# Appendix D.10

# Method for Computing Peak Discharge for Water Quality Storm

**METHOD FOR COMPUTING PEAK DISCHARGE FOR WATER QUALITY STORM**
(Adapted from Claytor and Schueler, 1996)

The peak rate of discharge is needed for the sizing of off-line diversion structures and to design grass channels. Conventional SCS methods underestimate the volume and rate of runoff for rainfall events less than 2". This discrepancy in estimating runoff and discharge rates can lead to situations where a significant amount of runoff by-passes the filtering treatment practice due to an inadequately sized diversion structure or leads to the design of undersized grass channels.

The following procedure can be used to estimate peak discharges for small storm events. It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt, 1994) and utilizes the NRCS, TR-55 Graphical Peak Discharge Method (USDA, 1986).

- Using the $WQ_V$ methodology, a corresponding Curve Number (CN) is computed utilizing the following equation:

$$CN = \frac{1000}{[10 + 5P + 10Q_a - 10\sqrt{Q_a^2 + 1.25Q_aP}]}$$

where: $P$ = rainfall, in inches (use 1.0" or 0.9" for the Water Quality Storm)
$Q_a$ = runoff volume, in inches (equal to $P \times R_v$)

Note: The above equation is derived from the SCS Runoff Curve Number method described in detail in NEH-4, Hydrology (SCS 1985) and SCS TR-55 Chapter 2: Estimating Runoff. The CN can also be obtained graphically using Figure D.10.1 or from TR-55.

- Once a CN is computed, the time of concentration ($t_c$) is computed (based on the methods identified in TR-55, Chapter 3: "Time Of Concentration And Travel Time").

- Using the computed CN, $t_c$ and drainage area ($A$), in acres; the peak discharge ($Q_p$) for the Water Quality Storm is computed (based on the procedures identified in TR-55, Chapter 4: "Graphical Peak Discharge Method"). Use Rainfall distribution type II.

  - Read initial abstraction ($I_a$), compute $I_a/P$
  - Read the unit peak discharge ($q_u$) from Exhibit 4-II for appropriate $t_c$
  - Using the runoff volume ($Q_a$), compute the peak discharge ($Q_p$); $\boldsymbol{Q_p = q_u \times A \times Q_a}$

    where: $Q_p$ = the peak discharge, in cfs
    $q_u$ = the unit peak discharge, in cfs/mi²/inch
    $A$ = drainage area, in square miles
    $Q_a$ = runoff volume, in watershed inches

Example Calculation of Peak Discharge for Water Quality Storm

Using a 3.0 acre small shopping center having a 1.0 acre flat roof, 1.6 acres of parking, and 0.4 acres of open space, and using $P = 1.0"$; the weighted volumetric runoff coefficient ($R_v$) is:

$$R_v = 0.05 + 0.009(I);\ I = 2.6 \text{ acres}/3.0 \text{ acres} = 0.867\ (86.7\%)$$
$$= 0.05 + 0.009(86.7\%)$$
$$= 0.83$$

The runoff volume, $Q_a$ is:

$$Q_a = P \times R_v$$
$$= 1.0" \times 0.83$$
$$= 0.83 \text{ watershed inches}$$

and $WQ_v$ is:

$$WQ_v = \frac{[(1.0")(0.83)(3.0\ acres)]}{12} \times \frac{43{,}560\ ft^2}{acre} = 9{,}039\ ft^3$$

Using $Q_a = 0.83$ watershed inches and $P = 1.0"$; CN for the water quality storm is:

$$\text{CN} = \frac{1000}{[10 + (5)(1.0") + (10)(0.83) - 10\sqrt{(0.83)^2 + 1.25(0.83)(1.0")}]} = 98$$

