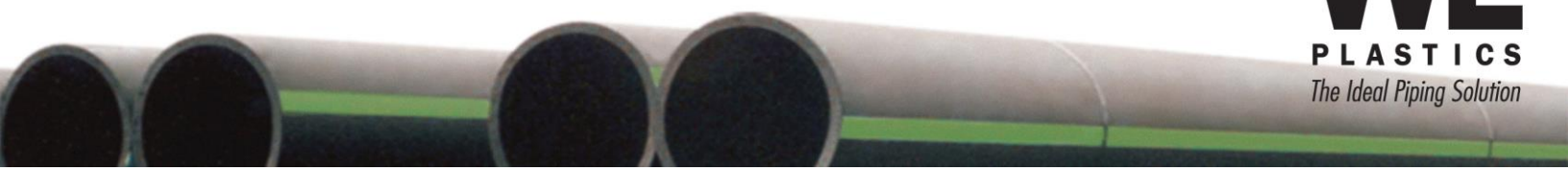
WL113 Trench Installation Guidelines



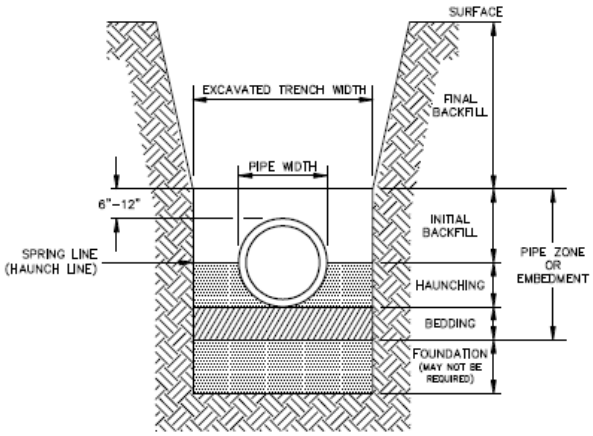
Guidelines for Trench Installation

WL Plastics polyethylene pipe is tough, flexible pipe that when properly installed underground works together with its soil embedment to resist static loads from embedment above the pipe, static loads from structures above the pipe, and dynamic surface loads from vehicular traffic. Buried flexible pipe embedment design is not unique to polyethylene pipe. Flexible pipe design is applied to pipes constructed form metallic and non-metallic materials and having various solid wall, corrugated and profile wall constructions.

Trench and Embedment Design

Some applications involve native soil conditions where there is no alternative to geotechnical soil analysis, and a custom designed trench and embedment. Marshy or rock trench conditions, high fills or high vehicular loads such as earthmoving equipment without pavement or railroad loads generally require designed trench and embedment. In these conditions, a recommended reference is the *Handbook of Polyethylene Pipe, Second Edition*, 2008 from the Plastics Pipe Institute, Chapter 6, Section 3, and Chapter 7.

Terminology



PPI Handbook chapters may be downloaded from the PPI website www.plasticpipe.org. Some application conditions may be addressed using the PPI Calculator, http://plasticpipe.org/publications/software-ppi-calculator.html.

Depending on site and native soil conditions, foundation or bedding may not be required. Foundation, bedding, haunching and initial embedment materials may be native soils or imported materials that provide a stable structural envelope around the pipe. Stable materials interlock to provide structural load support, and are angular particle native soils, sands and gravels. (See the table, *Soil Reaction Modulus, E'*, below) Unstable rounded particle materials do not interlock, and are unsuitable for foundation, bedding, haunching and initial backfill. To properly withstand loads above the pipe, the placement of initial backfill embedment should that provide for void-free haunching.

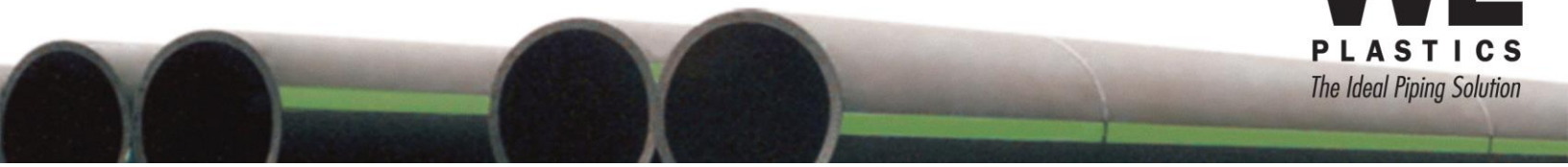
The Pre-Designed Option

For DR 21 and lower PE pipes, certain embedment materials, and certain installation quality conditions, the PPI *Handbook of Polyethylene Pipe* presents an "AWWA M-55 Design Window" for solid-wall PE pipe. The "Design Window" is a pre-designed set of embedment materials and installation conditions. When the "Design Window" can be met, pipe deflection will be within design guidelines, and the safety factor against constrained buckling will exceed 2.

