C-3: Extended Detention Basin


Source: City of Reno

Description

Extended detention basins are permanent basins formed by excavation and/or construction of embankments to temporarily detain stormwater runoff to allow for sedimentation of particulates to occur before the stormwater runoff is discharged. An extended detention basin reduces peak stormwater flow rates and provides stormwater runoff treatment. Extended detention basins are typically dry between storm events, although a shallow pool, one (1) to three (3) feet deep, can be included in the design for aesthetic purposes and to promote biological uptake and conversion of pollutants. A bottom outlet provides a controlled slow release of the detained stormwater runoff over a specified period of time. Extended detention basins can also be used to provide flood control by including additional storage capacity. The basic elements of an extended detention basin are presented in Figure 8-23. This configuration is most appropriate for large sites.

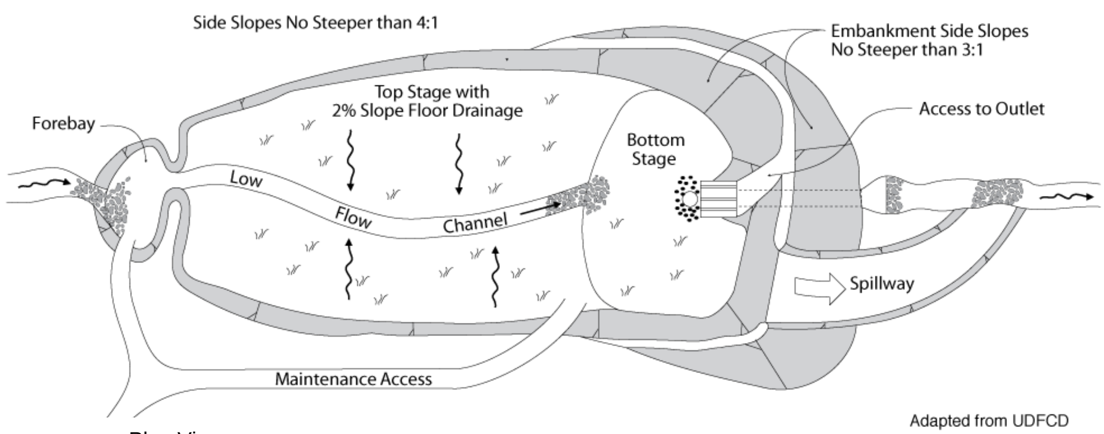
Advantages

- May be designed to provide other benefits such as recreation (i.e., playfields), wildlife habitat, and open space. Safety issues must be addressed.
- Relatively easy and inexpensive to build and operate due to its simple design.
- Useful in retrofit situations where low hydraulic head requirements allow basins to be sited within the constraints of the existing storm drain system. Can be designed into flood control basins or sometimes retrofitted into existing flood control basins.

Disadvantages

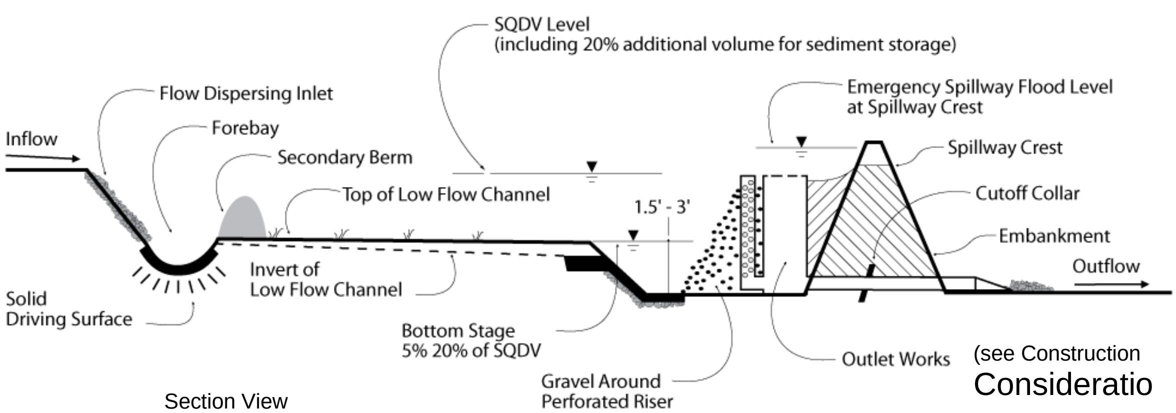
- Discharge from extended detention basins may pose a risk to cold water receiving waters because water retained in the permanent pool is typically heated over time.
- Although wet extended detention basins can increase property values, dry extended detention basins can adversely affect property value of nearby property due to the adverse aesthetics of dry, bare areas, and exposure of inlet and outlet structures. Appropriate vegetation selection and maintenance can help mitigate these adverse effects.

