

6. The calculated outflow volume, V_o , (cubic feet), during the given duration and the adjustment factor at that duration calculated using the equation:

$$V_o = Q_{av} (60T) \quad (\text{SO-9})$$

7. The required storage volume, V_s (cubic feet), calculated using the equation:

$$V_s = V_i - V_o \quad (\text{SO-10})$$

The value of V_s increases with time, reaches a maximum value, and then starts to decrease. The maximum value of V_s is the required storage volume for the detention facility. Sample calculations using this procedure are presented in Design Example 6.2. The modified *FAA Worksheet* of the [UD-Detention Spreadsheet](#) performs these calculations.

3.2.4 Simplified Full-Spectrum Detention Sizing (Excess Urban Runoff Flow Control)

With urbanization, the runoff volume increases. Percentage-wise, this increase is much more noticeable for the smaller storm events than for the very big ones, such as the 100-year storm. Wulliman and Urbonas (2005) suggested a concept they termed *Full Spectrum Detention*. This concept was studied using extensive modeling, including continuous simulations of a calibrated watershed. Based on this modeling the original set of equations was slightly modified to increase the EURV by 10%. The protocol that resulted and that is described below reduced runoff peak flows from urbanized areas to more closely approximate the runoff peaks along major drainageways before urbanization occurred.

This concept captures a volume of runoff defined as the *Excess Urban Runoff Volume* (EURV) and then releases it over approximately 72-hours. EURV is larger than the Water Quality Capture Volume (WQCV) defined in Volume 3 of this *Manual* and varies with the type of NRCS soil group upon which urbanization occurs. EURV includes within its volume the WQCV, which then makes it unnecessary to deal with it separately when the *Full Spectrum Detention* design is used. *Full Spectrum Detention* Equations SO-11, -12 and -13 may be used to find the EURV depths in watershed inches. They were developed using the hydrologic methods described in this *Manual*.

$$\text{NRCS Soil Group A:} \quad EURV_A = 1.1 \cdot (2.0491 \cdot i - 0.1113) \quad (\text{SO-11})$$

$$\text{NRCS Soil Group B:} \quad EURV_B = 1.1 \cdot (1.2846 \cdot i - 0.0461) \quad (\text{SO-12})$$

$$\text{NRCS Soil Group C/D:} \quad EURV_{CD} = 1.1 \cdot (1.1381 \cdot i - 0.0339) \quad (\text{SO-13})$$

in which, $EURV_K$ = Excess Urban Runoff Volume in watershed inches ($K = A, B$ or CD),

i = Imperviousness ratio ($I/100$)

By combining the capture and slow release of the EURV with the 100-year control volumes for Soil Types B, C and D recommended by [Equations SO-1](#) and [SO-2](#) or for Soil Type A recommended by [Equation SO-5](#) with the 100-year release rates based on recommendations in [Table SO-1](#), this concept was found to be more effective in controlling peak flow along major drainageways for almost all levels of storms than provided by the simplified equations or the FAA Method, even for relatively large urban catchments.

The EURV is found using volumes obtained for each soil type, which are then area weighted in proportion to the total catchment's area. The watershed inches of EURV are then converted to cubic feet or acre-feet. The total 100-year detention basin volume is found using [Equations SO-1](#) and [SO-2](#) for Type B, C and D soils or [Equation SO-5](#) for Type A soils, which are also area-weighted by soil types and converted to cubic feet or acre feet. The outlet is designed to empty the EURV in approximately 72 hours. Volumes exceeding EURV are controlled by an outlet designed for a composite maximum 100-year release rate based on unit rates recommended in [Table SO-1](#).

[Equation 13a](#) was developed to assist in the sizing of the openings of the perforated plate outlet to drain the EURV in 72 hours, provided the outlet follows the standardized design developed originally with the WQCV outlet for an Extended Detention Basin (EDB) described in Volume 3, namely the perforations are spaced vertically on 4" centers. [Figure SO-8](#) depicts the results of this equation in graphical form. The equation and the figure are only applicable for water depths in the basin between one and eight feet and designers should not extrapolate beyond this range. Outlets needing greater or lesser depths than these need to be designed individually using either EPA SWMM, UD-Detention spreadsheet or other appropriate software. The *Full-Spectrum Worksheet* of the [UD-Detention Spreadsheet](#) performs all of these calculations for the standardized designs, including adjustments for imperviousness due to Level 1 and 2 of MDCIA, accounts for the effects of various soil type distributions in the tributary catchment and has a provision for selecting the local government's policy in how the WQCV is treated as part of the 100-year volume, although the District does not recommend adding any portion of the WQCV to the 100-year volume calculated using this spreadsheet.

$$A = \left[\frac{EURV}{0.0166 \cdot H^2 + 0.2055 \cdot H + 0.1543} \right]^{\frac{1}{-0.0018 \cdot H^2 - 0.0068 \cdot H + 1.0015}} \quad \text{SO-13a}$$

In which, A = open area per row of perforations, in square inches
 H = maximum water depth in basin above the bottom of lowest perforation, in feet
 $EURV$ = excess urban runoff volume, in acre feet

Whenever possible, it is suggested that circular orifice openings be used, beveled on the downstream side. The goal is to find a commonly available drill-bit size that will match the needed area with as few columns of perforations as possible. To achieve this, the designer should seek a drill bit size that will deliver an area within +5% and -10% of the one calculated using Equation SO-13a or Figure SO-8.

