



## PONDS 3.2 TECHNICAL MEMO

Date: September 25, 2006

Re: **Adjusting Geometry Parameters (etc) for an Exfiltration Trench**

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The following memo outlines some details that may need to be considered when modeling an exfiltration trench (i.e., French drain, etc.) using the PONDS 3.2 Refined Method. These considerations affect the following:

- Stage vs Area Data
- Maximum Area for Unsaturated Infiltration

Consider the example of a gravel filled trench as depicted in Exhibit 1 below.

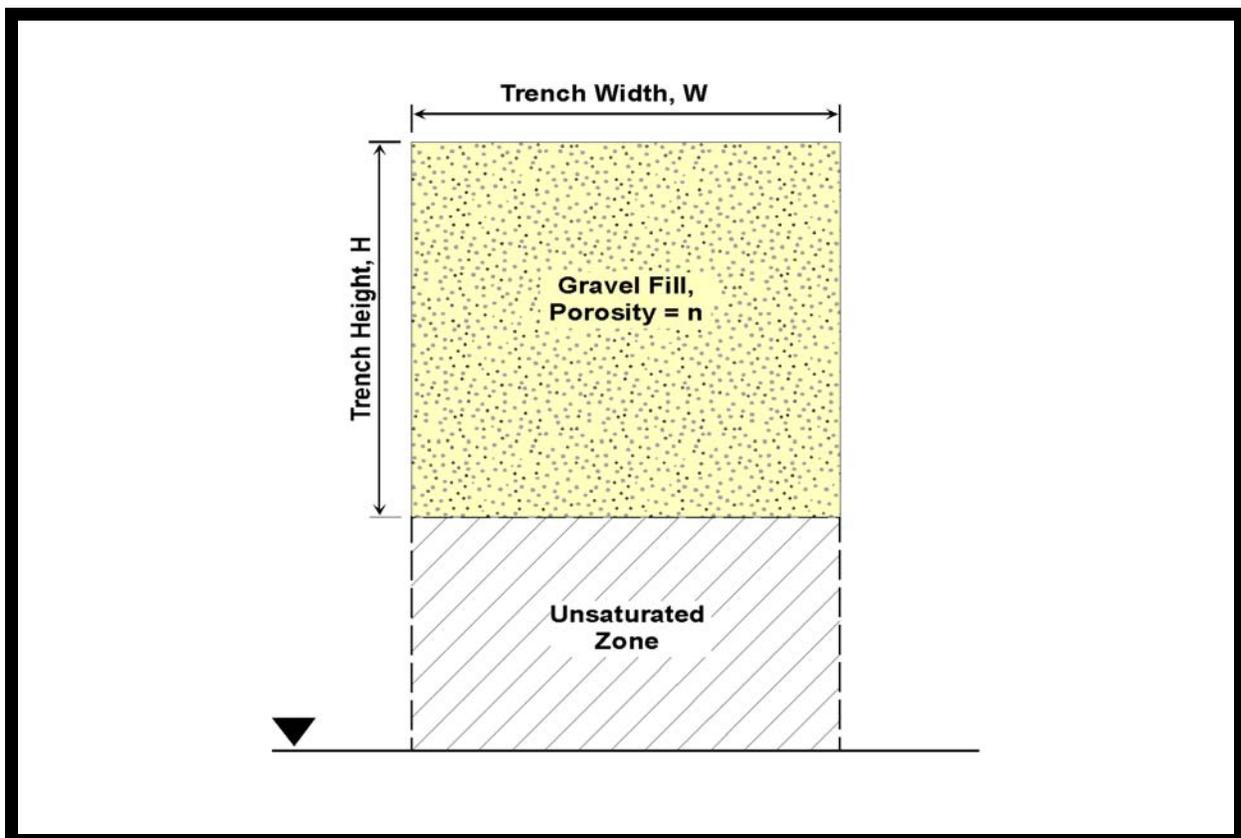


Exhibit 1. Gravel filled exfiltration trench

- The width of the trench excavation is  $W$ . The bottom area of the excavation is  $W \times L$
- The porosity of the gravel fill is  $n$ , which for gravel fill is typically on the order of  $n = 0.4$ , or 40%.
- If vertical unsaturated infiltration is considered, then the soil voids in the soil beneath the trench bottom are available for filling.

### Problem...

PONDS 3.2 models an open pond/trench, i.e., porosity within the pond equals 1.0. It does not directly model a pond/trench with a porosity less than 1.0.

In PONDS 3.2, the stage vs area data are used to define the storage volume relationship of the pond, i.e., the stage vs area data are integrated in order to calculate the storage volume. When analyzing a gravel filled exfiltration trench (or other trench configuration in which the internal porosity of the trench is less than 1.0) the stage vs area data needs to be adjusted so that the resulting storage calculation remains correct.

