinyl chloride solid wall pipe..... 720.08

Type E Conduits - Miscellaneous small drain connections and headers:

Non-reinforced concrete pipe 706.01
Reinforced concrete pipe 706.02
Reinforced concrete elliptical pipe 706.04
Concrete drain tile, extra quality 706.07
Vitrified clay pipe 706.08
Clay drain tile, extra quality 706.09
Corrugated steel conduit 707.01 or 707.02
Corrugated aluminum alloy pipe 707.21 or 707.22
Corrugated polyethylene
smooth lined pipe 720.12
Polyvinyl chloride plastic pipe
(non-perforated)..... 720.07
Polyvinyl chloride corrugated
smooth interior pipe 720.10
Polyvinyl chloride solid wall pipe..... 720.08

Type F Conduits - Conduits on steep slopes; underdrain outlets:

Corrugated steel conduits
(steep slope conduit), Type C 707.05 or 707.07
Corrugated aluminum alloy pipe
(steep slope conduit)..... 707.21 or 707.22
Corrugated polyethylene
smooth lined pipe (underdrain outlets) 720.12
Polyvinyl chloride plastic pipe
(non-perforated underdrain outlets) 720.07
Polyvinyl chloride corrugated
smooth interior pipe (underdrain outlets) 720.10
Polyvinyl chloride solid wall pipe
(underdrain outlets) 720.08

603.03 Definitions. For the purposes of this specification, the following definitions are used:

- A. Long span structure includes all of the following material kinds: 706.05, 706.051, and 706.052.
- B. Plastic pipe includes all of the following material kinds: 720.01, 720.07, 720.08, 720.10, and 720.12.
- C. Corrugated metal pipe includes all of the following material kinds: 707.01, 707.02, 707.03, 707.04, 707.05, 707.07, 707.13, 707.14, 707.21, 707.22, and 707.23.
- D. Not used

- E. Rigid Pipe includes all of the following material kinds: 706.01, 706.02, 706.03, 706.04, 706.08, and 706.09.
- F. Conduit includes long span structures, pipe, culverts, sewers, drains, or any other item specified herein.
- G. Backfill is soil, granular embankment, or structural backfill placed above the bedding to the elevation as described.
- H. A cut situation is an existing field situation when the top of the conduit is below the existing ground where an embankment may be constructed.
- I. A fill situation is an existing field situation when the top of the conduit is above the existing ground where an embankment is to be constructed.
- J. A fill situation meets the requirements of a cut if the fill is constructed to at least 2 feet (600 mm) above the top of the conduit before placing the conduit.
- K. The conduit rise is the vertical distance from outside wall to outside wall or outside corrugation measured at the middle of the conduit.
- L. The conduit span is the horizontal distance from outside wall to outside wall or outside corrugation measured at the widest point of the conduit.
- M. The conduit spring line is equal to the rise divided by two.
- N. Trench width is the horizontal distance between the vertical walls of the trench measured in feet.

603.04 Material Provisions.

The Engineer will allow any of the following alternate material provisions:

- A. The Contractor may use Type 1 or 2 structural backfill if granular or soil embankment is required or allowed.
- B. Supply pipe of the required size or one size larger.
- C. If 707.05 or 707.07 conduit is specifically itemized or specified in the Proposal, the Contractor may provide conduit conforming to 707.04 and having a bituminous paved invert. Provide the same corrugation profile and sheet thickness listed in the Proposal.
- D. The Contractor may furnish higher strength concrete or plastic pipe of the same type where lower strength pipe is specified.
- E. The Contractor may furnish a thicker metal pipe of the same corrugation profile and type where a lesser thickness is permitted or specified.
- F. If 706.02 reinforced concrete pipe is specifically shown on the plans as “special design”, the manufacturer shall submit shop drawings and design calculations by a Registered Engineer for review and written approval before manufacture. Submit a minimum of seven copies of the shop drawings and allow a minimum of 4 weeks for approval. Include the following in the shop drawings:
 - 1. All structural design and loading information.
 - 2. All material specifications.

