

For situations 1 and 2 see figure 14-9.1.

A third situation occurs with culverts installed on steep slopes. The inlet may or may not be submerged. A major portion of the culvert will not be flowing full (free water surface in culvert barrel) and the outlet is free. (See figure 14-9.2.)

For the cases cited above culvert flow may be classified as either flow with outlet control or flow with inlet control. In cases where it is not obvious which flow condition exists, determine the culvert size (or discharge) for each condition. The condition that gives the larger pipe size (or smaller discharge) governs.

#### Outlet Control

Outlet control exists under the following conditions:

1. Culvert is on mild or no slope.
2. Inlet is submerged.
3. Head ( $H$ ) is difference between the headwater level and the tailwater level when the outlet is completely submerged or the  $0.6D$  level when the outlet is partially submerged.

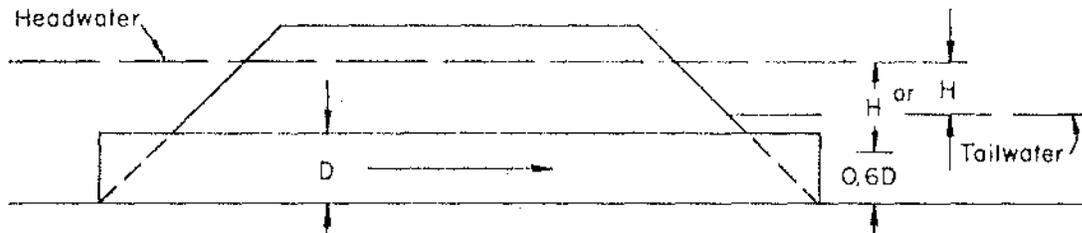


Figure 14-9.1 Outlet control - full pipe flow

#### Inlet Control

Inlet control exists under the following conditions:

1. Inlet may or may not be submerged.
2. Culvert is on a steep slope.
3. Culvert has free outlet.
4. There is a free water surface in the culvert barrel.

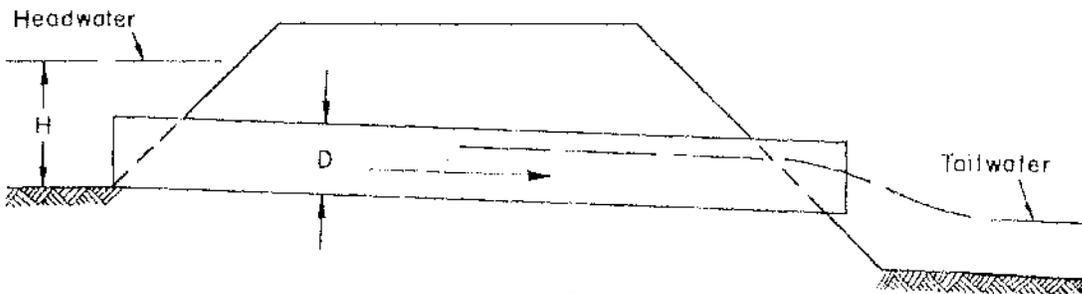


Figure 14-9.2 Inlet control

The above is a very simplified discussion of culvert hydraulics. Conditions that cannot be classified as outlet or inlet control will generally be some type of channel flow. Capacity tables for culverts with outlet and inlet control are given in Exhibits 14-4.1 and 14-4.2, respectively.

#### Culvert Elevation

An alternate procedure for establishing the hydraulic gradient and the culvert elevation is shown in Figure 14-9.3.

More complete information on the hydraulics of culvert and drain ditch design may be found in Chapter 3 of this handbook and in Chapter 6, Section 16, National Engineering Handbook.

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