In order to do this, the areas in the stage vs area are adjusted as follows:

$$\text{Area}_{\text{adjusted}} = \text{Area}_{\text{actual}} \times n = W \times L \times n$$

where

$n$  is the porosity of the gravel fill

$W$  is the width of the trench excavation

$L$  is the length of the trench excavation

Adjusting the stage vs area data in this fashion, is equivalent to modeling an open trench (porosity = 1.0) as depicted in Exhibit 2 below.

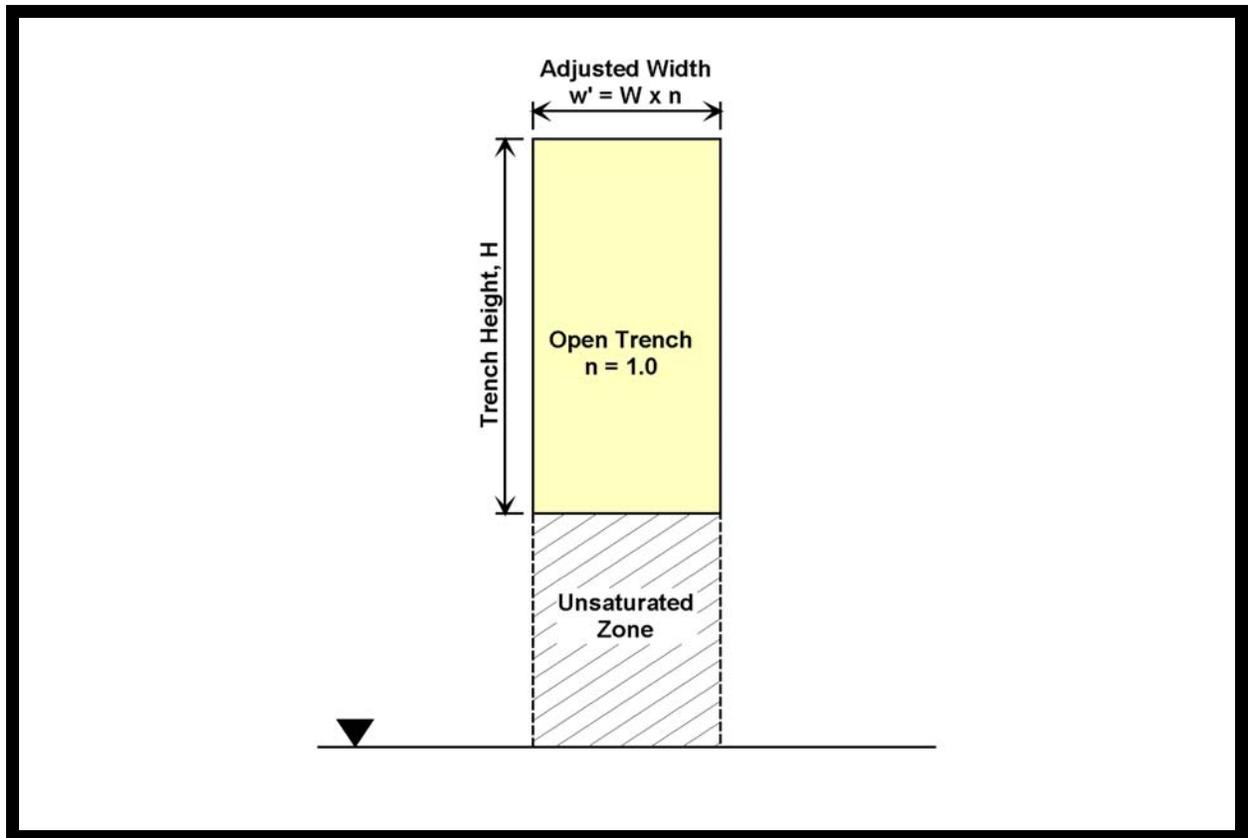


Exhibit 2. Equivalent open trench

### Problem...

In PONDS 3.2 the volume of soil voids which is available for filling during vertical unsaturated infiltration is determined by specifying a **MAXIMUM AREA FOR UNSATURATED INFILTRATION**. PONDS calculates the volume in the soil voids beneath the specified area, and unsaturated infiltration occurs until the soil void volume is filled. However, the Maximum Area for Unsaturated Infiltration cannot be greater than the largest area in the stage vs area data, and for an exfiltration trench (assuming vertical walls) the Maximum Area for Unsaturated Infiltration is generally equal to the area of the trench bottom.

