

## **APPENDIX F**

### **FLOW CONTROL STRUCTURES AND OUTFALL SIZING**

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## APPENDIX F

### CONTROL STRUCTURES FOR DETENTION SYSTEMS

This appendix presents the methods and equations for the design of flow control structures. It includes illustrations and equations for the design of orifices, rectangular sharp crested weirs and v-notch weirs.

Detention control structures shall be either weir structures or orifice structures. Weir structures may be enclosed in a catch basin, manhole, or vault, or may be installed in the open, provided they are accessible for maintenance and are not exposed to damage. Riser type restrictor devices also provide some incidental oil/water separation and spill control. Weir structures provide some oil/water separation when fitted with a baffle plate located upstream of the weir.

#### Orifices

- Orifices may be constructed on a pipe, “tee” riser, baffle, or other structure intended for conveyance.
- The minimum allowable diameter for an orifice used to control flows in a public facility is 2 inches. Private facilities may utilize a 1-inch diameter orifice if additional clogging prevention measures are implemented. The orifice diameter shall always be greater than the thickness of the orifice plate.
- Multiple orifices may be necessary to meet the flood control design storm performance for a detention system. However, extremely low flow rates may result in small orifices (< 2 inches) that are prone to clogging. In these cases, retention facilities that do not rely on orifice structures shall be used to the maximum extent practicable to meet flow control requirements. Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice.

### Orifice Sizing Equation:

$$Q = C A \sqrt{2gh}$$

where:

Q = Orifice discharge rate, cfs

C = Coefficient of discharge, feet (suggested value = 0.60 for plate orifices)

A = Area of orifice, square feet

h = hydraulic head, feet

g = 32.2 ft/sec<sup>2</sup>

The diameter of plate orifices is typically calculated from the given flow. The orifice equation is often useful when expressed as an equivalent orifice diameter in inches.

$$d = \sqrt{\frac{36.88 Q}{\sqrt{h}}}$$

where:

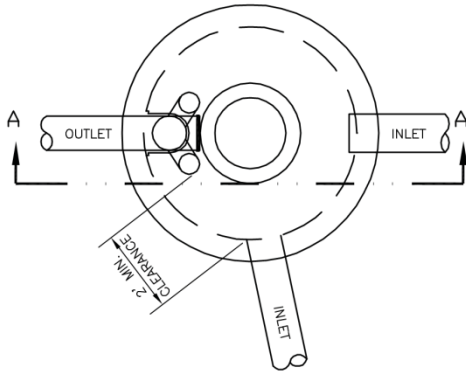
Q = flow, cfs

d = orifice diameter, inches

h = hydraulic head, feet

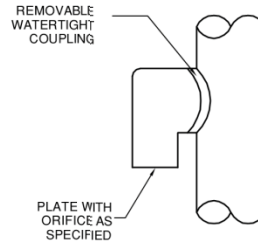
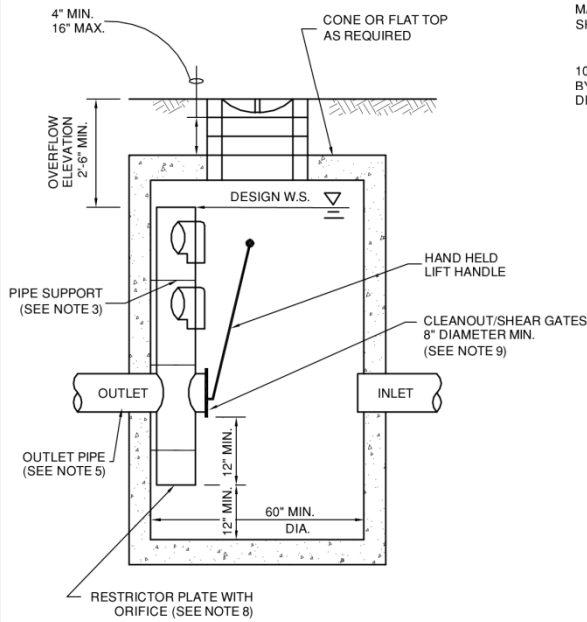
- Orifices shall be protected within a manhole structure, or by a minimum 18-inch-thick layer of 1½" to 3" evenly graded, washed rock. Orifice holes shall be externally protected by stainless steel or galvanized wire screen (hardware cloth) with a mesh of ¾" or less. Chicken wire shall not be used for this application.
- Orifice diameter shall be greater than or equal to the thickness of the orifice plate (see diagram).
- If less than 3", the orifice shall not be made of concrete. A thin material (e.g., stainless steel, HDPE or PVC) shall be used to make the orifice plate; the plate shall be attached to the concrete or structure.

