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Polyethylene Piping Systems Field Manual for Municipal Water Applications

M&I Division
2009 Edition

PE Water Distribution Piping

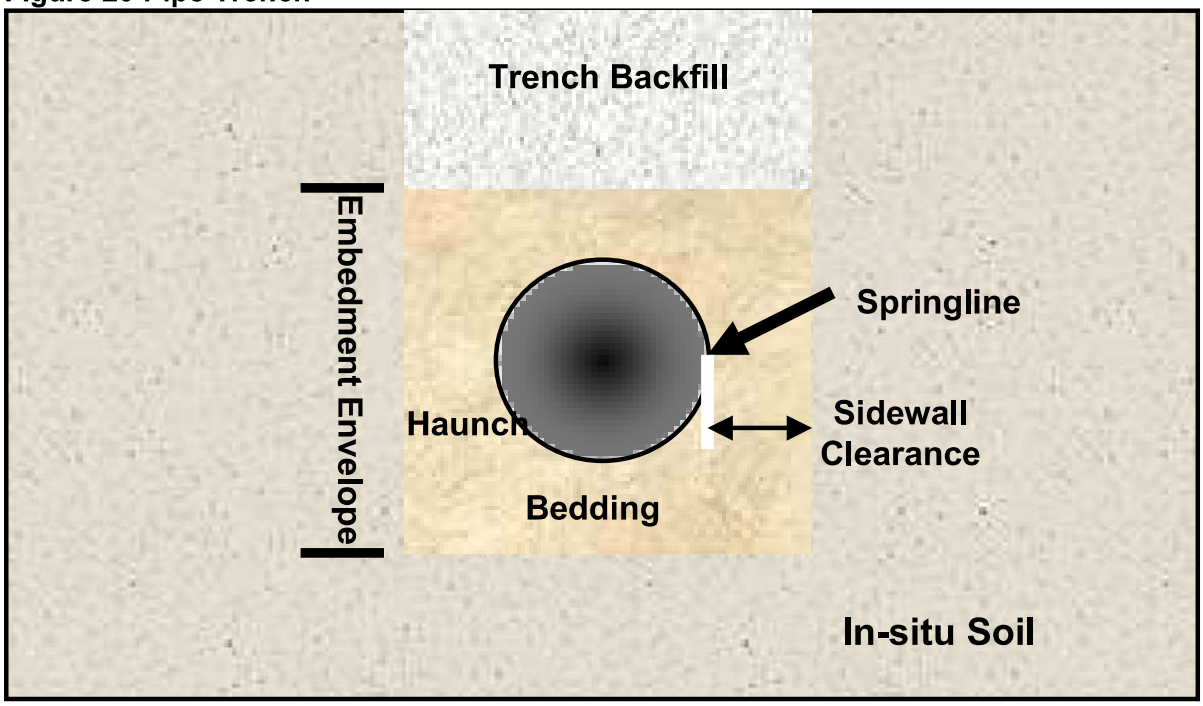
Sizes, Pressures, and Specifications

PE water distribution lines are typically 4" to 12" nominal diameter pipe in accordance with AWWA C906, ASTM D3035, or ASTM F714, with rated pressure of 80 to 250 psig in accordance with Table 1.

Burial

The materials enveloping a buried pipe are generally identified as shown by their function or location (see Figure 20).

Figure 20 Pipe Trench



Installation Guidelines for PE Pipe

Install PE pressure pipe in accordance with ASTM D2774.

The engineer must evaluate the site conditions, the subsurface conditions, and the application objectives to determine the extent of support the pipe may need from the surrounding soil. Where the pipe burial depth is relatively deep, where subsurface soil conditions are not supportive of pipe, where surface loads or live loads are present, or where the pipe DR is high, the engineer will generally prepare a specific installation specification. The specific engineered installation instructions should be followed.

The following are general guidelines for the installation of 12” and smaller diameter PE pipe with a minimum cover depth of 2 ft (3 ft under traffic loading; up to 5 feet for frost protection) and a maximum depth of cover of 16 feet. For other depths consult the engineer. Other satisfactory methods or specifications may be available. This information should not be substituted for the judgment of a professional engineer in achieving specific requirements.

Figure 21: Pipe Placement in Open Trench

Trench Construction

Principal considerations in trench construction are trench width, length, and depth; soil stability; and groundwater accumulation in the trench. Unstable soils or wet conditions should be controlled by sloping or bracing the trench walls, de-watering the trench bottom, and/or other measures.

Trench Width

The trench width should allow sufficient room for joining the pipe, if required, snaking small diameter from side to side along the bottom of trench for thermal affects, and filling and compacting the side fills.Table 3 gives suggested minimum trench width values.