603.05

3. All dimensions.

Design reinforced concrete pipe based on *AASHTO LRFD Bridge Design Specifications*, Section 12.

G. If a 706.05 structure is specifically itemized or specified in the Contract, the Contractor may submit to the City for approval a request to supply a 706.051 structure placed on precast slab bottom, or a 706.052 structure placed on precast slab bottom, that is hydraulically equivalent and meets all cover requirements. The manufacturer shall submit shop drawings and hydraulic calculations by a Registered Engineer for review and approval before manufacture. The bottom slab may be cast-in-place with approval from the City; however, there will be no increase in time permitted.

H. If 706.051 or 706.052 is specifically itemized or specified in the Contract, on footers, the Contractor may substitute each one for the other upon structure approval for hydraulics and cover. The manufacturer shall submit shop drawings and hydraulic calculations by a Registered Engineer for review and approval before manufacture. If 706.051 or 706.052 is specifically itemized or specified in the Contract, on pedestal walls, the Contractor may substitute each one for the other upon structure approval for hydraulics, cover and pedestal wall design. 706.051 or 706.052 require different pedestal wall designs.

I. All 706.051 or 706.052 shop drawings require a Registered Engineer signature for design and check. The manufacturer shall submit shop drawings and hydraulic calculations to the City for review and approval before manufacture.

J. For metal pipe 54 inch (1350 mm) diameter or larger and pipe-arch, ensure the manufacturer provides match marked ends and a layout drawing.

603.05 Excavation. Measure trench width at the span of the conduit. Center the trench excavation about the centerline of the conduit.

Use Method A for a cut situation, and use Method B for a fill situation.

A. Method A. Excavate the trench for the conduit. Provide vertical trench walls.

If long span culvert is used, provide a minimum trench width of the span plus 2 feet (0.6 m) on each side.

If rigid pipe is used, provide a minimum trench width of the span times 1.33.

If plastic or corrugated metal pipe is used, provide a minimum trench width of the span times 1.25 plus 1 foot (0.3 m).

If plastic pipe is used and the ID is 8 inch (200 mm) or less, furnish a minimum trench width of the OD.

Increase these minimums to a width that allows the jointing of the conduit, and the placement and compaction of the backfill.

B. Method B. Construct the embankment to a height at least equal to half of the rise and to a width on each side of the conduit two times the span of the conduit before excavating for the conduit. Excavate the trench in the constructed embankment to a width conforming to Method A above.

Furnish a firm foundation for the conduit bed for its full length. The Engineer will require the removal of unsuitable material below the conduit bedding or below the bottom of the conduit if bedding is not required for the width of the trench. Replace the unsuitable material with structural backfill. Remove rock or shale in the conduit foundation for at least 6 inches (150 mm) below the bottom of the bedding. Replace the rock or shale with structural backfill. Unless in the contract documents, the City will pay for this work according to 109.05.

If the Engineer changes the flow line by more than one foot (0.3m), the City will pay according to 109.05.

The Contractor may jack or tunnel the pipe with the written permission of the Director.

603.06 Bedding. Type 1 bedding consists of structural backfill extending at least 6 inches (150 mm) below the bottom of the conduit for the full width of the trench. Compact the bedding according to 603.11.

Use Type 1 bedding for 706.05, or 706.051 and 706.052 on slab bottoms, or corrugated invert plates.

Type 2 bedding consists of structural backfill extending at least 3 inches (75 mm) for all 706 rigid pipe conduits and 6 inches (150 mm) for all other conduits below the bottom of the conduit for the full width of the trench. Extend the bedding up around the pipe for a depth of not less than 30 percent of the rise of the conduit. Shape the bedding to fit the conduit with recesses shaped to receive the bell of bell-and-spigot pipe. Leave the bedding below the middle one-third of the pipe span uncompacted. Compact the remaining bedding according to 603.11.

