

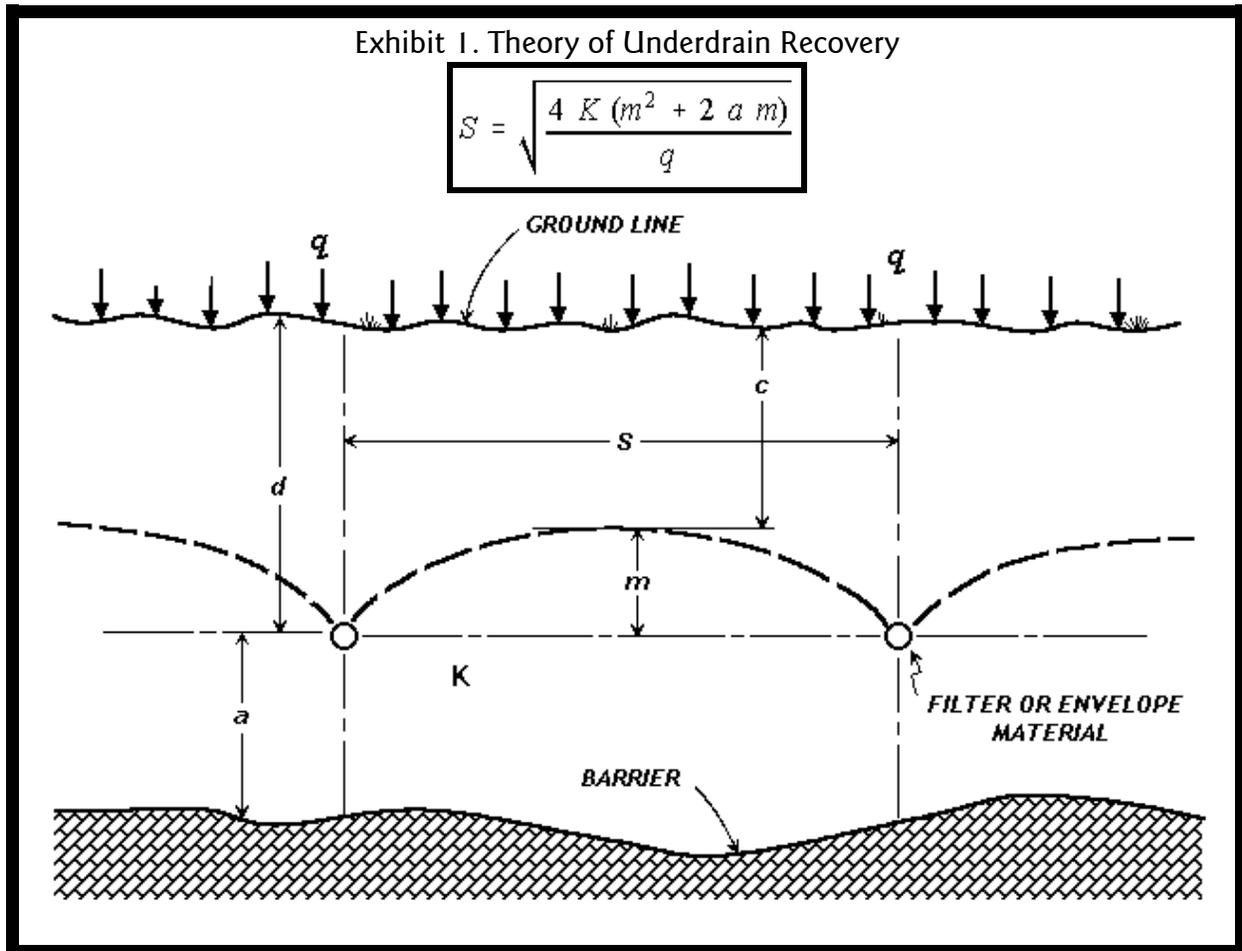
PONDS 3.2 TECHNICAL MEMO

Date: December 12, 2006

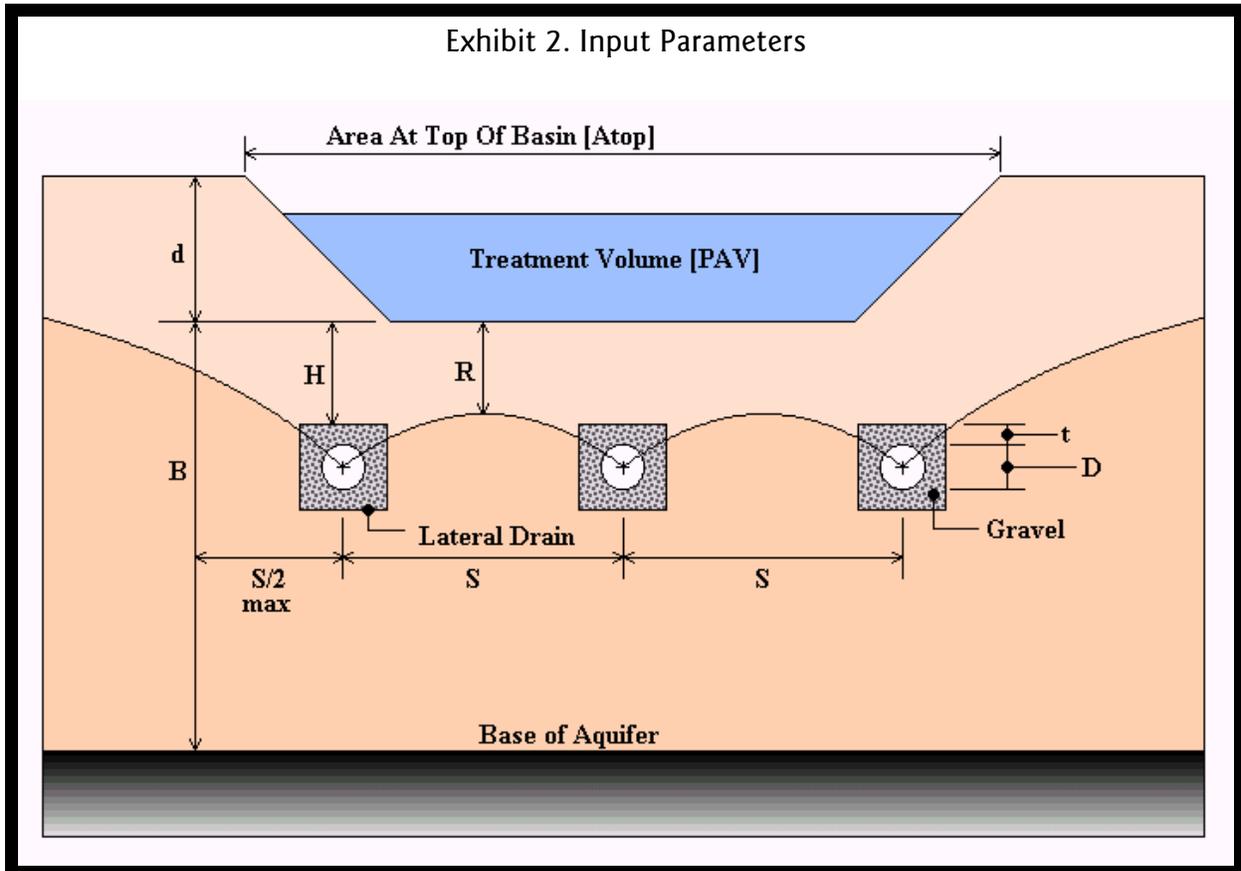
Re: Defining Tailwater Conditions in PONDS Underdrain Module

How to account for tailwater condition when the tailwater elevation at the point of discharge is higher than the underdrain invert elevation.

Exhibit 1 (below) shows the theory of underdrain recovery which is implemented in the PONDS Underdrain module.



In the PONDS Underdrain module the input parameters, based on the formula in Exhibit 1, are expressed as shown in Exhibit 2 below. Note that the parameter d in Exhibit 1 is equivalent to $H+t+D/2$ in Exhibit 2, and that this quantity represents the distance from ground surface (pond bottom) to the discharge control elevation (centerline of the drain pipe for free discharge conditions).



The parameter d (or $H+t+D/2$) has the following two (2) mathematical interpretations (depending on tailwater effects):

- ① When the tailwater elevation is at or below the center of the underdrain pipe, there is free discharge and d is the vertical separation from the pond bottom to the pipe centerline, as shown in Exhibit 3 below.

and

- ② When the tailwater elevation is above the center of the underdrain pipe, d is the vertical separation between the pond bottom elevation and the tailwater elevation, as seen in Exhibits 4 and 5 below. Note that Exhibit 5 depicts the special case of an upturned drain pipe.

