

# **CULVERTS AND STORM DRAINS -**

## **Section 701**

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Earthwork forms a part of the installation procedures of conduit. In order to ensure an adequate foundation for such conduits, backfill material must meet certain specifications and be compacted to adequate density by acceptable methods. The use of poor soils as a bed for conduit, the failure to adequately compact soils surrounding conduit, or poor construction techniques can lead to premature failure of drainage systems, embankments, and surfacing.

The scope of this section is limited to the earthwork associated with the installation of culverts and storm drains.

### **TRENCH EXCAVATION AND BEDDING**

For all types of drainage structures, the trench must be at least 18 inches wider than the conduit on each side or as indicated on the plans. For example, the bottom of the trench must be at least 36 inches wider than the diameter of the pipe, plus wall thickness. The bottom of the trench must be graded so that the flow line of the conduit will match the flow line shown on the plans. In the case of multiple lines of conduit, the trench shall be at least 36 inches plus the outside dimensions edge to edge of the multiple lines of conduit including the plan distance between the lines of conduit.

When the trench is in suitable, stable foundation material, the trench shall conform to plan grade and dimensions.

When the excavation must be below specified grade because of unsuitable, but stable foundation material (e.g., rock, dense, heavy clay), a cushion must be formed for the conduit. The cushion must be constructed with backfill material appropriate to the type of pipe and location of the installation. The depth of the trench shall be at least one-half inch per foot of fill height over the top of the conduit. The minimum depth of excavation, regardless of fill height, shall be eight inches. For example, if 18 feet of fill are required above the top of the pipe, the trench must be excavated to a depth of at least nine inches ( $1/2 \text{ inch} \times 18 = 9 \text{ inches}$ ). For 16 feet of fill or less, the minimum depth of the excavated trench shall be at least 8 inches. (For example, if 12 feet of fill are required over the top of the pipe, even though  $12 \times 1/2 \text{ inch} = 6 \text{ inches}$ , the minimum depth of the excavated trench shall be at least 8 inches.)

When excavation must be below specified grade because of unsuitable, unstable foundation, unstable soil below established grade shall be removed and replaced. If there is no item for bedding material in the contract, the bottom of the trench shall be reconstructed with usable or selected soils conforming to Specification Subsection 203.06. Replacement material shall be compacted as directed to at least the density of the surrounding soils. If bedding material is specified, the trench shall be excavated below grade and bedding material or granular material shall be placed and constructed in accordance with the requirements of Specification Subsection 726. Even when bedding material is not specified, it may be necessary when unstable or unsatisfactory

material is encountered. Examples of unsatisfactory or unstable material include excessive moisture content, high organic content, water seepage, soft materials, and excessive P.I. **When water seepage occurs, bedding material will be required. Clay seals are not an acceptable solution.**

When no trench is to be excavated, the contractor shall construct a uniformly firm bed on which to place the pipe. The bed shall be composed of usable or selected soils conforming to the requirements of Specification Subsection 203.06 and compacted as directed to at least the density of the surrounding soils.

**SHORING** The contractor shall adhere to all state and federal guidelines in providing protection against the cave-in of any excavated area. The contractor shall not conduct operations in the trench unless adequate shoring is in place, when needed, all safety provisions are met, and all federal and state guidelines for protection are met. The safety of the excavation depends on the characteristics of the material in which the excavation is made, seepage, depth of excavation, and side slopes. Trenches shall be braced when needed to prevent the sloughing of side or top material. The contractor shall take all measures necessary to protect workers in the trench area and shall provide them with safety equipment as needed. The design of shoring in no way affects the specification density requirements for the full width and depth of the trench.

## **BACKFILL MATERIALS**

All materials shall be tested and approved prior to use.

This manual specifically addresses pipe trench and backfill construction using soil or aggregate. However, **flowable fill** is an approved backfill material composed of Portland cement, fly ash, concrete sand, and water. When specified or allowed this material must meet the requirements of Specification Section 710.

Exposed pipe backfill shall be covered with an outside layer of plastic soil blanket in accordance with Specifications Subsection 203.10. When flowable fill is used for backfill, the exposed backfill area will be covered and protected as directed.

## **SIDEDRAINS - NONPAVED AREAS**

### **Plastic Pipe**

Sidedrain trenches in which plastic pipe has been placed shall be backfilled with granular material conforming to Specification Subsection 1003.07.

### **Pipe Other Than Plastic Pipe**

Sidedrain trenches in which pipe other than plastic pipe has been placed shall be backfilled with usable soils conforming to Specification Subsection 203.06(a).

### **SIDEDRAINS - PAVED AREAS**

For backfill requirements for sidedrains under paved areas, refer to **Pipes Other Than Sidedrains**.

### **PIPES OTHER THAN SIDEDRAINS**

#### **Plastic Pipe**

Trenches in which plastic pipe has been placed shall be backfilled with granular material conforming to Specification Subsection 1003.07.

#### **Corrugated Metal Pipe**

Trenches in which corrugated metal pipe has been placed shall be backfilled with selected soil conforming to Specification Subsection 203.06(b) or granular material conforming to Specification Subsection 1003.07. Both selected soils and granular material placed as backfill for corrugated metal pipe must also meet resistivity and pH requirements. The resistivity of the material shall be greater than 1500 ohm-cm when tested in accordance with DOTD TR 429. The pH shall be greater than 5.0 when tested in accordance with DOTD TR 430.

#### **Pipe Other than Plastic or Corrugated Metal (Concrete Pipe)**

Other pipe shall be backfilled with either selected soil conforming to Specification Subsection 203.06(b) or granular material conforming to Specification Subsection 1003.07.

