Designation: ~~F449 – 16~~ F449 – 20

Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control[1]

This standard is issued under the fixed designation F449; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice is recommended for and limited to gravity flow subsurface drainage systems or water table control, but not recommended for sanitary or storm sewer applications. Procedures are outlined to minimize pipe deflection or structural damage during and after the installation process. These installation procedures are in accordance with "flexible conduit" principles.

1.2 This practice applies to all agricultural subsurface drainage or water table control installations using Specification F667, F2648, or other plastic pipe.

NOTE 1—Specific references to the appendix in the body of this practice are for informational purposes.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information ~~only~~ only, may not be equivalents and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1600 Terminology for Abbreviated Terms Relating to Plastics

D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

F412 Terminology Relating to Plastic Piping Systems

F667 Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings

F2648 Specification for 2 to 60 inch [50 to 1500 mm] Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications

3. Terminology

3.1 Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D1600, unless otherwise specified.

3.2 *backfill*—materials used to fill the trench following installation of the pipe and bedding.

3.3 *bedding*—material which provides ~~stable~~ bottom and side support for the ~~pipe including the trench bottom groove support angle or select material placed around the pipe, and envelope or filter materials where used during installation.~~pipe.

3.4 *blinding*—the placement of ~~soil,~~ bedding material over and on the sides of the pipe ~~or envelope~~ to ensure proper grade, alignment, support, and protection of pipe during backfilling ~~and~~ after installation.

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.65 on Land Drainage.
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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

3.5 *boot (also shield)*—~~the~~—the protecting apparatus linked to the rear of the installation machine in a manner which allows placement of the pipe on the trench bottom, protection of the workman, or placement of envelope or filter material, or both.

3.6 *cradle*—a ~~prefabricated rigid~~ structure designed to provide trench bottom support for the ~~pipe when soil support is inadequate.~~pipe.

3.7 *envelope*—porous material placed around the pipe to ~~provide bedding, improve the flow of ground water into the drain, or function as a filter.~~fill the excavated space.

3.8 *filter*—an envelope of natural or synthetic materials placed completely around ~~a drain~~the pipe to permit free water movement into ~~the drain, provide stabilizing support at the soil-filter interface,~~ pipe perforations and restrict movement of silt and sand into the ~~drain.~~pipe.

3.8.1 *Discussion*—

When crushed stone is used as the filter medium it also provides stabilizing support for the pipe.

3.9 *grade*—the slope of the pipe invert.

3.10 *groove support angle*—angle between the radii of the pipe at points of contact with the formed groove of undisturbed soil or a cradle.

3.11 *in-situ*—soil in the natural or original position, undisturbed. Applied to a soil when occurring in the situation in which it was originally formed or deposited.

3.12 *mineral soils*—soil containing (*1*) less than 30 % organic matter by weight provided the mineral fraction is 60 % or more clay, or (*2*) less than 20 % organic matter by weight provided the mineral fraction has no clay, or (*3*) less than a proportional content of organic matter between 20 and 30 % if the clay content of the mineral fraction is between 0 and 60 %.

3.13 *natural granular envelope*—an envelope of granular material, usually highly permeable well-graded sand and gravel.

3.14 *organic soil*—soil containing (*1*) 30 % or more organic matter provided the mineral fraction is 60 % or more clay, or (*2*) 20 % or more organic matter provided the mineral fraction has no clay, or (*3*) a proportional content of organic matter between 20 and 30 % if the clay content of mineral fraction is between 0 and 60 %. (It is a general rule that a soil is classed as an organic soil (histosol) either if more than one half of upper 32 in. (80 mm) of soil is organic or if organic soil material of any thickness rests on rock or on fragmental material having voids filled with organic material.)

3.15 *pipe stiffness*—force per unit length, per unit deflection as defined in Test Method D2412.

3.16 *power feeder*—mechanism that applies force to the pipe as it passes through the boot or shield to reduce stretch during installation.