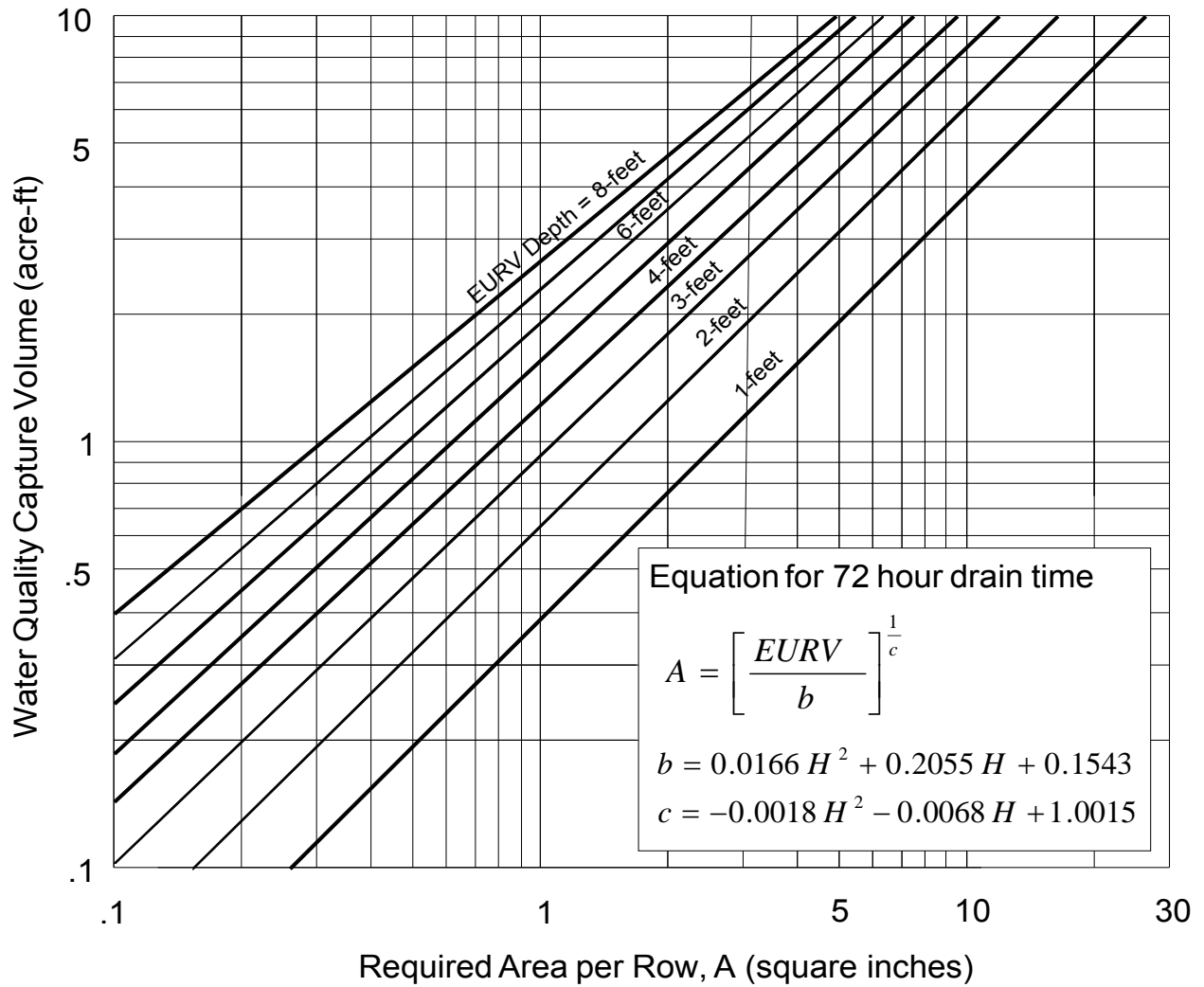


Figure SO-8—Outlet Sizing for EURV Control with 72-hour Drain Time for On-Site Detention

5.0 DISTRICT MAINTENANCE ELIGIBILITY FOR DETENTION FACILITIES

The District has a program to assist local jurisdictions in the on-going maintenance of major drainage facilities including detention facilities. These guidelines change over time as budgets, priorities and needs of the community change. Check the District's Web site (www.udfcd.org) for the most-current maintenance eligibility requirements. Maintenance Eligibility Guidelines as of June 2001 are provided on the CD version of this *Manual*.

There are some common features for which the District's policy is unlikely to change over time. One is the requirement that the facility be owned by or be under control of a public body. "Public body" is defined as a local government (city or county), special district (such as a park district), or a metropolitan district that has a service plan that includes the maintenance and operation of drainage facilities. The public body has to have a reliable funding source to fund maintenance. Legal maintenance access to the detention facility must be made available to the District by the local jurisdiction in accordance with any of the following criteria:

1. The facility is owned by a public body that has accepted primary maintenance responsibility for it.
2. The ownership of the facility is by a private entity (such as a homeowners association owning common areas), but a body has accepted primary maintenance responsibility and has a maintenance access easement(s) that allows it to perform maintenance if the owner does not. Easements crossing individual lots are not acceptable.