Use Type 2 bedding for Types A and D conduits except for long span structures and for conduits that require Type 3 bedding.

Type 3 bedding consists of a natural foundation with recesses shaped to receive the bell of bell-and-spigot pipe. Scarify and loosen the middle one-third of the pipe span.

Use Type 3 bedding for Type D conduits of the following materials: 706.01, 706.02, or 706.03.

Type 4 bedding consists of a natural foundation shaped to fit the conduit with recesses shaped to receive the bell of bell-and-spigot pipe.

Use Type 4 bedding for Types E and F conduits.

603.07 Laying Conduit. Lay the conduit in the center of the trench starting at the outlet end with the bell or groove-end laid upgrade. Ensure that the conduit is in contact with the bedding throughout its full length such that line and grade is maintained. Lay metal conduits according to one of the following methods:

- A. If the seam is longitudinally either riveted or welded, place the seam or weld at the spring line.
- B. If the metal pipe is fabricated helically (having a continuous seam running around the outside of the pipe), arrange the corrugations so the helix angle or twist is rotating downstream in the direction of the flow to increase hydraulic performance.

603.08

Maintain flows at all times until the new facilities are completed and in service. Maintain the flows through existing facilities to be replaced unless a temporary bypass conduit is used.

Construct the inlet and outlet ends of all conduit runs with pipe ends as normally fabricated by the manufacturer. If field cutting is necessary, locate the cut end at an interior joint within the run and provide a cradle, collar, or band to ensure a stable joint.

Construct a concrete collar on the last joint if field cutting is necessary to meet a structure or headwall.

Erect 707.03 and 707.23 conduits according to 522.03. Where two plate thicknesses are specified, locate the thicker plates at the bottom and corner plates in pipe-arch structures, and the bottom row, if centered, or bottom two rows, if not centered, in round structures.

Set the 706.051 units on the concrete footing shown on the plans. Unless otherwise shown on the plans, provide a 3-inch (75 mm) deep by 14-inch (350 mm) wide keyway in the center of the footing. Place the units in a 1/2-inch (13 mm) bed of mortar. If proper line and grade of the structure cannot be maintained on the bed of mortar, set the units on 5 × 5-inch (125 × 125 mm) masonite or steel shims. Fill the entire keyway joint with mortar.

Set the 706.052 units on the concrete footing shown on the plans. Unless otherwise shown on the plans, provide a 3-inch (75 mm) deep by 14-inch (350 mm) wide keyway in the center of the footing. Place the units on 5 × 5-inch (125 × 125 mm) masonite or steel shims to provide a minimum 1/2-inch (13 mm) gap between the footing and bottom of the unit's bottom leg. Fill the entire keyway joint with mortar.

If reinforced concrete pipe has elliptical reinforcing, the top and bottom of the pipe are clearly marked on the pipe. Handle and place reinforced concrete pipe with elliptical reinforcement and reinforced concrete horizontal elliptical pipe with single cage reinforcement with the reinforcement markings along a vertical plane as marked on the pipe. Handle and place reinforced concrete pipe with auxiliary supports (S-stirrups) with the centerline of the auxiliary support system (S-stirrups) in a vertical plane as marked on the pipe.

For 706.05, 706.051, or 706.052 structures fill the lifting devices with mortar. Cover the exterior of the lifting devices with joint-wrap material if outside the limits of the membrane waterproofing. Use joint-wrap with a minimum width of 9 inches (225 mm). Use only lifting devices that do not require a hole through the structure.

For all 707 conduit, use only lifting devices that do not require a hole through the structure.

Immediately after placing conduit, construct the end treatments at both the outlet and inlet ends. These end treatments include headwalls, concrete riprap, rock channel protection, sod or other erosion control items.

603.08 Joining Conduit. Join the conduit sections so that the ends are fully entered and the inner surfaces are flush and even. Furnish sealed, banded, or bolted joints for Types A, D, and F conduits. Provide open joints for Type E conduits wrapped with 4-

inch (100 mm) wide tarred paper or tarred burlap with pack soil placed around this material to hold it in place during backfilling.