3.17 *pre-ripping*—the practice of making a pass with the plow without installing pipe to locate rocks and to reduce draft.

3.18 *semi-circular groove*—a rounded trench bottom in native ~~*insitu*~~*in-situ* soil that conforms to the outside diameter from the invert to the springline of the ~~pipe.~~pipe (180°).

3.19 *start hole*—a trench sufficiently long and wide to allow working room for placing the boot or shield, blade or cutting mechanism on grade to start the trench and to install connections or pipe.

3.19.1 *Discussion*—

Start holes are usually dug with a backhoe or excavator with a flat-bottom trench.

3.20 *springline*—an imaginary horizontal reference line located at mid-height, or halfway point of a pipe.

3.21 *stretch*—the increase in length of the pipe caused by tension forces during installation. It is expressed as a percent increase of the length prior to installation. Stretch differs from elongation in that elongation is a material test and stretch is an installation test.

3.22 *synthetic envelope*—an envelope made of synthetic geotextiles, usually thin synthetic fabrics or thicker fibrous material, or both, often selected to function as a filter.

3.23 *trench depth*—the depth of the trench measured from the bottom of the pipe.

3.24 *trench width*—the width of the trench measured at the top of the pipe.

~~3.23 Fig. 1 illustrates the terms bedding, vertical deflection, backfill material, cover, groove support angle, horizontal deflection, trench width, and trench depth.~~