Requirements for the "Design Window" are:

- DR 21 and lower PE3608 or PE4710 pipe
- Ground water at or below surface grade
- Pipe installation per ASTM D2774 or D2321[1]
- Control bending and shear loads per *Minimum Field Bending Radius* and *Shear and Concentrated Loads* in this publication
- No static surface loads
- Maximum cover depth – 25 ft (7.62 m)
- Minimum cover depth:
  - Without AASHTO H20/HS20 truck loadings: 2 ft (0.61 m) or one pipe diameter, whichever is greater
  - With AASHTO H20/HS20 truck loadings: 3 ft (0.9 m) or one pipe diameter, whichever is greater
- The particle size of material in contact with pressure pipe shall not exceed 1⁄2 in. (13 mm) for pipe to 4 in. (115 mm), 3⁄4 in. (20 mm) for pipes up to 8 in. (220 mm); 1 in. (25 mm) for pipes up to 16 in. (410 mm); and 1 1⁄2 in. (40 mm) for larger pipes.
- The particle size of material in contact with non-pressure pipe shall not exceed 1 1⁄2 in. (40 mm).
- Embedment material (see Table 1)
  - Density – 120 lbs/ft^3 (1900 kg/m^3) or less

[1] ASTM D2774 is for pressure pipe installation; ASTM D2321 is for non-pressure pipe installation.



- Soil reaction modulus, E', of at least 1000 psi (6.9 MPa) when compacted to at least 85% Standard Proctor Density

Table 1 Soil Reaction Modulus, E' and Soil Type

Degree of Bedding Compaction,	*Pipe Embedment Material Soil Type*			
	A	B	C	D
	Average Value for E', psi (MPa)			
Moderate, 85-95% Proctor, 40-70% Relative Density	3000 (20.68)	2000 (13.79)	1000 (6.89)	NA
High, >95% Proctor, >70% Relative Density	3000 (20.68)	3000 (20.68	2000 (13.79)	1000 (6.89)

Pipe Embedment Material Soil Type (Unified Classification System[1])

A – Crushed rock

B – GW, GP, SW, SP[2] Coarse grained soils with less than 12% fines

C – CL, ML, ML-CL, fine grained soils (LL<50[3]); soils with medium to no plasticity; soils with less than 25% coarse grained particles. GM, GC, SM, SC coarse grained soils with more than 12% fines

D – CL, ML, ML-CL fine grained soils (LL<50); soils with medium to no plasticity; soils with less than 25% coarse grained particles

Note – Standard Proctor Density in accordance with ASTM D 698 is used with this table. Values applicable only for fills less than 50 ft (15 m). Table does not include a safety factor. For use in predicting initial deflections only; appropriate Deflection Lag Factor must be applied for long-term deflections.

[1] ASTM D2487; USBR E-3.

[2] Or any borderline soil beginning with one of these symbols (i.e., GM-GC, GC-SC).

[3] LL = liquid limit.

- All native and other materials in the pipe embedment zone shall be free from refuse, organic material, cobbles, boulders, large rocks or stones, or frozen soils. Blocking, if used, shall be removed.
- Shallow cover pipe is to be installed with provisions for flotation prevention.
  - "Shallow cover" applies to pipe greater than 24-inch (600 mm) diameter without H20/HS20 truck loading or pipe greater than 36-inch (900 mm) diameter with H20/HS20 truck loading.
- Embedment placed and compacted in layers. Typical layers are 6 to 12 in (150-300 mm).