The Engineer may allow joint materials other than those listed below, provided the Contractor demonstrates the proposed material makes durable sealed joints.

Furnish joints that do not allow infiltration of backfill material into the conduit or use a fabric wrap on the outside of the conduit.

Install conduit so that match marks align and in accordance with the layout drawings supplied by the manufacturer.

A. Joints.

1. Metal Pipe.

If using corrugated metal pipe, provide coupling bands conforming to 707.01 or 707.02. These bands will have the same coating as the pipe being joined and use gasketed coupling bands or fabric wrap the coupling bands when using structural backfill Type 2 for the bedding or backfill. A maximum difference between adjacent pipe sections of 1/2 inch (15 mm) will be allowed before coupling bands are placed. Securely strut the end of each pipe section for pipe diameters 54 inches (1350 mm) or greater that have a wall thickness of less than 0.109 inch (2.77 mm). Install the ties or strapping in the first or second valley of the annular corrugations on each end of each piece of pipe. Install two struts per end such that they are perpendicular to one another and cross at their midpoints. Strut by using wire ties or other approved methods. Remove the strutting after securing the coupling bands.

2. Rigid Pipe.

a. For 706.01, 706.02, or 706.04, 706.05, or 706.08 that require sealed joints, use any of the following methods:

i. Apply 706.10 to the pipe in sufficient quantity to completely fill the joint once the pipe is placed in its final position at a gap of 1 inch (25.4 mm) or less. After placing the pipe in its final position, point and trowel the 706.10 to form a smooth transition on the inside and a complete seal on the outside.

ii. Apply 706.14 to the pipe in sufficient quantity to seal the joint but not necessarily fill the joint once the pipe is placed in its final position at a gap of 1 inch (25.4 mm) or less. Immediately before installing 706.14, clean the joint free of all debris then prime both sides of the joint with an asphalt based primer according to the 706.14 manufacturer's recommendations.

iii. Provide 706.11 or 706.12 as specified.

b. For 706.03 conduit, use fibrated coal tar joint compound applied according to the manufacturer's recommendations.

B. Filling Joints. After placing 706.05, 706.051, or 706.052 in their final position with a maximum joint gap of 1 inch (25.4 mm), clean the joint gap or joint of all debris and perform the following:

1. For 706.05 joints, fill the top exterior joint gap and the bottom and side interior joint gap with mortar. Next, for any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 9-inch (225 mm) wide strip of joint wrap.

603.09

Center the joint wrap on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side.

2. For 706.051, fill the top keyway joint with 705.22. The side or leg joints shall also be filled with 705.22 for the key way type joint or filled per 706.05 for a tongue and groove type joint. Clean the joint of all debris immediately before installing the joint filling material. Prepare, place, and cure the 705.22 according to the manufacturer's recommendations. Wet all surfaces of the keyway joint, but do not allow excess water in the joint. Next, for any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 12-inch (300 mm) wide strip of joint wrap. Center the joint wrap on the joint. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side.

3. For 706.052, install a $7/8 \times 1\ 3/8$ -inch (24×34 mm) 706.14 joint filler along the outside joint chamfer. Use a continuous length of joint filler sufficient to extend from the bottom of the vertical face on one side to the bottom vertical face on the other side. Before installing the joint filler, prime the joint chamfer with a primer according to manufacturer's recommendations. Next, cover the exterior joint with a 9-inch (225 mm) wide strip of Type 3 membrane waterproofing centered on the joint, and then apply all waterproofing as shown on the plans. For any exterior joint not covered by membrane waterproofing, cover the exterior joint with a 12-inch (300 mm) wide strip of joint wrap. Use a continuous length of joint wrap sufficient to extend from the bottom of the vertical face on one side of the structure to the bottom vertical face on the other side.