Figure 8-23. Extended Detention Basin Conceptual Layout



Adapted from UDFCD

Plan View



Section View

Planning and Site Considerations

- If constructed early in the land development cycle, extended detention basins can serve as sediment traps during construction within the tributary area.
- Surface basins are typical, but underground vaults may be appropriate in a small commercial development.
- Small- to medium-sized tributary areas with available open space and drainage areas greater than five (5) acres are typical drainage area sizes.
- Approximately 0.5 to 2 percent of the tributary development area is the required area needed for an extended detention basin.
- Extended detention basins can be used with almost all soils and geology with minor adjustments for regions with rapidly percolating soils. In these areas, impermeable liners can be installed to prevent groundwater contamination.

Design Criteria

Design criteria for extended detention basins are listed in Table 8-44. Extended detention basins may also serve as a flood control detention basin under the City's Storm Drainage System Engineer Design Standards. Such dual-purpose basins must also conform to design criteria for detention basins set forth in Chapter 4 of the City's Standard Specifications.

Table 8-44. Extended Detention Basin Design Criteria

Design Parameter	Design Criteria	Notes
Design volume	WQV	80% annual capture. Use Figure 6-1.
Drawdown time for WQV	48 hr (minimum)	Outlet controls or pumping stations must be designed to withdraw WQV over a minimum period of 48 hours
Drawdown time for 50% WQV	12 hr (minimum)	Time before release of 50% WQV
Basin design volume	120%	Percentage of WQV. Provide 20% for sediment storage volume
Inlet/outlet erosion control	–	Provide energy dissipaters to reduce velocity
Forebay		
- Volume	5-10%	Percentage of WQV
- Drain time	< 45 min	
Low-flow channel		
- Depth	9 in	
- Flow capacity	200%	Percentage of forebay outlet release capacity
Upper stage		
- Bottom slope	2%	
- Depth	2 ft (minimum)	
- Width	30 ft (minimum)	
Length to width ratio	2:1 (minimum)	Larger preferred
Bottom stage		
- Volume	5-20%	Percentage of WQV
- Depth	1.5-3 ft	Deeper than upper stage
Freeboard	1 ft (minimum)	
Embankment side slope (H:V)	≥ 4:1	Inside
	≥ 3:1	Outside (without retaining wall)
Maintenance access ramp slope (H:V)	10:1 or flatter	
Maintenance access ramp width	16 ft (minimum)	Approach paved with asphalt concrete

Design Procedure

Step 1 – Calculate WQV

Using Fact Sheet C-2, calculate the effective tributary drainage area and WQV based on a 48-hour drawdown period.

Step 2 – Determine Minimum Basin Storage Design Volume (V_{bs})

The volume of the basin (V_{bs}) shall not be less than 120% of the WQV. The additional 20% provides allowance for sediment accumulation.

$$V_{bs} \geq 1.2 \times WQV$$

Where:

WQV = water quality volume (ft^3).

Step 3 – Design Outlet Works

The outlet works, including pump stations, are to be designed to release the WQV over a minimum 48-hour period with no more than 50% released in 12 hours. Protect the outlet from clogging with a trash rack and a skimmer shield that extends below the outlet and above the maximum WQV depth. See Figure 8-24 and Figure 8-25 for schematics pertaining to structure geometry, grates, trash racks, and screens for perforated riser pipe and orifice plate outlets.