Minimum Field Bending Radius

Field bending depends on pipe diameter, wall thickness (DR) and whether or not fittings are or will be present in the bend.

$$R_F = \frac{D}{12} f_R$$

R_F = minimum field bending radius, ft

D = pipe outside diameter, in (mm)

f_R = bending radius factor (Table 2)

Table 2 Bending Radius Factor, f_R

Pipe DR	*Bending Radius Factor, f_R*
≤ 9	20
> 9 ≤ 13.5	25
> 13.5 ≤ 21	27
> 21	30
Fitting in bend	100

The length of pipe required to deflect HDPE pipe around a sweep bend of θ degrees is

$$L = \frac{\Theta}{180} \pi \left(r + \frac{D}{24} \right)$$

L = pipe length along pipe bend centerline, ft

θ = sweep bend in degrees

π = pi, approximately 3.1416

r = bend radius, ft,

$$r \geq R_F$$

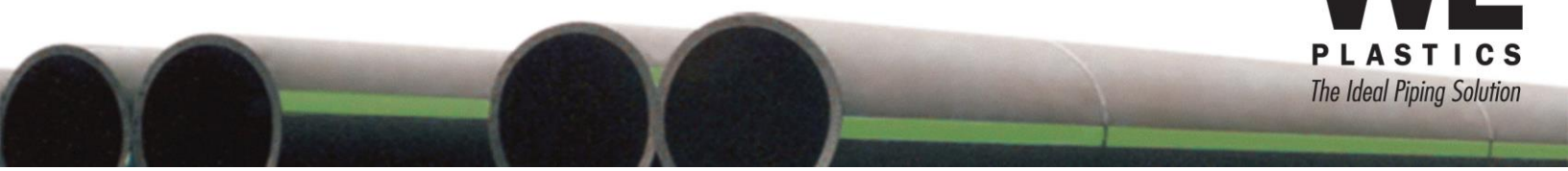
Shear and Concentrated Loads

To provide uniform support and avoid developing shear or other concentrated loading on the pipe under differential pipe support conditions such as in transitions from structural penetrations to trench, or casing exit to trench, or from hard to soft soils, a transition support region should be provided. A transition region is provided by over excavating soil next to the more rigid support to a depth of at least 12 inches (300 mm) for a distance of 2 pipe diameters from the more rigid support. For an additional 2 pipe diameters, the depth of over-excavation is gradually decreased to foundation or undisturbed soil grade. Pipe grade is then restored by the addition of compacted bedding material. Where PE pipe exits the casing, padding such as an elastomeric sheet or a curved segment of PE pipe should be installed between the PE pipe and the casing edge to distribute the edge load. Padding should be approximately ½ pipe diameter long around the bottom third of the pipe diameter.

Contaminated Soil Conditions

Virtually all piping materials and systems can be adversely affected if installed in contaminated embedment soil or if soil becomes contaminated after installation. *No piping system is immune to contamination effects.*

Soil can be contaminated by various chemicals such as liquid hydrocarbons, solvents, cleaning fluids, industrial chemicals, and the like. Depending on the piping material and joining methods, soil contamination may degrade or



permeate through a pipe or fitting, or through materials used in joining, packing, or sealing.

HDPE and PE4710 are highly resistant to many solvents and chemicals that may be present in contaminated soils.

HDPE and PE4710 are rarely attacked or degraded by contaminants in soils, but permeation through the pipe wall may occur.

If the piping system conveys potable water or a fluid where purity must be maintained, pipe installation should incorporate measures to prevent pipeline contact with soil borne contaminants.

The preferred contamination preventative installation method is not to install the pipeline in contaminated soils or in an area where contamination is likely to occur. If the pipeline cannot be rerouted, the pipeline should be run within a casing pipe that extends at least 10 ft (3 m) past the contaminated area on both ends. The casing pipe may be fused HDPE or another piping material such as welded steel that does not have gasketed joints.

Alternatively, the trench from 10 ft (3 m) beyond the contaminated area at both ends may be lined with a geotextile sheet to provide a liquid migration barrier. The sheet is laid on the trench foundation, and should extend up both sides of the trench for a distance equal to the depth of initial backfill plus trench width and sufficient additional length to extend six to twelve inches above the pipe plus fold over the initial backfill to the opposite trench wall. Bedding material is placed and compacted over the sheet, the pipeline placed on the bedding and initial backfill is placed and compacted to at 6 to 12 inches above the pipe. Then fold one side of the trench liner over the initial backfill, and then the other side over the first. Final backfill is then placed over the folded geotextile sheet liner.