CAPACITY OF CORRUGATED METAL PIPE OUTLETS AND CROSSINGS

The Manning's "n" value of the CMP is usually larger than that of the drain and the CMP pipe usually has a smaller capacity than the drain of the same size and slope. The difference in "n" value causing the difference in capacity should be considered in the design of the system. The problem is not unique to drain outlets; it also occurs anywhere the "n" value varies. This difference is "n" values in a subsurface drainage system usually occurs at crossings under roads, at junction boxes or other drainage appurtenances that involve different drain materials than that installed in the main lines.

The considerations for designing for uniform capacity throughout the subsurface drainage system are as follows:

The capacity of drains is calculated using Manning's equation. In determining the capacity of the drain, the drain is assumed to be full of water with the hydraulic gradient at the crown of the drain. These assumptions are made so the drain at design capacity will not flow under pressure and the movement of the ground water will generally be into the drain. Under field conditions drains may run part full, under pressure or at the design capacity. While these different flow conditions may occur, the drain design should generally be made using the previously designated assumptions.

The design can be made using any of the following methods. The method used may depend on outlet conditions or equipment available for construction.

1. Use a CMP outlet the same diameter as the drain and construct it on adequate slope to carry the design flow.

   Example: Design flow = 0.83 $ft^3$/sec

   Drain size = 10"

   Using drain capacity chart, Exhibit 14-11.3, RTSC-NE-ENG-1443, for "n" value of .025 the required slope is .0055 feet per foot or .11 foot in a 20-foot length of pipe. Some soil conditions may require a concrete connector for the same size pipes or the outlet pipe to be large enough to slip over the main drain.

2. Use the same grade as the main drain and increase the size of the CMP to carry the design flow from the drain.

   Example: Design flow = 0.83 $ft^3$/sec

   Size of the main drain = 10"

   Slope of the drain = .0023 feet/foot

   Capacity of the main drain = 1.25 $ft^3$/sec

The actual capacity of the main drain of 1.25 $ft^3$/sec is more than the design capacity of 0.83 $ft^3$/sec based on a drainage coefficient. Using Exhibit 14-11.3, a 12-inch CMP is required to carry the 0.83 cfs design flow on a grade of .0020 feet per foot. The actual capacity of the 12-inch CMP on a grade of .0023 feet per foot is 0.89 $ft^3$/sec.

3. In some instances, the size of the CMP required may be several inches larger than the drain size. To prevent excessive pressure flow in the main drain use a combination of next larger size CMP outlet and increase the gradient until the CMP outlet has the required capacity.

Example: Design flow = 0.83 $ft^3$/sec

Size of main drain = 10"

Slope of main drain = .00096 feet/foot

Try 12" CMP on .00096 grade. Capacity = 0.57 $ft^3$/sec. The slope must be increased to carry the design flow.

Using Exhibit 14-11.3, the slope of the 12" CMP must be increased to .002 feet per foot to carry the 0.83 cubic feet per second or an .04 foot fall in a 20-foot length of pipe.

Any of the procedures outlined above should be adequate to provide for the design flow of drains with varying "n" values. The same procedure can be used if the design problem is at the outlet of the drain or at any location along the drain.