C. Sealing Concrete Surfaces. For 706.05, 706.051, or 706.052, apply an approved epoxy sealer per the plans to all top surfaces not covered by membrane waterproofing. Extend the sealer 1 foot (0.3 m) below the backfill on all sides of the culvert sections including the joint.

The Engineer and Contractor will visually inspect all conduit and joints before any backfill is placed. Rejoin, re-lay, or replace all conduit out of joint tolerance, alignment, settled, or damaged.

603.09 Exterior Coatings and Membrane Waterproofing. Apply waterproofing to 706.05, 706.051, 706.052, 707.03, and 707.23 conduits with less than eight feet of cover by one of the following methods.

A. Coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are thoroughly sealed. The coating material and application shall conform to AASHTO M 243. Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

B. Construct Buried Liner Waterproofing Membrane protection in the fill per the manufacturer's recommendations. The Buried Liner Waterproofing Membrane protection will be a seamless continuous sheet placed over the conduit and extend at least 10 feet (3.3m) outside of the paved shoulder and for the width of the trench.

For 707.03 and 707.23 conduits, coat the exterior of the conduit above the limits of the bedding and within the limits of backfill. Ensure that all plate seams and bolts are

thoroughly sealed. The coating material and application shall conform to AASHTO M 243. Allow asphalt mastic material to dry 48 hours and tar base material to dry 28 hours before placing the conduit backfill. Rib stiffeners do not need to be coated.

Include the cost for the waterproofing and application in the unit price bid for the Item 603 Conduit.

603.10 Backfilling. Place backfill to the limits described and according to the compaction requirements. Place the backfill in the trench and embankment outside the trench uniformly on both sides of the conduit for all conduit installations.

A. General. The Contractor may operate small compaction equipment with less than a total weight of 1 ton (0.9 metric ton) over the conduit to compact the backfill. Do not use hoe packs on top of the conduit until 2 feet (0.6 m) of backfill is compacted on top of the conduit. The Contractor may operate compaction equipment with less than a total weight of 8 tons (7 metric tons), but more than 1 ton (0.9 metric ton), over the conduit after placing and compacting 2 feet (0.6 m) of backfill. Do not operate equipment with a total weight of 8 tons (7 metric tons) or more, until placing and compacting a cover of 4 feet (1.2 m) over the top of the conduit. The above restrictions apply when working within one span on each side of the conduit, or 6 feet (1.8 m), whichever is less. As shown on the plans, encase conduits with the specified thickness of Class C concrete.

B. Long Span.

1. For long span structures in cut, place and compact structural backfill over the top of the section to a minimum depth 4 feet (1.2 m) or to the subgrade elevation, whichever is less, and for a width of 2 feet (0.6 m) on each side of the section. Use soil, granular embankment, or structural backfill to construct the adjacent embankment and for the remaining depth to the subgrade. Construct the adjacent material according to Item 203.

2. For long span structures in fill, place and compact structural backfill over the top of the section to a minimum depth of 2 feet (0.6 m) or to the subgrade elevation, whichever is less, and for a width of 2 feet (0.6 m) on each side of the section. Use soil, granular embankment, or structural backfill to construct the adjacent embankment and for the remaining depth to the subgrade. Construct the adjacent material according to Item 203.

C. Type A. Backfill Type A conduits except for long span structures as follows:

1. In a cut situation, place and compact structural backfill above the bedding for the full depth of the trench. Within the trench and more than 4 feet (1.2 m) above the top of the conduit, if the trench can accommodate compaction equipment, the Contractor may construct Item 203 Embankment. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

2. In a fill situation, place and compact structural backfill above the bedding for the full depth of the trench specified in 603.05.B. Above these limits, uniformly place the lesser of one pipe span or 4 feet (1.2 m) of structural backfill on each side of the conduit and to a depth of 2 feet (0.6 m) above the top of the conduit. Construct the embankment outside the limits of the backfill. For plastic pipe with an ID 8 inch (200