~~Fig. 2a and b illustrates various support grooves or trench bottom shapes.~~

~~Fig. 3 illustrates envelope and filter.~~

~~Fig. 4 illustrates rodent protection devices.~~

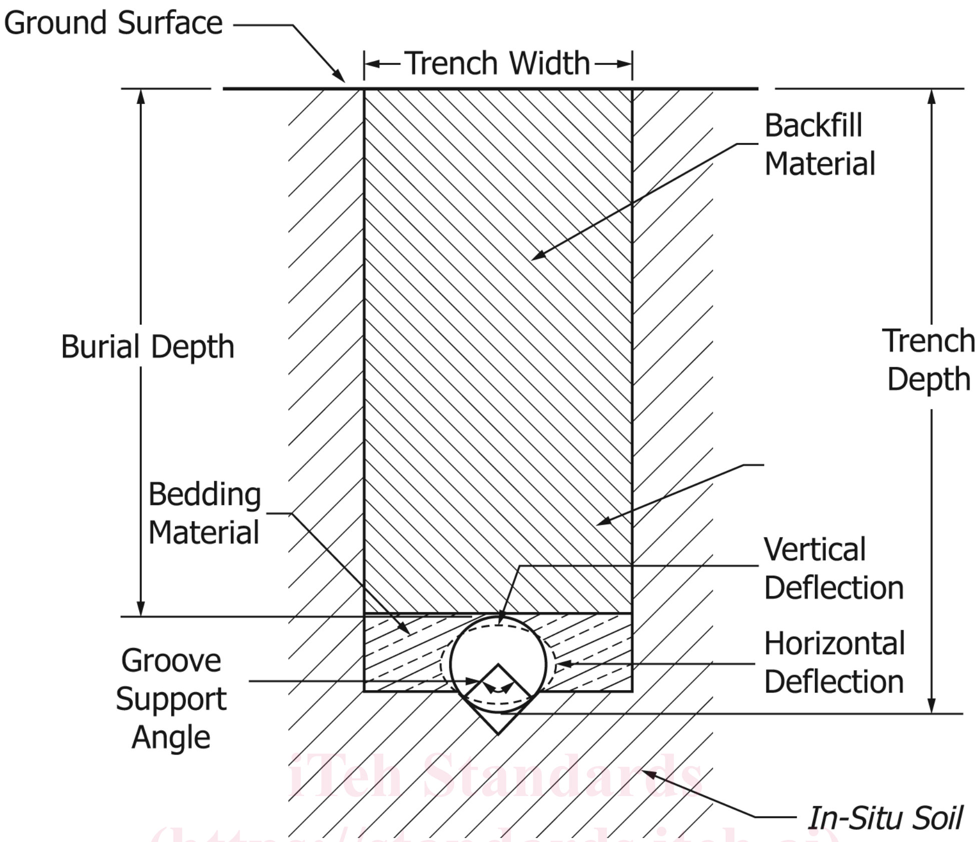

FIG. 1 Terminology for Installation of Plastic Drain Pipe

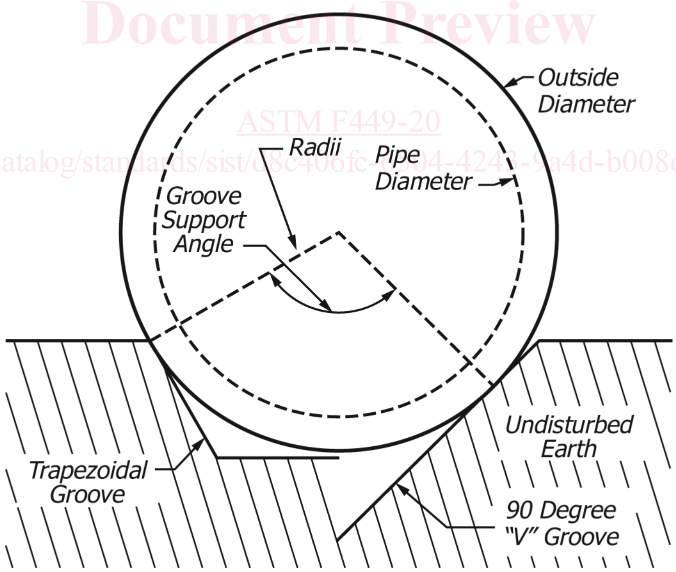

FIG. 2 a Support Grooves

~~Fig. 5 illustrates boot or shield.~~

4. General Requirements

4.1 *Burial*—The maximum and minimum burial depth are affected by the following factors, groove support angle or shape of the trench bottom, bedding, blinding backfill soil density, envelope density, envelope placement, pipe stiffness, the live load expected, desired water table depth, and width of trench.