## **CONSTRUCTION DETAILS**

Soil and aggregate backfill material shall be of uniform characteristics and moisture content and shall be placed in lifts of uniform thicknesses. Lift thickness may require adjustment based on those characteristics, but shall not be increased above the specification requirements. Lift thickness shall be uniform both vertically and horizontally and shall be correlated with compactive effort to achieve specification density. The portions of any lifts in excess of specification requirements shall be removed and the lift recompacted. Backfill material shall be brought up evenly on both sides of the conduit for its full length in accordance with Specification Subsection 701.08.

Pipe backfill using flowable fill will be in accordance with Specification Section 710 and as directed by the project engineer.

### **SIDE DRAINS UNDER UNPAVED AREAS**

Backfill material shall be placed by methods approved by the engineer and shall be compacted as directed.

## **PIPES OTHER THAN SIDE DRAINS AND SIDE DRAINS UNDER PAVED AREAS**

Before any construction equipment is allowed to cross the installed pipe, at least 2 feet, compacted thickness, of backfill shall be placed over the top. The backfill will help prevent the equipment from damaging the pipe or moving it out of alignment or flow line. If the final thickness of cover over the installed pipe is less than two feet, the contractor shall install the pipe after all heavy hauling has been completed. If it is not possible to install the pipe after the need to cross the line with heavy equipment, with the approval of the engineer, the contractor shall install the pipe and place excess material over the installed pipe to a compacted depth of at least two feet. After all heavy hauling is completed, the contractor shall remove the excess material to grade.

### **TOP OF PIPE EVEN WITH OR BELOW TOP OF TRENCH**

When the top of the conduit is even with or below the top of the trench, backfill material shall be placed and compacted in lifts evenly on both sides of the conduit for its full length. The top of the compacted backfill shall be one foot above the top of the conduit or to subgrade (if less than one foot), or to natural ground elevation, whichever is greater.

### **TOP OF PIPE ABOVE TOP OF TRENCH**

When the top of the conduit is above the top of the trench, backfill material shall be placed and compacted in lifts evenly on both sides of the conduit for its full length. The top of the compacted backfill shall be one foot above the top of the conduit or to subgrade, if the distance from the top of the conduit to the subgrade is less than one foot. Specification backfill material shall be used for backfilling the trench and as cover at least one foot above the pipe. The backfill shall extend on each side of the pipe for at least a distance equal to the outside diameter of the pipe.

## **COMPACTION**

**Compaction of backfill material by flooding will not be permitted.**

Backfill placed in the haunch shall be compacted by positive mechanical means. This area will be inspected and approved by the engineer prior to the placement of the full lift. Areas that are inaccessible to conventional backfill compaction equipment shall be compacted by hand-held pneumatic tampers. Backfill shall be placed and compacted for each lift in the haunch area prior to the placement of the full lift until backfill reaches the midpoint of the pipe. Backfill shall be placed and compacted without disturbing the alignment or flowline of the conduit.

Culverts for sidedrain ramps and driveways to be paved, cross drains, storm sewers and sanitary sewers under or immediately adjacent to roadways, driveways, parking lots, or

other paved areas will be backfilled and compacted in lifts to 95% of maximum dry density with soil or aggregate, at or near optimum moisture, meeting the specification requirements for backfill materials.

When flowable fill is used there are no compaction requirements. The material flows and consolidates under its weight while being placed at the appropriate consistency.

### **Selected Soils**

Selected soils backfill shall be placed and compacted in lifts not to exceed six inches compacted thickness. Optimum moisture will be determined in accordance with DOTD TR 415 or TR 418 . Each layer shall be compacted to at least 95% of maximum density as determined in accordance with DOTD TR 415 or TR 418. Project personnel will determine percent compaction in accordance with DOTD TR 401.

### **Granular Material**

Granular material backfill shall be placed and compacted in lifts not to exceed twelve inches compacted thickness. Optimum moisture will be determined in accordance with DOTD TR 415 or TR 418. Each layer shall be compacted to at least 95% of maximum density as determined in accordance with DOTD TR 415 or TR 418. Project personnel will determine percent compaction in accordance with DOTD TR 401.

## **QUALITY ASSURANCE**

### **QUALITY CONTROL**

The contractor shall submit a quality control plan for approval. Plan modifications or additional control sampling and testing may be directed by the project engineer.

When flowable fill is specified, or allowed, the contractor shall submit a mix design for approval. The mix design and control of the mixture will follow the general guidelines of Specification Section 710 and the appropriate Application of Quality Assurance manual.

### **INSPECTION AND ACCEPTANCE**

Materials will be sampled and tested for specification compliance in accordance with requirements for each type of material. Trenching, bedding, pipe placement (alignment, slope, etc.) and material placement (lift thickness, staggered lifts, moisture control, etc.) will be constantly monitored to ensure that installations which do not meet specifications do not occur.

When flowable fill is used as backfill, the inspector shall ensure that the material has a suitable flow, that it is filling all voids, that the backfill is being placed equally around the pipe, that containment is satisfactory, and that the material is setting up (hardening) properly.

When density is a requirement, the project engineer will ascertain that the compaction and moisture requirements are met by taking a minimum of one compaction test per three feet thickness and in the top six inches of backfill material per 100 linear feet of

conduit installation. Each individual pipe installation less than 100 feet in length will be tested in accordance with the above backfill thickness frequency requirement. The project engineer will take as many tests as necessary to ensure that each layer of backfill material meets the density requirements. Compaction reports will document the location of the test, both vertically and horizontally. Compaction equipment required will be at the discretion of the contractor; however, the equipment selected must be approved and maintain the structural integrity of the pipe.