603.11

mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

D. Type D. Backfill D conduits as follows:

1. In a cut situation, for plastic pipe, place and compact structural backfill above the bedding and to 12 inches (300 mm) over the top of the pipe. All other conduit material types place and compact backfill. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

2. In a fill situation, for plastic pipe, place and compact structural backfill above the bedding for the full depth of the trench specified in 603.05.B. Above these limits, uniformly place the lesser of one pipe span or 4 feet (1.2 m) of structural backfill on each side of the conduit and vertically to the top of the conduit. Then place for a depth of 12 inches (300 mm) structural backfill over the top of the pipe equal to the trench width centered on the pipe center line. Construct the embankment outside the limits of the backfill. For all other conduit material types, place and compact backfill. For plastic pipe with an ID 8 inch (200 mm) or less, place and compact structural backfill above the bedding for the full depth of the trench.

E. Type E. Place and compact backfill above the bedding to a height equal to two-thirds of the conduit rise, then place and lightly compact backfill for a depth of 12 inches (0.3 m) above the pipe. Place no stones larger than 4 inches (100 mm) that will be part of the embankment in contact with the pipe.

F. Type F. Place and compact backfill above the bedding. Backfill Type F conduits for underdrain outlets according to 605.03.C.

603.11 Placement and Compaction Requirements. Place soil, granular embankment, or Structural Backfill Type 1 or 2 in lifts not to exceed 8 inches (200 mm). The City will perform all compaction testing according to ODOT Supplement 1015. The compaction requirements per material type are as follows:

A. For soil embankment, compact each lift until 96 percent of AASHTO T 99 is achieved.

B. For granular embankment and Structural Backfill, Type 1 or 2, compact each lift of material according to 603.11.E using mechanical devices, hoe packs, jumping jacks, hand devices, vibrating plates, or other equipment that meets the restrictions in 603.10. Provide compaction equipment that compacts the material under the haunch of the pipe. If the compaction equipment cannot fully compact the material under the haunch, supplement the compaction equipment by using shovel slicing, spud bars, or mechanical spud bars to compact the material under the haunch of the pipe. Use shovel slicing and spud bars in conjunction with the compaction operations to compact the material and to manipulate the material under the haunch of the pipe.

C. For Structural Backfill Type 2, compact each lift of material according to 603.11.E using flood compaction or mechanical devices, hoe packs, jumping jacks, hand devices, vibrating plates, or other equipment that meets the restrictions in 603.10. Provide compaction equipment that compacts the material under the haunch of the pipe. If the compaction equipment cannot fully compact the material under the haunch, supplement the compaction equipment by using shovel slicing, spud bars, or mechanical spud bars to

compact the material under the haunch of the pipe. Use shovel slicing and spud bars in conjunction with the compaction operations to compact the material and to manipulate the material under the haunch of the pipe

D. Place Structural Backfill Type 3 in layers not to exceed 12 inches (300 mm) loose depth. Vibrate, tamp, or compact to approximately 85 percent of the original layer thickness.

E. At the beginning of the work, construct a test section in the conduit trench. The Engineer will use at least 96 percent of the test section maximum dry density for acceptance of the production areas. Use at least the same number of passes or compactive effort used to construct the test section to compact the production areas. Use compaction equipment with a total weight or centrifugal force of at least 1/2 ton (0.5 metric tons). Supply the manufacture's specification for the compaction equipment. Except when using a hoe pack, use at least six passes with the compaction equipment in the production areas.

The Engineer may reduce the minimum passes if the passes are detrimental to compaction.

Construct a new test section if the pipe type, bedding material, backfill material, or trench conditions change.

F. If using trench boxes with Type A conduit, configure the trench box so that the bedding and backfill material is compacted directly against the trench walls.

G. The Engineer may adjust the lift thickness to obtain the required compaction, fill all the voids, achieve the proper seating of the backfill material, and achieve the stability of the backfill material and the pipe. Do not use equipment or methods that compromise the structural integrity of the pipe.