4.1.1 *Minimum Depth:*

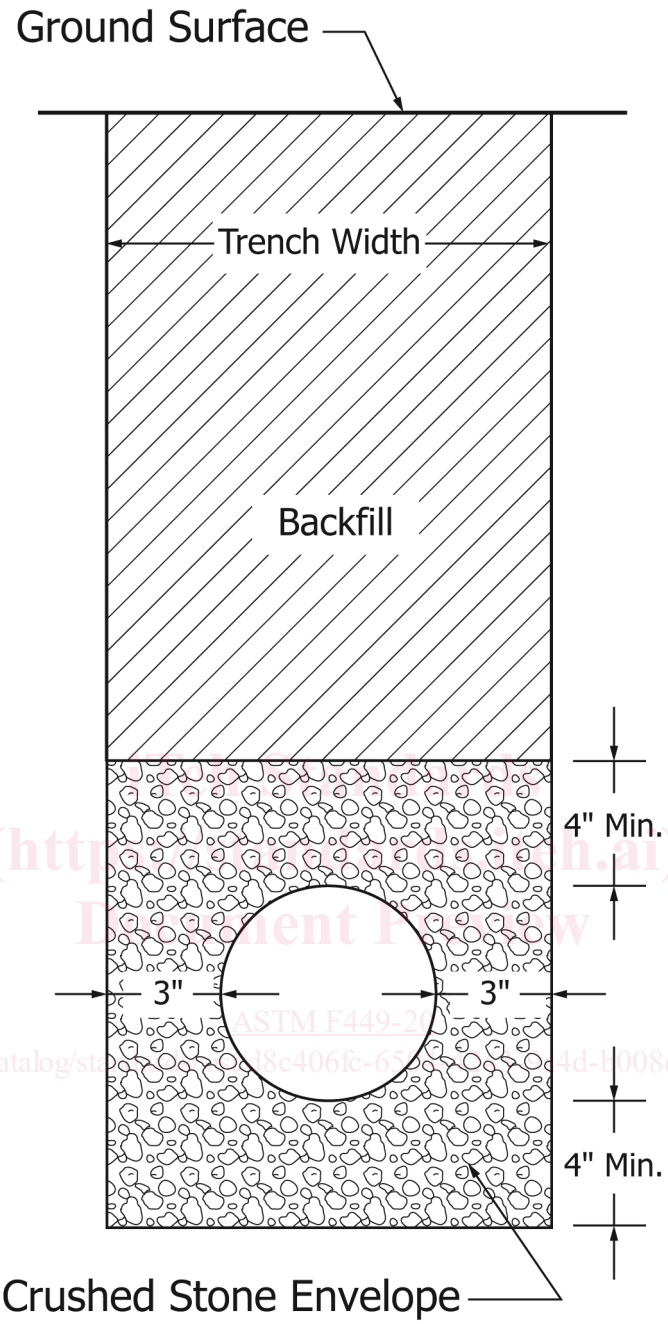

FIG. 3 Pipe Encased in ~~Bedding for Support (left) and Pipe Encased in Sand and Gravel~~ Crushed Stone Envelope Designed as ~~Filter (right)~~Filter.

4.1.1.1 *Mineral Soils*—The minimum recommended cover needed to protect the pipe from ~~crushing~~ excessive deflection under live loads ~~is~~ beyond what is listed in 5.2 for maximum deflection is 2 ft (0.6 m). Granular bedding or special construction techniques may be used to reduce the cover. The time for consolidation of backfill may be a factor (see 8.1). The minimum cover may have limiting factors other than ~~crushing~~deflection such as clearance for subsoiling and utility ~~crossing~~ crossing.

4.1.1.2 *Organic Soils*—Subsurface drains should be installed in these soils only after initial subsidence has occurred. To produce initial subsidence open ditches should be constructed in deep organic soils to carry off free water, and the area should be allowed to stand or be partially cultivated for a period of 3 to 5 years before installing pipe. The recommended minimum cover for the pipe in organic soils is 2.5 ft (0.7 m). If water level controls are not provided in the drainage system to hold subsidence to a minimum, the depth of cover should be increased to 3 ft (0.9 m).

NOTE 2—These minimum depths are recommended to prevent ~~crushing~~ excessive deflection of the pipe by normal agricultural vehicle ~~loads.~~ loads beyond what is listed in 5.2 for maximum deflection. Other drainage factors such as those encountered with salinity control in arid irrigated lands may require minimum depths of 6 ft (1.8 ~~m).~~m)