TABLE 3
Minimum Trench Width in Stable Ground vs. Pipe Size

Nominal Pipe Size (in.)	Minimum Trench Width (in.)
<3	12
3-12	Pipe OD + 12

Trench Length

The length of open trench required for fused pipe sections should be such that bending and lowering the pipe into the ditch does not exceed the manufacturer's minimum recommended bend radius and result in kinking. Table 4 lists the recommended lengths of trench openings for placement of continuous lengths of fused pipe, assembled above the trench. When the trench sidewalls are significantly sloped, somewhat shorter trench openings may be used.

TABLE 4: Suggested Length of Minimum Trench Opening (Feet) for Installation of Joined Lengths of PE Pipe

Nominal Pipe Size (inches)	Depth of Trench (feet)					
	3	5	7	9	11	13
½ to 3	15	20	25	30	35	40
4 to 8	25	30	35	40	45	50
10 to 12	35	40	45	50	55	60

Stability of Trench Walls

The embedment material must be placed from undisturbed trench sidewall to undisturbed trench sidewall. Walls of trenches below the elevation of the crown of the pipe should be maintained as vertical as possible. Sloping of trench walls in granular and cohesionless soils should be provided whenever the walls are more than about four feet in depth or otherwise required by state, local or federal regulations. For safety, if the walls are not sloped, they should be stabilized by shoring or bracing. The slope should be approved by the engineer.

Stable soils can be cut vertically or nearly vertically without significant sloughing. If trench sidewalls readily slough off or the trench floor is soft and will not support workers or compaction, it is unstable. The instability is usually a condition of the trench and not the soil. Most often the cause is high groundwater. In unstable soils, the engineer should determine the necessity for special procedures such as a "wide" trench or permanent trench sheeting.

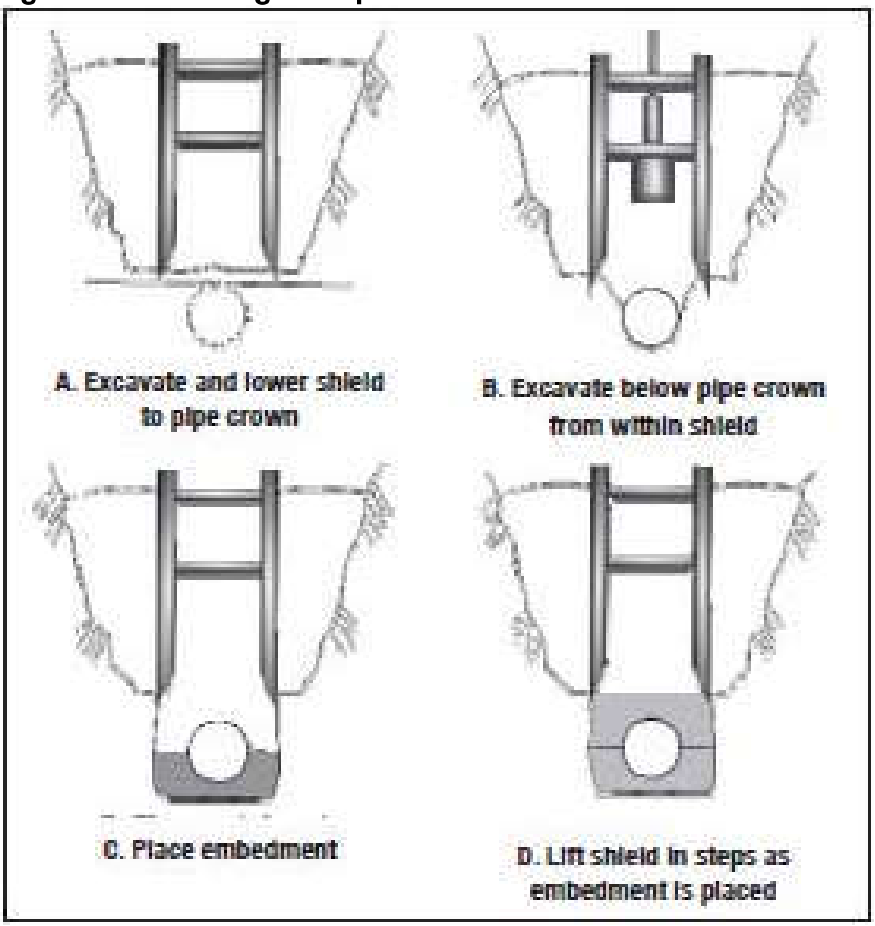
Wherever possible, temporary sheathing and bracing to protect workers should be installed so that its bottom extends no lower than about one-quarter of the pipe diameter below the pipe crown. Sheathing that is installed to project below the pipe springline should be left in place unless, as with some thinner sheathing, it is designed to be pulled and removed without disturbing the embedment next to the pipe. In this case, the trench width should be increased by 12 to 24 inches, depending on the pipe diameter, to allow for minor disturbance to the embedment near the sheathing. Do not use vibratory placement or extraction of sheeting. This can cause severe disturbance to the bedding and liquefaction of the surrounding soils.