603.12 Clearing Site and Restoring Damaged Surfaces. Immediately after completion of the placing and compacting of the backfill, remove and dispose of all surplus material according to 603.01 and clear the site and restore all required surfaces

603.13 Field Paving of New or Existing Pipe. Field pave the bottom of the conduit with concrete as shown on the plans.

For new pipe installations, do not pave until at least 4 feet (1.2 m) of fill is placed on top of the conduit, or the top of subgrade is reached. If the paving is placed before completion of the entire fill, clean any gaps between the conduit and concrete paving, then fill with heated bituminous material conforming to 705.04.

Reinforce the paving with 4 × 4-W1.4 × W1.4 galvanized welded wire fabric (or comparable). Provide a mesh with a width 4 inches (100 mm) less than the finished paving. Securely fasten the mesh to the conduit near each edge and at the center of the mesh at points not more than 4 feet (1.2 m) apart along the flow line of the culvert. Repair any damage to the galvanizing or other coating material caused by placement or by tack welding. Use wire brushing and paint with zinc rich paint to make the repairs.

For aluminum structural plate, securely fasten the mesh to the circumferential seam bolts with galvanized tie wire.

Provide a paving that is 3 inches (75 mm) thick measured from the top of the corrugations of the conduit to a height equal to 1/3 of the rise. Provide galvanized

603.14

reinforcing steel support chairs beneath the mesh where necessary. Give special care to the mesh during concrete placement. After placing the concrete, strike it off with a template to produce the proper radius, and finish with a float to produce a smooth finish. Cure the concrete according to 451.10.

603.14 Method of Measurement. The City will measure conduit by the number of feet (meters), measured from center-to-center of appurtenant small structures or between open ends inclusive of lengths of pipe bends and branches. The City will not deduct for catch basins, inlets, or manholes that are 6 feet (2 m) or less across, measured in the direction of flow. Where the location of an appurtenance or an open end is changed with the approval of the Engineer to accommodate full conduit sections, the City will measure the length placed. Conduits placed on slopes steeper than 3:1 or with beveled or skewed ends will be measured along the invert.

When the pay item calls for concrete encasement, payment for furnishing and placing the concrete encasement and for any additional excavation required shall be included in the unit bid price for the pertinent conduit. When the pay item calls for a new conduit to be field paved, payment for the field paving, including all work and materials necessary for the item, shall be included in the unit bid price for the pertinent conduit.

The City will measure field paving of existing pipe by the number of feet (meters).

603.15 Basis of Payment. The City will pay for accepted quantities at the contract prices as follows:

Item	Unit	Description
603	Foot (Meter)	___ " (___ mm) Conduit, Type ___
603	Foot (Meter)	___ × ___ Conduit, Type ___
603	Foot (Meter)	___ " (___ mm) Conduit Reconstructed, Type ___
603	Foot (Meter)	Type ___ Precast Reinforced Concrete Flat Topped Three-Sided Culvert, ___ ' (___ mm) Span × ___ ' (___ mm) Rise
603	Foot (Meter)	Type ___ Precast Reinforced Concrete Arch Sections, ___ ' (___ mm) Span × ___ ' (___ mm) Rise
603	Foot (Meter)	___ ' (___ mm) Rise × ___ ' (___ mm) Span Conduit, Type A Corrugated Steel Box Culvert, ___ ' (___ mm) Minimum Cover, ___ ' (___ mm) Maximum Cover
603	Foot (Meter)	___ ' (___ mm) Rise × ___ ' (___ mm) Span Conduit, Type ___ Corrugated Aluminum Box Culvert, ___ ' (___ mm) Minimum

		Cover, ___' (___ mm) Maximum Cover
603	Foot (Meter)	___" (___ mm) Conduit, Type ___, with Field Paving of Pipe
603	Foot (Meter)	___" (___ mm) Conduit, Type ___, Field Paving of Existing Pipe
603	Foot (Meter)	Conduit, Type F for underdrain outlets