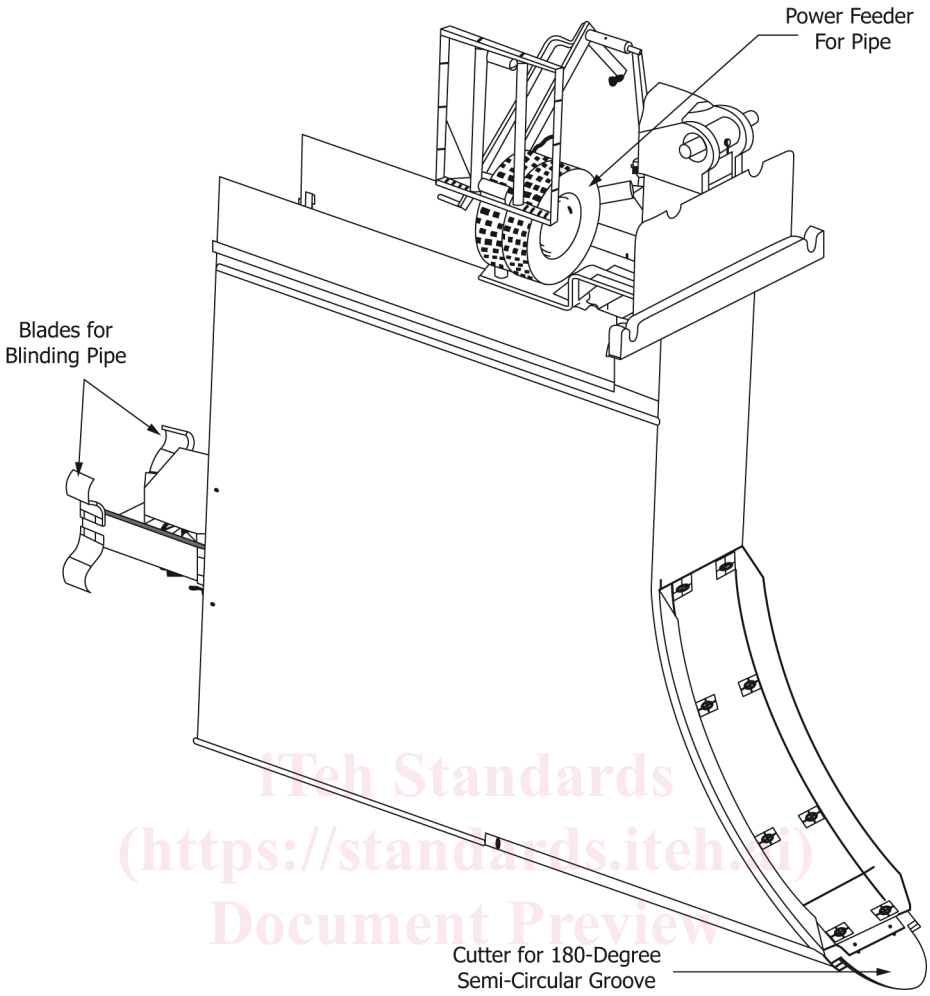

FIG. 4 ~~Suggested Methods of Providing Rodent Protection for Outlet Pipes~~Tile Boot

FIG. 5 ~~Example Boot Design~~Tile Plow

4.1.2 *Maximum Depth*—The maximum burial depth is influenced by such factors as degree of compaction, type of bedding, support from the trench bottom, trench width, size of pipe, pipe stiffness, weight of backfill, and live loads imposed. Without an engineering design, maximum buried depths should be limited to those listed in Table 1 or Table 2. For installation at depths greater than those listed in Table 1 or Table 2, specifications of ~~and~~an engineering design should be followed.

4.1.3 *Trench Width*—Increasing the trench width increases the soil load on the pipe. ~~Side clearances of more than 150 mm (6 in.) on each side should only be used with an engineering design and special construction (see Table 1).~~ For Table 1 designs, the trench width must be at least ~~50 mm (2 in.)~~2 in. (50 mm) wider than the pipe on each side for plow installation and ~~75 to 150 mm (3 to 6 in.)~~3 to 6 in. (75 to 150 mm) on each side for open trench installation to allow sufficient bedding to support the pipe. If fine material cannot be placed alongside and over the pipe, a wider trench should be considered or special bedding material supplied. Side clearances of more than 6 in. (150 mm) on each side should only be used with an engineering design and special construction. For Table 2 designs, a maximum and minimum trench width is specified to limit excessive deflection and allow a larger amount of soil arching to reduce the load on the pipe. The tile boot or trench box used to construct the semi-circular groove shall conform as closely as possible to the pipe OD and shall be within ~~1%~~1 % or ~~½ in.~~ in. (12 mm), whichever is greater, of the pipe OD. The trench width requirements only pertain to the vertical distance from the springline to the top of the pipe. It is permissible for the trench width above the top of the pipe to slope to the natural angle of repose of the soil.