**PLAN VIEW**



**NOTES:**

1. EXCEPT AS SHOWN OR NOTED, UNITS SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS FOR LARGER PRECAST CONCRETE MANHOLE PER STANDARD PLAN.
2. FOR DETAILS SHOWING GRADE RING, MANHOLES, AND TOP SLABS, SEE STANDARD PLAN.
3. PIPE SUPPORTS SHALL ANCHORED AT 3' MAX. SPACING BY 3/8 DIA. STAINLESS STEEL EXPANSION BOLTS EMBEDDED 2" IN WALL.
4. THE RESTRICTOR/SEPARATOR SHALL BE FABRICATED FROM SOLID WALL HDPE PIPE, OR APPROVED EQUAL.
5. OUTLET SHALL BE CONNECTED TO RESTRICTOR PIPE WITH A FLEXIBLE COUPLING.
6. THE VERTICAL RISER STEM OF THE RESTRICTOR/SEPARATOR SHALL BE THE SAME DIAMETER AS THE HORIZONTAL OUTLET PIPE, WITH A 10" MINIMUM DIAMETER.
7. MULTI-ORIFICE ELBOWS MAY BE LOCATED AS SHOWN OR ALL ON ONE SIDE OF RISER. SIZE OF ELBOWS AND PLACEMENT TO BE CLEARLY LABELED ON PLANS.
8. RESTRICTOR PLATE WITH ORIFICE AS SPECIFIED ON PLANS. SPECIFIED OPENING TO BE CUT ROUND AND SMOOTH.
9. CLEANOUT/SHEAR GATE:  
ALUMINUM ALLOY PER B-26-26-32E OR CAST IRON ASTM A48 CLASS 308 AS REQUIRED. LIFT HANDLE EITHER SOLID OR TUBING WITH ADJUSTABLE HOOK AS REQUIRED. NEOPRENE RUBBER GASKET REQUIRED BETWEEN RISER MOUNTING FLANGE AND GATE FLANGE. MATING SURFACES OF LID AND BODY TO BE MACHINED FOR PROPER FIT. FLANGE MOUNTING BOLTS SHALL BE 3/4" DIA. STAINLESS STEEL.
10. GATE SHALL NOT OPEN BEYOND THE CLEAR OPENING BY LIMITED HINGE MOVEMENT. STOP TABS, OR SOME OTHER DEVICE.



