CHAPTER 5
FLOW CONTROL DESIGN

KING COUNTY, WASHINGTON SURFACE WATER DESIGN MANUAL

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5.3.1 DETENTION PONDS — DESIGN CRITERIA

FIGURE 5.3.1.D PERMANENT SURFACE WATER CONTROL POND SIGN

SPECIFICATIONS:

Size: 48 inches by 24 inches

Material: 0.125-gauge aluminum

Face: Non-reflective vinyl or 3 coats outdoor enamel (sprayed).

Lettering: Silk screen enamel where possible, or vinyl letters.

Colors: Beige background, teal letters.

Type face: Helvetica condensed. Title: 3 inch; Sub-Title: 1 1/2-inch; Text: 1 inch; Outer border: 1/8-inch border distance from edge; 1/4-inch; all text 1 3/4-inch from border.

Posts: Pressure treated, beveled tops, 1 1/2-inch higher than sign.

Installation: Secure to chain link fence if available. Otherwise install on two 4”x4” posts, pressure treated, mounted atop a gravel bed, installed in 30-inch concrete filled post holes (8-inch minimum diameter), with the top of sign no higher than 42 inches from ground surface.

Placement: Face sign in direction of primary visual or physical access. Do not block any access road. Do not place within 6 feet of structural facilities (e.g. manholes, spillways, pipe inlets).

Note: If the facility has a liner to restrict infiltration of stormwater, the following note must be added to the face of the sign: “This facility is lined to protect groundwater quality.” In addition, specific information about the liner must be added to the back of the sign as specified in Section 6.2.4.
5.3.1.2 METHODS OF ANALYSIS

Detention Volume and Outflow

The volume and outflow design for detention ponds shall be in accordance with the performance requirements in Chapter 1 and the hydrologic analysis and design methods in Chapter 3. Restrictor orifice structure design shall comply with Section 5.3.4 (p. 5-38). Note: The design water surface elevation is the highest elevation that occurs in order to meet the required outflow performance for the pond.

Detention Ponds in Infiltrative Soils

Detention ponds may occasionally be sited on till soils that otherwise meet the basic criteria of "sufficient permeable soil" for a properly functioning infiltration system (see Section 5.4.1, p. 5-57). These detention ponds have a surface discharge and may also utilize infiltration as a second pond outflow. Detention ponds sized with infiltration as a second outflow must meet all the requirements of Section 5.4 for infiltration ponds, including a soils report, performance testing, groundwater protection, presettling, and construction techniques.

Emergency Overflow Spillway Capacity

The emergency overflow spillway weir section shall be designed to pass the 100-year runoff event for developed conditions assuming a broad-crested weir. The broad-crested weir equation for the spillway section in Figure 5.3.1.E, for example, would be:

\[ Q_{100} = C \left( 2g \right)^{1/2} \left[ \frac{2}{3} LH^{3/2} + \frac{5}{15} (\tan \theta) H^{5/2} \right] \]  

where

- \( Q_{100} \) = peak flow for the 100-year runoff event (cfs)
- \( C \) = discharge coefficient (0.6)
- \( g \) = gravity (32.2 ft/sec²)
- \( L \) = length of weir (ft)
- \( H \) = height of water over weir (ft)
- \( \theta \) = angle of side slopes

Assuming \( C = 0.6 \) and \( \tan \theta = 3 \) (for 3:1 slopes), the equation becomes:

\[ Q_{100} = 3.21 \left( LH^{3/2} + 2.4 H^{5/2} \right) \]  

To find width \( L \) for the weir section, the equation is rearranged to use the computed \( Q_{100} \) and trial values of \( H \) (0.2 feet minimum):

\[ L = \left[ \frac{Q_{100}}{3.21 H^{3/2}} \right] - 2.4 H \quad \text{or} \quad 6 \text{ feet minimum} \]  

FIGURE 5.3.1.E WEIR SECTION FOR EMERGENCY OVERFLOW SPILLWAY
FIGURE 5.3.3.A TYPICAL DETENTION VAULT

NOTE: All vault areas must be within 50' of an access point

PLAN VIEW

NTS

optional
5' x 10' access vault
may be used in
lieu of top access

frames, grates and round solid covers
marked "DRAIN" with locking bolts.
See KCRS dwg. 7-022, 7-023
for specification

wall flange
(typical)

12" min.

SECTION A-A

NTS

NOTES:
1. All metal parts must be corrosion resistant. Steel parts must be galvanized and
asphalt coated (treatment I or better).
2. Provide water stop at all cast-in-place construction joints.
   Precast vaults shall have approved rubber gasket system.
3. Vaults ≤10' wide must use removable lids.
4. Prefabricated vault sections may require structural modifications
to support 5' x 10' opening over main vault. Alternatively, access
can be provided via a side vestibule as shown.
5.3.4 CONTROL STRUCTURES

Control structures are catch basins or manholes with a restrictor device for controlling outflow from a facility to meet the desired performance. The restrictor device is typically a tee section with an orifice plate welded to the bottom (called a "FROP-T"). To meet performance requirements, one or more elbow sections with orifice plates may need to be mounted on the side of the tee section. The restrictor device may also be a weir section sized to meet performance requirements.