The representation shown in Exhibit 2 above implies a Maximum Area for Unsaturated Infiltration equal to  $W \times L \times n$  which is less than the actual bottom width of the trench,  $W \times L$ . Therefore, using this model configuration provides less available soil void volume for vertical unsaturated infiltration, which may or may not be acceptable depending on the application.

In order to ensure that all of the soil void volume beneath the trench is available for vertical unsaturated infiltration, the trench configuration shown in Exhibit 3 can alternately be utilized.

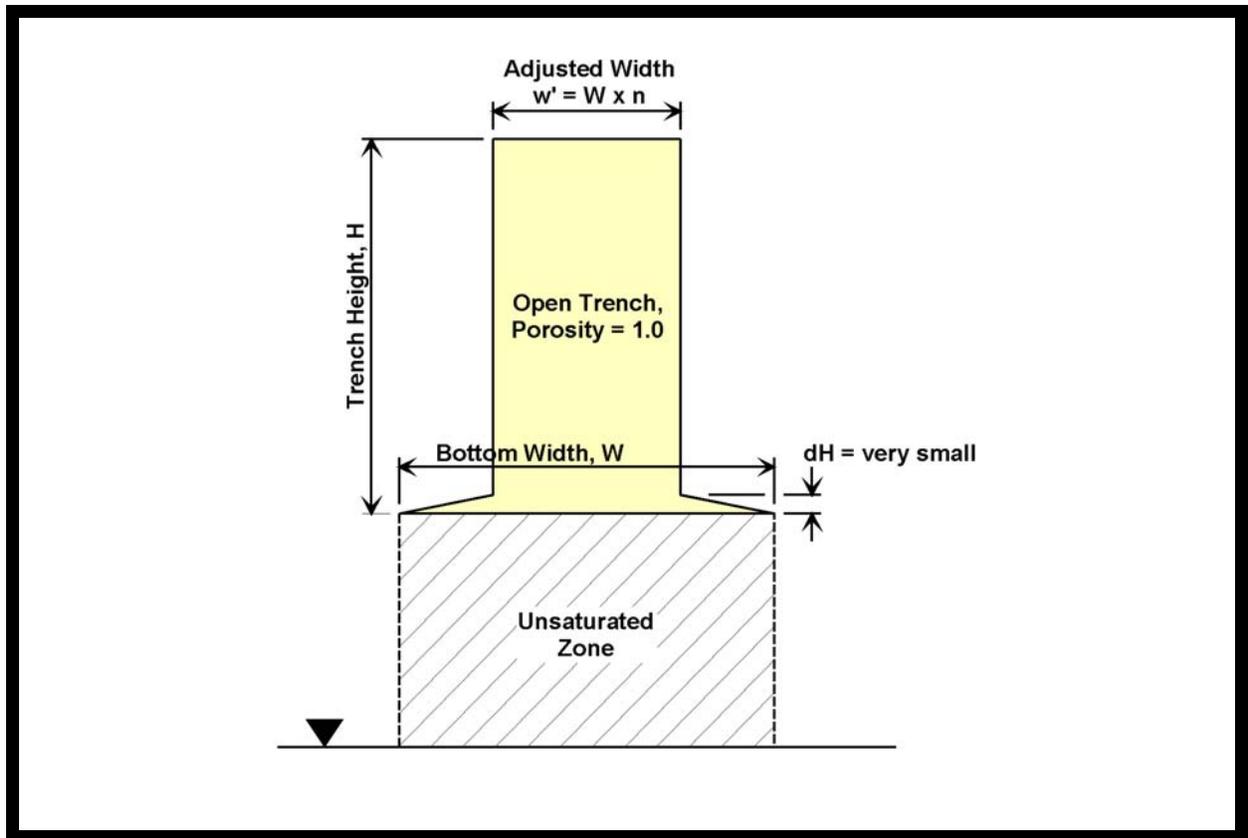


Exhibit 3. Alternate equivalent open trench in PONDS 3.2

In Exhibit 3 above, the area of the trench transitions from the actual trench bottom area ( $W \times L$ ) to the equivalent porosity-adjusted area ( $W \times L \times n$ ) over a small vertical increment ( $dH$ ). This preserves the soil void volume available for unsaturated infiltration, because it allows the Maximum Area for Vertical Infiltration to be set to the actual trench bottom area. However, the vertical increment ( $dH$ ) needs to be set very small to avoid introducing a significant error in the resulting storage volume calculation within the trench. (Setting the value of  $dH$  *too small* may result in convergence problems, so this value may need to be determined iteratively.)

Note: This example can be adapted for other types of trench configurations, such as a drain pipe in a gravel envelope or a manufactured infiltration chamber system.