**ELBOW DETAIL**

**SECTION A-A**

CITY OF EUGENE  
EXHIBIT DRAWING



**ORIFICE LOCATION TEE RISER**

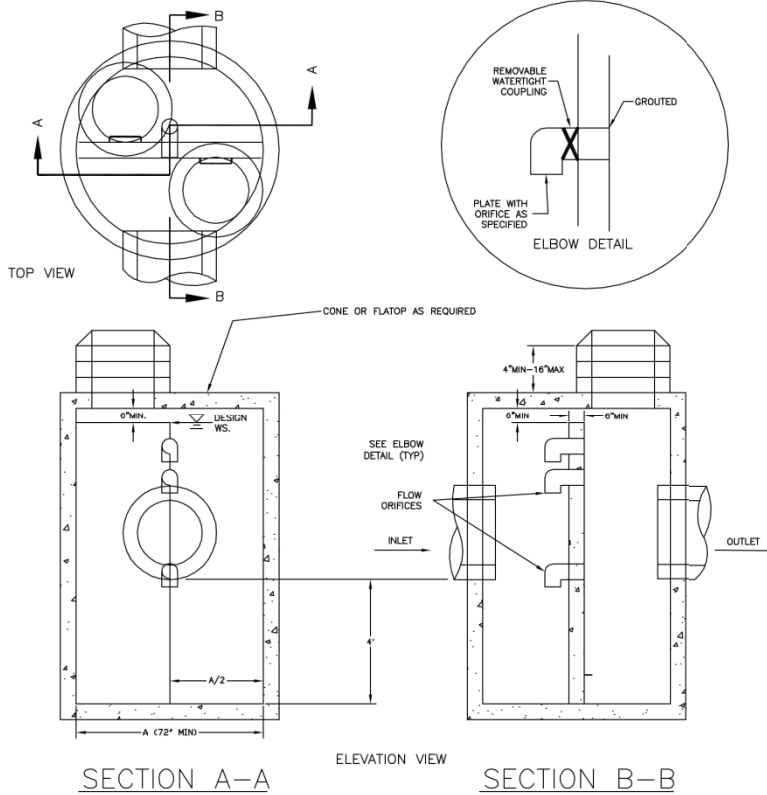
REVISIONS	
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6/06


EXHIBIT 2-7

NOTES

1. EXCEPT AS SHOWN OR NOTED, UNIT SHALL BE CONSTRUCTED IN ACCORDANCE WITH THE REQUIREMENTS FOR LARGE PRE CAST CONCRETE MANHOLES.
2. SEE PROJECT PLANS FOR SIZE AND LOCATION OF ORIFICES.
3. PIPE SIZES, SLOPES AND ALL ELEVATIONS AS SHOWN IN THE PLANS.
4. BAFFLE WALL SHALL HAVE #4 BAR AT 12" SPACING EACH WAY.
5. PRE CAST BAFFLE WALL SHALL BE KEYPED AND GROUTED IN PLACE.
6. ORIFICE PLATES TO BE 1/4" THICK MIN. HDPE OR APPROVED EQUAL AND ATTACHED WITH 1/2" STAINLESS STEEL BOLTS.