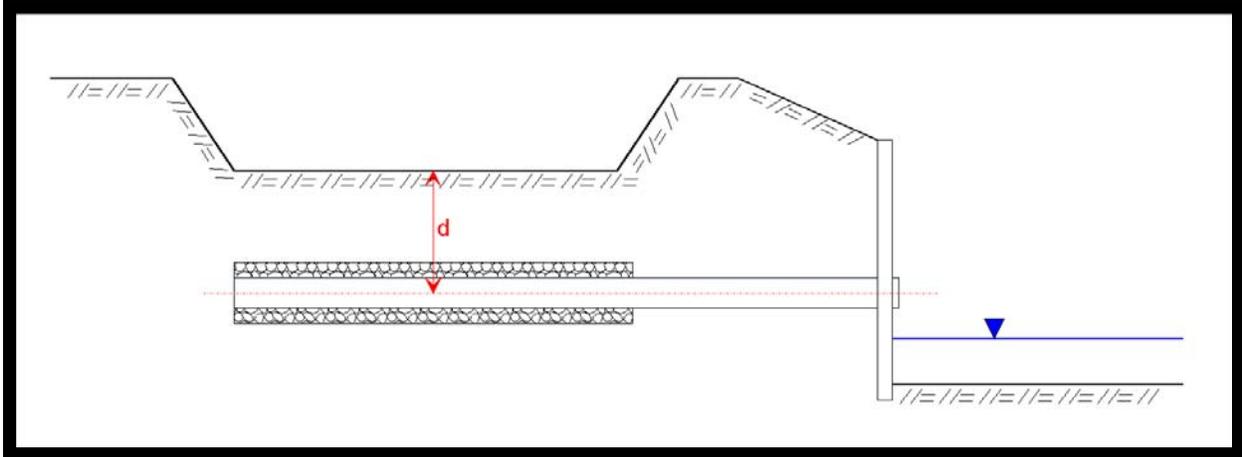


Exhibit 3. Definition of “**d**” for free discharge

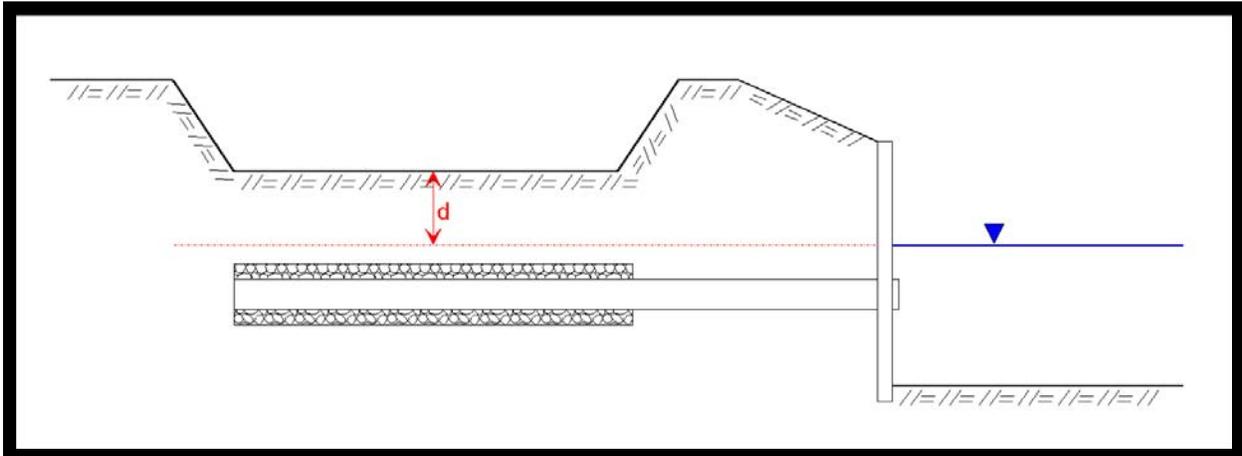


Exhibit 4. Definition of “**d**” when tailwater is present

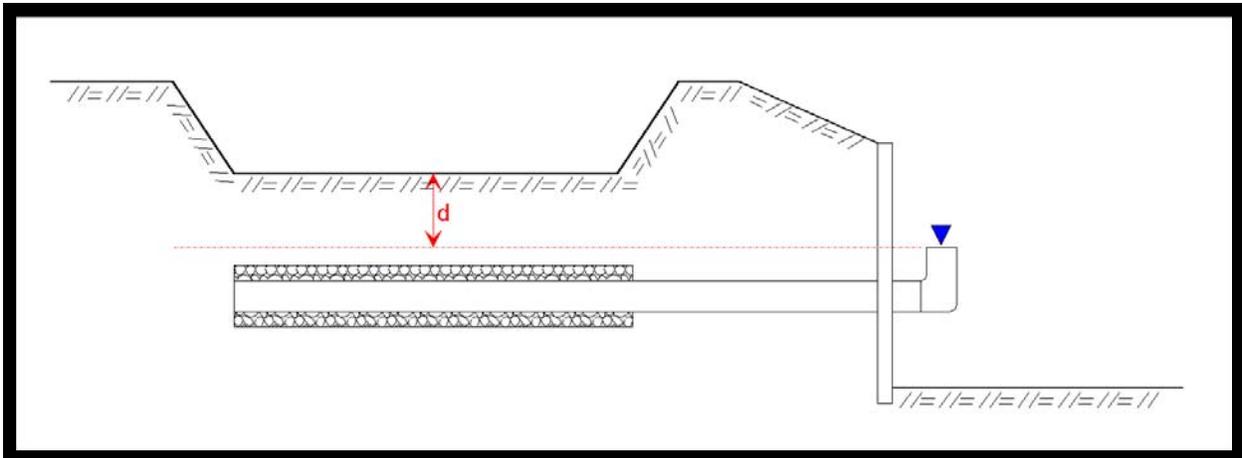


Exhibit 5. Definition of “**d**” for upturned drain pipe

Early versions of the PONDS Underdrain module did not include an option for directly specifying the tailwater elevation, but the tailwater effect could be included by manually adjusting the value of d (i.e., $H+t+D/2$), as described above.

Recent versions of the PONDS Underdrain module include an option to directly specify the tailwater elevation and the adjustments in the calculation of " d " (as defined above) are made internally in the software, i.e., the user specifies the actual thickness of soil cover (H), thickness of gravel pack (t) and underdrain pipe diameter (D).