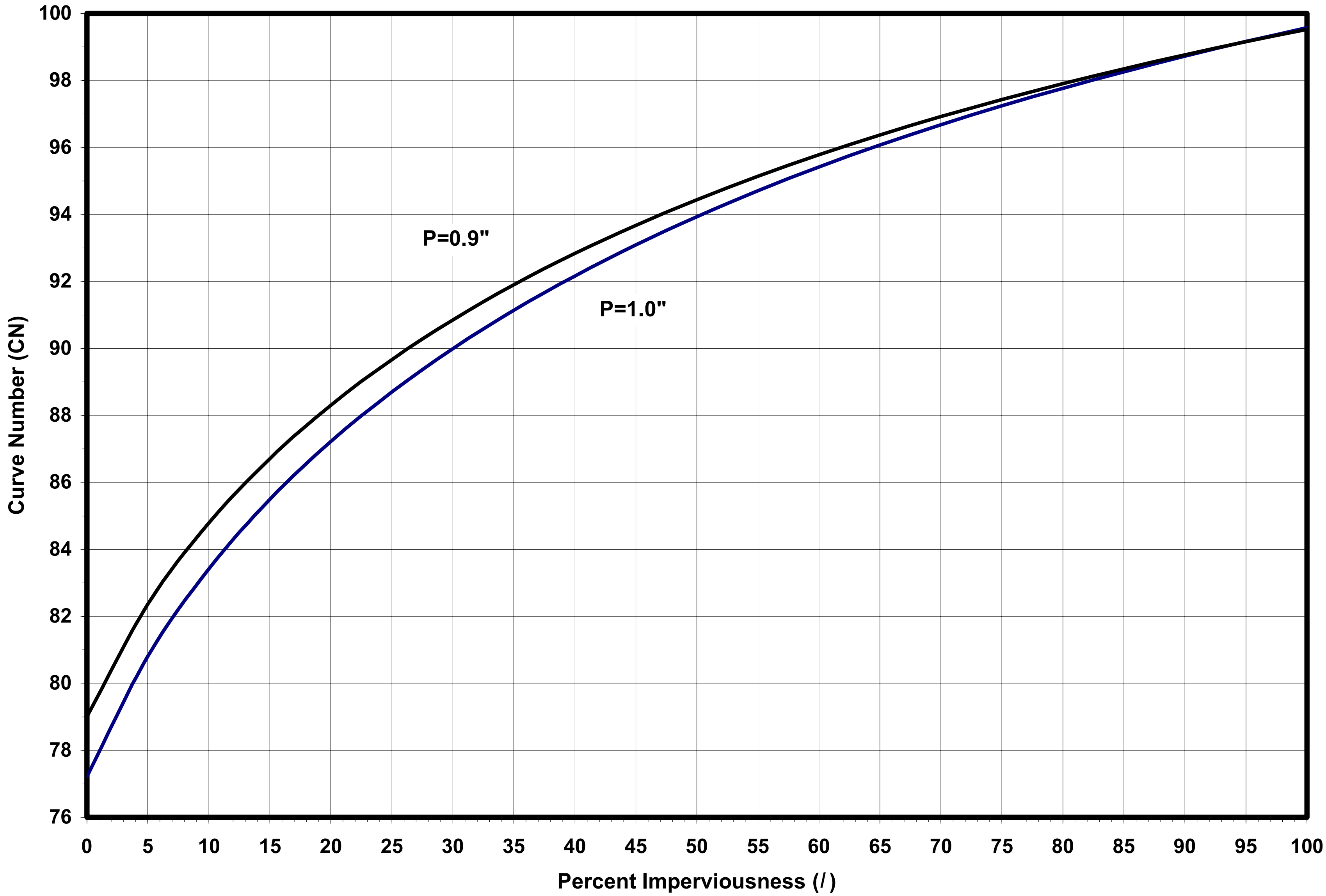
Using: $t_c = 10$ minutes (0.17 hour);
$I_a = (200/\text{CN}) - 2 = 0.041$;
$I_a/P = (0.041/1.0") = 0.041$;
$q_u = 950$ csm/in. (from TR-55 Exhibit 4-II); and
$A = 3.0 \text{ acres} \times {}^{1}/_{640} \text{ mi}^2 \text{ per acre} = 0.0047 \text{ mi}^2$

$$Q_p = (950 \text{ csm/in.})(0.0047 \text{ mi}^2)(0.83") = 3.7 \text{ cfs}$$

For computing runoff volume and peak rate for storms larger than the Water Quality Storm (i.e., 2, 10 and 100 year storms), use the published CN's from TR-55 and follow the prescribed procedure in TR-55.

In some cases the Rational Formula may be used to compute peak discharges associated with the Water Quality Storm. The designer must have available reliable intensity, duration, frequency (IDF) tables or curves for the storm and region of interest. This information may not be available for many locations and therefore the TR-55 method described above is recommended.

**Figure D-10.1 Curve Number (CN) for Water Quality Storm - Rainfall (P) =1.0" & 0.9"**



**References**

Pitt, R., 1994, Small Storm Hydrology. University of Alabama - Birmingham. Unpublished manuscript. Presented at design of stormwater quality management practices. Madison, WI, May 17-19 1994.

Schueler, T.R. and R.A. Claytor, 1996, Design of Stormwater Filter Systems. Center for Watershed Protection, Silver Spring, MD.

United States Department of Agriculture (USDA), 1986. Urban Hydrology for Small Watersheds. Soil Conservation Service, Engineering Division. Technical Release 55 (TR-55).