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EXHIBIT DRAWING

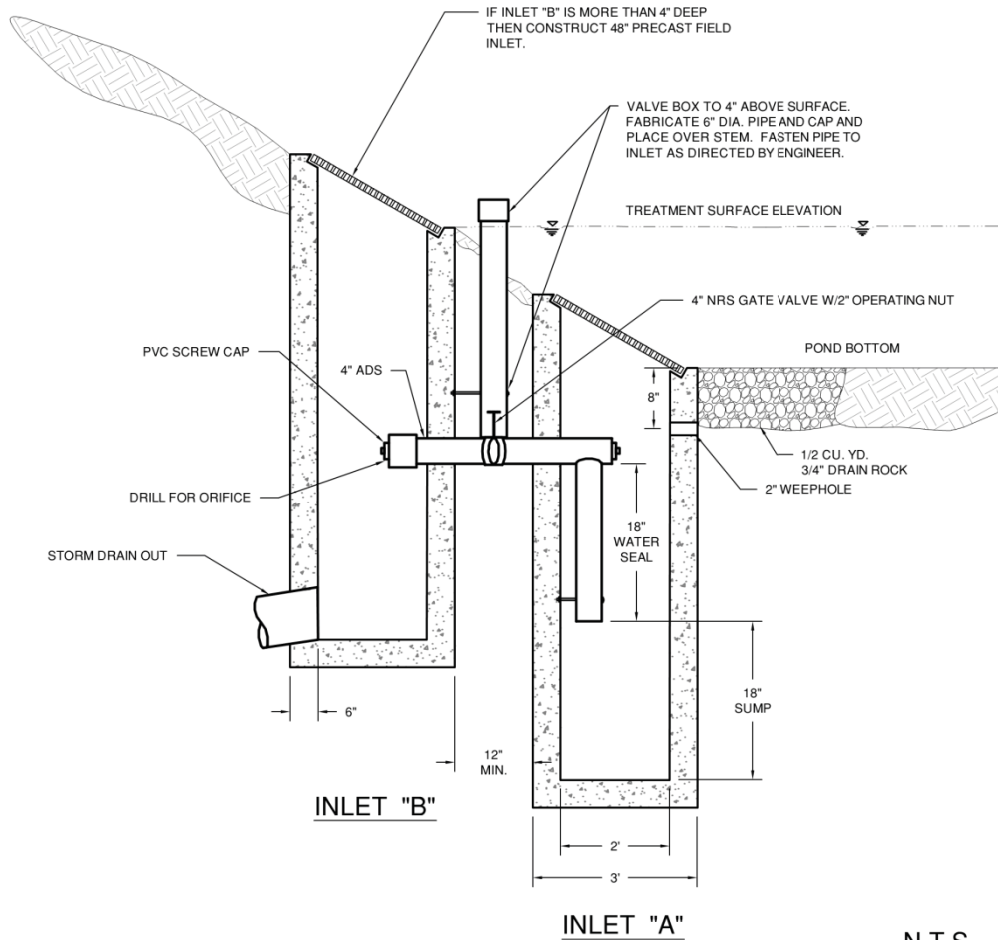


ORIFICE LOCATION BAFFLE RISER


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EXHIBIT 2-8



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EXHIBIT DRAWING



ORIFICE STRUCTURE

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6/06 EXHIBIT 2-9

## Rectangular Notched Sharp Crested Weir

$$Q = C(L - 0.2H) * H^{1.5}$$

Where:

Q=Weir discharge, cubic feet per second (cfs)

C = 3.27 + 0.40\*H/P, feet

P = Height of weir bottom above downstream water surface, feet

H = Height from weir bottom to crest, feet

L = Length of weir, feet\*

\* For weirs notched out of circular risers, length is the portion of the riser circumference not to exceed 50 percent of the circumference.

## V-Notched Sharp Crested Weir

$$Q = C_d \left( \tan \frac{\theta}{2} \right) H^{\frac{5}{2}}$$

Where:

Q = Weir discharge, cfs

C<sub>d</sub> = Contraction coefficient, feet (suggested value = 2.5 for 90 degree weir)

θ = Internal angle of notch, degrees

H = Height from weir bottom to crest, feet



**ROCK PROTECTION AT OUTFALLS FOR PIPES GREATER THAN 6 INCHES IN DIAMETER**

Discharge Velocity at Design Flow (fps)			REQUIRED PROTECTION Minimum Dimensions				
			Type	Depth*	Width	Length**	Height
0	To	5	Riprap*	2 x (max stone size)	Diameter + 6 ft.	As calculated	Crown + 1 ft.
6	To	10	Riprap*	2 x (max stone size)	Diameter + 6 ft. or 3x dia. whichever is greater	As calculated	Crown + 1 ft.
11	To	20	Gabion or Riprap*	2 x (max stone size)	Diameter + 6 ft. or 4x dia. whichever is greater	As calculated	Crown + 1 ft.
Over 20			Engineered Energy Dissipater Required				

\* Riprap size shall be determined using the following formulae\*\*\* and the City's *Standard Construction Specifications*

V = Average velocity (ft/s) \*Riprap size  $ds=0.25*Do*Fo$  (6" minimum)

Do = Pipe diameter (ft) Depth= $2*ds$  (1 foot minimum)

ds = Riprap diameter (ft) \*\*Apron length  $Lsp= Do(8+17*Log Fo)$

Lsp = Apron length (ft)

depth = Thickness (ft)

$Fo = V/(g*Do)^{0.5}$

$g = 32.2 \text{ ft/s}^2$

\*\*\*US Army Corps of Engineers design formulas from *Erosion and Riprap Requirements at Culvert and Storm Outlets*, January 1970

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