Standard control structure details are shown in Figure 5.3.4.A (p. 5-39) through Figure 5.3.4.C (p. 5-41).

5.3.4.1 DESIGN CRITERIA

Multiple Orifice Restrictor

In most cases, control structures need only two orifices: one at the bottom and one near the top of the riser, although additional orifices may best utilize detention storage volume. Several orifices may be located at the same elevation if necessary to meet performance requirements.

1. Minimum orifice diameter is 0.25 inches. Note: In some instances, a 0.25-inch bottom orifice may be too large to meet target release rates, even with minimal head. In these cases, the live storage depth need not be reduced to less than 3 feet to meet performance.

2. Orifices shall be constructed on a tee section as shown in Figure 5.3.4.A (p. 5-39) or on a baffle as shown in Figure 5.3.4.B (p. 5-40).

3. In some cases, performance requirements may require the top orifice/elbow to be located too high on the riser to be physically constructed (e.g., a 13-inch diameter orifice positioned 0.5 feet from the top of the riser). In these cases, a notch weir in the riser pipe may be used to meet performance requirements (see Figure 5.3.4.E, p. 5-43).

4. Consideration shall be given to the backwater effect of water surface elevations in the downstream conveyance system. High tailwater elevations may affect performance of the restrictor system and reduce live storage volumes. Note: The KCRTS program, version 4.0 and later, supports the design of a partially tailwatered control structure by using a headwater/tailwater (HW/TW) data file generated using the KCBW program. The user can specify the use of a HW/TW file within the "Point of Compliance Setup," located within the "Edit Facility" menu screen.

Riser and Weir Restrictor

1. Properly designed weirs may be used as flow restrictors (see Figure 5.3.4.C and Figure 5.3.4.E through Figure 5.3.4.F). However, they must be designed to provide for primary overflow of the developed 100-year peak flow discharging to the detention facility.

2. The combined orifice and riser (or weir) overflow may be used to meet performance requirements; however, the design must still provide for primary overflow of the developed 100-year peak flow assuming all orifices are plugged. Figure 5.3.4.H (p. 5-47) may be used to calculate the head in feet above a riser of given diameter and flow.

Access Requirements

1. An access road to the control structure is required for inspection and maintenance, and shall be designed and constructed as specified for detention ponds in Section 5.3.1 (p. 5-20).

2. Manhole and catch basin lids for control structures shall be locking, and rim elevations shall match proposed finish grade.
FIGURE 5.3.4.A FLOW RESTRICCTOR (TEE)

NOTES:
1. Use a minimum of a 54° diameter type 2 catch basin.
2. Outlet Capacity: 100-year developed peak flow.
4. Frame and ladder or steps offset so:
   A. Cleanout gate is visible from top.
   B. Climb-down space is clear of riser and cleanout gate.
   C. Frame is clear of curb.
5. If metal outlet pipe connects to cement concrete pipe: outlet pipe to have smooth O.D. equal to concrete pipe I.D. less 1/4.
6. Provide at least one 3” X .090 gage support bracket anchored to concrete wall. (maximum 3’-0” vertical spacing).
7. Locate elbow restricter(s) as necessary to provide minimum clearance as shown.
8. Locate additional ladder rungs in structures used as access to tanks or vaults to allow access when catch basin is filled with water.
9. Tee shall be constructed of aluminum CMP or aluminized steel CMP meeting WSDOT/APWA standards.
FIGURE 5.3.4.B FLOW RESTRICTOR (BAFFLE)

NOTES:
1. Use a minimum of a 54" diameter type 2 catch basin.
2. Outlet Capacity: 100-year developed peak flow.
4. Frame and ladder or steps offset so:
   A. Cleanout gate is visible from top.
   B. Climb-down space is clear of riser and cleanout gate.
   C. Frame is clear of curb.
5. If metal outlet pipe connects to cement concrete pipe: outlet pipe to have smooth O.D. equal to concrete pipe I.D. less 1/2".
6. Provide at least one 3" X .090 gage support bracket anchored to concrete wall. (maximum 3'-0" vertical spacing).
7. Locate elbow restrictor(s) as necessary to provide minimum clearance as shown.
8. Locate additional ladder rungs in structures used as access to tanks or vaults to allow access when catch basin is filled with water.
9. Tee shall be constructed of aluminum CMP or aluminized steel CMP meeting WSDOT/APWA standards.