TABLE 1 Maximum Trench Depths for Pipe Buried in Loose, Fine-Textured Soils, ft (m)[A]

NOTE 1—These depths are based on limited research and should be used with caution. Differences in commercial pipe from several manufacturers, including corrugation design and pipe ~~stiffness and~~ soil conditions, may change the assumptions; and, therefore, maximum depths may be more or less than stated ~~above.~~

Nominal pipe diameter, in. (mm)	Pipe quality (ASTM)	Trench width at top of pipe, m (ft)[A]			
		~~0.3 (1)~~	~~0.4 (1.3)~~	~~0.6 (2)~~	~~0.8 (2.6)~~ or greater
~~4 (102)~~	~~Standard[B]~~	~~3.9 (12.8)~~	~~2.1 (6.9)~~	~~1.7 (5.6)~~	~~1.6 (5.2)~~
	~~Heavy-Duty[C]~~	~~D~~	~~3.0 (9.8)~~	~~2.1 (6.9)~~	~~1.9 (6.2)~~
~~6 (152)~~	~~Standard[B]~~	~~3.1 (10.2)~~	~~2.1 (6.9)~~	~~1.7 (5.6)~~	~~1.6 (5.2)~~
	~~Heavy-Duty[C]~~	~~D~~	~~2.9 (9.5)~~	~~2.0 (6.6)~~	~~1.9 (6.2)~~
~~8 (203)~~	~~Standard[B]~~	~~3.1 (10.2)~~	~~2.2 (7.2)~~	~~1.7 (5.6)~~	~~1.6 (5.2)~~
	~~Heavy-Duty[C]~~	~~D~~	~~3.0 (9.8)~~	~~2.1 (6.9)~~	~~1.9 (6.2)~~
~~10 (254)~~	~~C~~	~~...~~	~~2.8 (9.2)~~	~~2.0 (6.6)~~	~~1.9 (6.2)~~
~~12 (305)~~	~~C~~	~~...~~	~~2.7 (8.9)~~	~~2.0 (6.6)~~	~~1.9 (6.2)~~
~~15 (381)~~	~~C~~	~~...~~	~~...~~	~~2.1 (6.9)~~	~~1.9 (6.2)~~
~~18 (457)~~	~~C~~				

TABLE 1 Maximum Trench Depths for Pipe Buried in Loose, Fine-Textured Soils, ft (m)[A]

NOTE 1—These depths are based on limited research and should be used with caution. See Appendix X1 for burial depth calculation method. Differences in commercial pipe from several manufacturers, including corrugation design and pipe stiffness, as well as soil conditions, may change the assumptions; and, therefore, maximum depths may be more or less than stated below. Consult the manufacturer for specific recommendations.

Nominal pipe diameter, in. (mm)	Pipe quality (ASTM)	Trench width at top of pipe, m (ft)[A]			
		1 (0.3)	1.3 (0.4)	2 (0.6)	2.6 (0.8) or greater
3 (76)	F667/F2648	9.8 (3.0)	9.8 (3.0)	6.9 (2.1)	6.2 (1.9)
4 (102)	F667/F2648	9.8 (3.0)	9.8 (3.0)	6.9 (2.1)	6.2 (1.9)
5 (127)	F667	9.8 (3.0)	9.8 (3.0)	6.9 (2.1)	6.2 (1.9)
6 (152)	F667/F2648	9.8 (3.0)	9.5 (2.9)	6.6 (2.0)	6.2 (1.9)
8 (203)	F667/F2648	9.8 (3.0)	9.8 (3.0)	6.9 (2.1)	6.2 (1.9)

~~[A] E' = 345 kN/m² (50 psi)~~
~~D_1 = 3.4~~
~~K = 0.096 (90° bedding angle)~~
~~w = 1750 kg/m³ (109 lb/ft³)~~
~~Y = 1.1x (x = horizontal deflection)~~
~~[B] Pipe stiffness 90 kN/m² (13 psi) for 20 % deflection.~~
~~[C] Pipe stiffness 124 kN/m² (18 psi) for 20 % deflection.~~
~~[A] Any depth is permissible for this or less width and for 0.2 m (0.67 ft) trench width for all sizes.~~Maximum trench depth is listed to the right of each size and type of pipe and is dependent on the trench width at the top of the pipe.