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TECHNICAL BULLETIN

FEBRUARY 2012

MINIMUM COVER TO PREVENT EAGLE CORR PE™ * PIPE FLOATATION

INTRODUCTION

This technical bulletin provides design guidance for minimum burial depths necessary to prevent flotation of Eagle Corr PE pipe. All types and sizes of pipe, including RCP, can float under the right conditions. The soil type, soil density, soil cover height, location of the water table, pipe weight per unit length, and the amount of effluent in the pipe will all affect the flotation potential of pipe.

Pipe installed in areas where the groundwater table regularly encroaches into the pipe zone is pipe that must be installed to resist buoyancy. Applications where Eagle Corr PE™ will be subjected to high groundwater tables or other consistent submersion should be designed to prevent the floatation of the pipe. These conditions may require minimum cover requirements greater than those specified in the Eagle Corr PE™ installation manual.

MINIMUM COVER REQUIREMENTS

Table 1 summarizes the minimum burial depths of fill over the top of Eagle Corr PE pipe to prevent flotation. These minimum cover recommendations are based on conservative assumptions for typical site conditions and are summarized below. It should be noted that in some cases the minimum burial depth to prevent flotation is less than one foot. However, structural considerations require a minimum of one foot of cover for most H-25 traffic loading conditions.

Table 1

MINIMUM COVER REQUIRED PREVENTING FLOTATION				
	NOMINAL DIAMETER (IN)	APPROX. OUTSIDE DIAMETER (IN)	APPROX. WEIGHT (LBS/LF)	COVER (IN)
Dual Wall	4	4.7	0.4	3
	6	6.9	1.1	5
	8	9.1	1.7	6
	10	11.4	2.5	7
	12	14.3	3.2	9
	15	17.5	4.8	11
	18	20.8	6.3	13
	24	27.5	11.2	17
	30	34.6	15.8	22
	36	41.5	20.9	26
	42	47.4	26.9	30
	48	53.8	34.0	34
	60	66.7	56.0	43
Single Wall	4	4.7	0.4	3
	6	6.9	1.1	5
	8	9.1	1.7	6

** Also applicable to Eagle Green PE.*

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METHODOLOGY

Table 1 is based on the following assumptions and site conditions:

1. The pipe was assumed to be empty. This assumption creates a conservative scenario. Empty pipe is not likely unless the system is constructed with watertight pipe.
2. Weight per unit length as shown in the *Table 1.*
3. A soil friction angle (Ø) of 90 degrees was used for the analysis above which is an ultra conservative value resulting in a column soil load on the pipe (see *Figure 1a*). A typical angle of 36.87 degrees is representative for most sand/gravel mixture soils used in backfilling Eagle Corr PE pipe and will yield conservative results. The loading condition shown in *Figure 1b* is a more typical loading scenario whereby soils outside of the column immediately above the pipe are also used in the downward soil forces.
4. The average of the inner and outer diameters was used to determine soil and water displacement.
5. Soil density used was 120 pcf, which is typical for many saturated soil mixtures. Soils of greater densities will reduce the minimum cover necessary to prevent flotation.
6. The depth of submerged soil (Hsat) or water table was assumed to be at the ground surface for a fully saturated soil condition. This assumption created a "worst case" condition to yield more conservative results. If effluent were in the pipe, as would be likely in the case of a fully saturated soil, its weight would reduce the minimum burial depth.
7. Granular soils are recommended in most installations. Many soils do exhibit some degree of cohesion which would reduce the effects of flotation; however, this sample problem involved granular or non cohesive soils.

It is noted, during installation the pipe should be covered at the end of the day. Unexpected rainfall events or groundwater conditions may float the pipe in the trench. This condition of water in the trench may results in migration of soil and can affect the grade and alignment.

Additionally, this technical bulletin provides design guidance for an analytical methodology to evaluate the potential for flotation for site conditions other than those described above. Since other site conditions may exist, the engineer is encouraged to evaluate specific site conditions and make an independent evaluation.

As shown in *Figure 1* below, there are three major forces affecting the potential for flotation (F_{soil}, $F_{buoyance}$ and F_{pipe}).

Figure 1:

FORCES AND VARIABLE DEFINITIONS AFFECTING FLOTATION

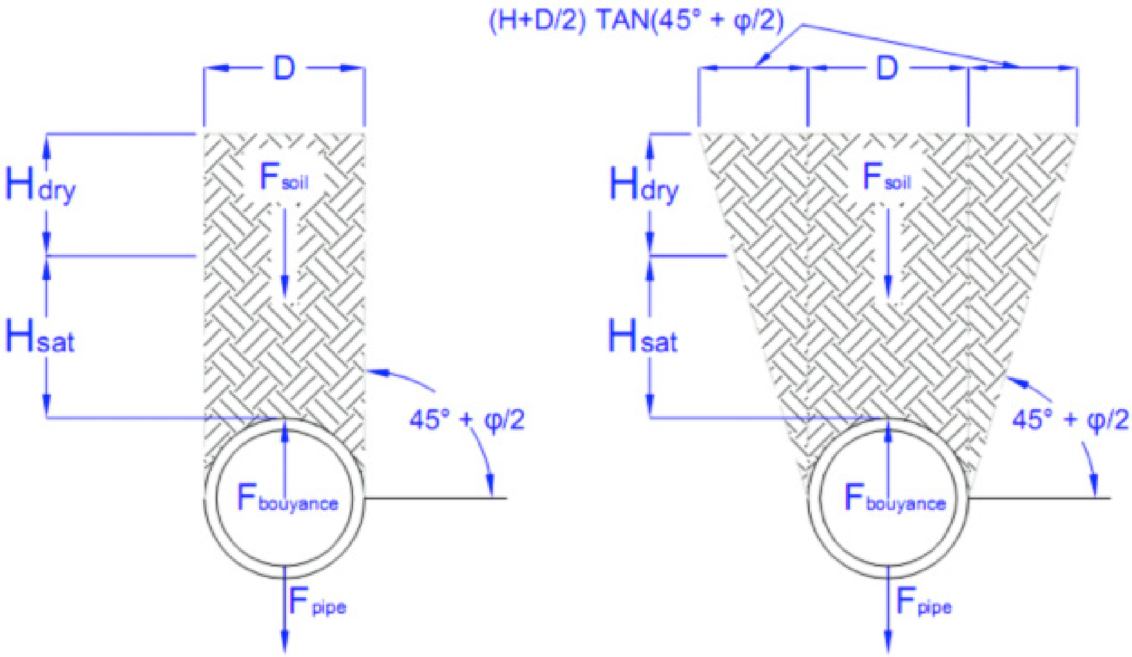

Figure 1a: Marston's, or column loading condition **Figure 1b:** Prism Loading condition

The minimum depth of cover (H) required to counteract the buoyant force of empty Eagle Corr PE pipe is calculated for a static condition where the sum of the forces acting on the pipe is zero (see *Equation 1*). To obtain a conservative minimum cover height recommendation, it is assumed that the soil friction angle is 90 degrees which results in a column load (see *Figure 1a*) of the soil; not the more traditional prism load associated with a friction angle less than 90 degrees (see *Figure 1b*). Equations used to derive the values found in *Table 1*, are shown on the right.

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The equation for weight of soils experienced by a pipe at various water depths, W_{soil}, can be calculated from *Equation 1*:

$$F_{soil} = \gamma_{dry} H_{dry} D + (\gamma_{sat} - \gamma_w)(H_{sub} + 0.1073D) D$$

$$F_{soil} = \text{Weight of soil, in LB/FT}$$
$$\gamma_{dry} = \text{Dry unit weight of soil, lb/ft}^3$$
$$D = \text{O.D. of the pipe, FT}$$
$$\gamma_{sat} = \text{Saturated unit weight of the soil, lb/ft}^3$$
$$\gamma_w = \text{unit weight of water, 62.4 lb/ft}^3$$
$$H_{sub} = \text{depth of submerged soil over crown of pipe, ft}$$

The hydrostatic uplift force, U, can be calculated from *Equation 2*, shown below:

$$F_{bouyance} = \frac{\pi}{4} D^2 \gamma_w$$

$$F_{bouyance} = \text{LB/LF of pipe}$$
$$D = \text{O.D. of the pipe, FT}$$
$$\gamma_w = \text{unit weight of water, 62.4 lb/ft}^3$$

In order to prevent pipe floatation from happening, the first step is to ensure that the hydrostatic uplift force is less than the combined downward forces of the pipe, W_{pipe} and the soils, W_{soil}. *Equation 3* demonstrates this basic principle.

$$\sum F = 0$$

$$F_{bouyance} - F_{soil} - F_{pipe} = 0$$

$$F_{bouyance} \leq F_{soil} + F_{pipe}$$

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Figure 2:

There are other methods to prevent soil floatation in the case that the pipe cannot be installed with adequate soil cover. These methods include, but are not limited to, precast concrete weights (see *Figure 2a*), or anchor assemblies (see *Figure 2b*). Precast concrete weights are used and installed over the top and sides of the pipe to increase the downward forces around the pipe to prevent floatation. Anchors, alternatively, secure the pipe more firmly to the bedding or surrounding trench walls. Flowable fill solutions are often used in pipe installation applications. Due to the varying densities of flowable fills, floatation analysis should be performed for pipe installed with this procedure.

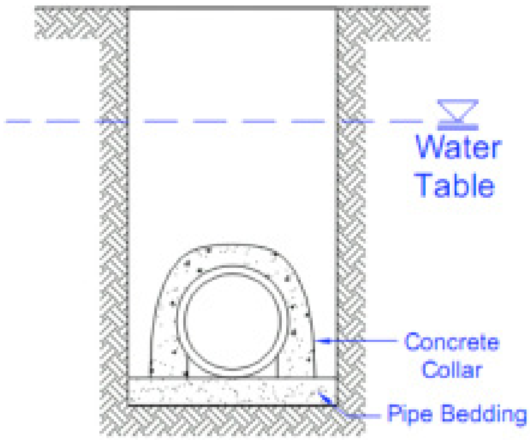

Figure 2a

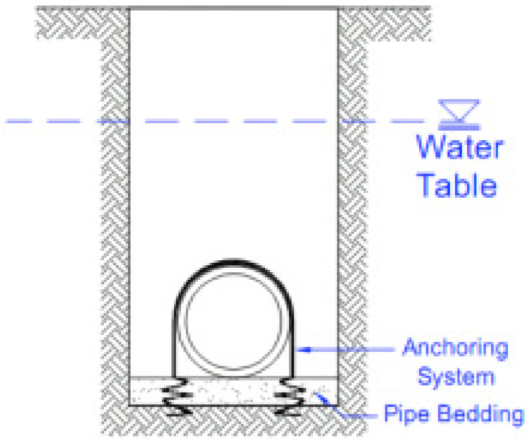

Figure 2b

Again, the engineer is encouraged to evaluate specific site conditions and make an independent evaluation. For additional information or assistance for unique site conditions, please contact your local JM Eagle sales representative.