Portable Trench Shield

Portable trench shields or boxes can be used with PE pipe. All excavation of the trench below the pipe crown elevation should be done from inside of the shield. The backhoe operator should dig inside of the shield and force the shield down as soil is removed. Where the bottom of the shield extends below the pipe crown, the shield must be vertically raised after each lift is placed and embedment material shovelled under the shield to fill the void created by the shield wall. Figure 22 illustrates the steps used with a Portable Trench Shield.

If possible, use shields that are placed with no portion of their sides extending lower than one-quarter of a pipe diameter below the pipe crown. This minimizes the amount of lifting required and precludes the possibility for disturbing embedment materials. The minimum inside clear width of the box or shield should allow for the minimum trench width requirements for the pipe plus an additional 12 to 24 inches

Figure 22: Installing PE Pipe with a Portable Trench Shield



Trench Floor Preparation

The trench floor must be stable in order to support the bedding material. Generally, if the trench floor can be walked on without showing foot prints it is considered stable. Where the trench floor is not stable, in many cases it can be stabilized by dewatering. Where dewatering is not possible stabilization of the trench floor may be accomplished by addition of crushed rock or by an alternate trench foundation.

Pressure pipe may be installed directly on the prepared trench floor as long as it is soil. The trench bottom may undulate but must support the pipe smoothly and be free of ridges, hollows, and lumps. The trench bottom should be relatively smooth and free of rock. Rocks, boulders, or large stones that can cause point loading on the pipe must be removed and the trench bottom padded with 4 to 6 inches of tamped bedding material. Bedding should consist of free-flowing material such as gravel, sand, silty sand, or clayey sand that is free of stones or hard particles larger than specified for the embedment size.

If you over-excavate the trench floor by more than 6 inches beyond grade, fill the over-excavation with acceptable material that is compacted to a density equal to that of the embedment material.

De-watering

The groundwater in the trench should be kept below the pipe invert, using deep wells, well points or sump pumps placed in the trench.

Placing Pipe in Trench

Place PE pressure pipe up to 8” in diameter in the trench by hand. Use equipment to lift, move, and lower larger diameter pipe into the trench. Pipe must not be dumped, dropped, pushed, or rolled into the trench.

Figure 23: Trench Wall Sloped for Safety

Pipe Embedment

ASTM D2774 calls for embedment materials to be sufficiently granular for haunching under the pipe and compacting. Typical soils include coarse grained soil, such as gravel or sand, or coarse grained soil containing fines, such as silty sand or clayey sand. Compactable native soil is acceptable where there is no traffic load. This includes lean clays and silty sand. The particle size should not exceed the values in Table 5.

Where the embedment is angular, crushed stone may be placed around the pipe by dumping and slicing with a shovel. Where the embedment is naturally occurring gravels, sands and mixtures with fines, the embedment should be placed in lifts not exceeding 8 inches in thickness and then tamped. Tamping should be accomplished by using a mechanical tamper. Compact to at least 85 percent Standard Proctor density as defined in ASTM D698, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort, (12 400 ft-lbf/ft^3 (600 kN-m/m^3))*. Under streets and roads, increase compaction to at least 95 percent Standard Proctor density.

Table 5: Embedment Size vs. Diameter of Pipe

Pipe Diameter	Particle Size
≤4”	≤1/2”
6” & 8”	≤3/4”
10” to 16”	≤1”
≥18”	≤1-1/2”

Figure 24: Typical granular embedment

Backfilling and Compaction

Backfilling should follow pipe placement and assembly as closely as possible to prevent the pipe from being shifted out of line by cave-ins, protect the pipe from external damage, eliminate pipe lifting due to flooding of open trench and lessen the possibility of backfill material becoming frozen in cold weather.

Where the in-situ soil is fine grain, backfill material should be selected to prevent material migration to or from the trench wall and other layers of embedment material.

Backfill under the pipe haunches to at least 6 inches above the pipe with the select embedment soil. Shovel slice or compact in lifts not exceeding 8" as required. Place lifts evenly on both sides of the pipe. Rock impingement may cause high contact stresses and stress raisers in pipe wall. Keep large hard objects away from the pipe. See Figure 25.

If the final backfill material contains large rock (boulder or cobble size) or clumps, then 18 inches of cushion material should be provided between the pipe crown and the trench backfill.

The final backfill may consist of the excavated material, provided it is free from unsuitable matter such as large lumps of clay, organic material, boulders or stones larger than 8 inches, or construction debris. The final backfill may be placed in the trench by machines.

There should be at least one foot of cover over the pipe before compaction of the final backfill by the use of self-powered compactors. Construction vehicles should not be driven over the pipe until a three foot cover of properly compacted material is placed over the pipe.

Where the pipe is located beneath a road, place the final backfill in lifts and compact to 95 percent Standard Proctor Density.