For single orifice outlet control or single row of orifices at the basin bottom surface elevation (see Figure 8-23), use the Orifice Equation based on the WQV (ft^3) and depth of water above orifice centerline D (ft) to determine orifice area (in^2):

$$Q = C \times A \times \sqrt{2gD}$$

Where:

C = orifice coefficient (use 0.61);
A = area of orifice (in^2);
g = acceleration due to gravity (32.2 ft/sec^2); and
D = depth of water above orifice centerline (D_{WQV}, ft).

The equation can be solved for A based on the WQV and design drawdown time (t) using the following conversion of the Orifice Equation:

$$A = \frac{WQV}{61.19 \times D^{0.5} \times t}$$

Where:

WQV = water quality volume (ft^3);
D = depth of water above orifice centerline (D_{WQV}, ft); and
t = drawdown period (hr) = 48 hours.

For perforated pipe outlets or vertical plates with multiple orifices (see Figure 8-24), use the following equation to determine required area per row of perforations, based on the WQV (acre-ft) and depth of water above centerline of the bottom perforation, D (ft).

$$A_r = \frac{WQV}{K_{48}}$$

Where:

WQV = water quality volume (acre-ft); and
$K_{48} = 0.013 \times D^2 + 0.22 \times D - 0.10.$

Select appropriate perforation diameter and number of perforations per row (columns) with the objective of minimizing the number of rows and using a maximum perforation diameter of two (2) inches. Rows are spaced at four (4) inches on center from the bottom perforation. Thus, there will be three (3) rows for each foot depth plus the top row. The number of rows (n_r) may be determined using the following equation:

$$n_r = 1 + (D \times 3)$$

Where:

D = depth of water above orifice center line (ft).

Calculate total outlet area by multiplying the area per row by the number of rows.

$$Total\ Orifice\ Area = A_r \times n_r$$

Where:

A_r = required area per row of perforations; and
n_r = number of rows.

Step 4 – Provide Trash Rack/Gravel Pack

A trash rack or gravel pack around perforated risers shall be provided to protect outlet orifices from clogging. Trash racks are better suited for use with perforated vertical plates for outlet control and allow easier access to outlet orifices for purposes of inspection and cleaning. Trash racks shall be sized to prevent clogging of the primary water quality outlet without restricting the hydraulic capacity of the outlet control orifices.

Step 5 – Design Basin Shape

Whenever possible, shape the basin with a gradual expansion from the inlet and a gradual contraction form the middle toward the outlet. The length to width ratio should be a minimum of 2:1. Internal baffling with berms or modification of inlet and outlet points may be necessary to achieve this ratio.

Step 6 – Two-Stage Design

A two-stage design, including a pool that fills often with frequently occurring stormwater runoff, minimizes standing water and sediment deposition in the remainder of the basin.

Upper stage: The upper stage should be a minimum of two (2) feet deep with a bottom sloped at two (2) percent toward the low flow channel. The minimum width of the upper stage should be thirty (30) feet.

Bottom stage: The active storage basin of the bottom stage should be 1.5 to 3 feet deeper than the upper stage and store 5-20% of the WQV. A micro-pool below the active storage volume of the bottom stage, if provided, should be one-half the depth of the top stage or two (2) feet, whichever is greater.

Step 7 – Design Forebay

The forebay provides a location for sedimentation of larger particles, and has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay has a volume comprising of five (5) to ten (10) percent of the WQV. Provide the forebay inlet with an energy dissipation structure and/or erosion protection. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from the forebay to the low-flow channel should be sized to drain the forebay volume in 45 minutes. The outlet pipe entrance should be offset from the forebay inlet to prevent short-circuiting.

Step 8 – Low-Flow Channel

The low-flow channel conveys flow from the forebay to the bottom stage. Erosion protection should be provided where the low-flow channel enters the bottom stage. Lining the low-flow channel with concrete is recommended. The channel depth should be at least nine (9) inches. The channel flow capacity should be twice the release capacity of the forebay outlet.

Step 9 – Select Vegetation

Bottom vegetation provides erosion protection and sediment entrapment. Basin bottoms, berms, and side slopes may be planted with native grasses or irrigated turf. Examples of types of vegetation that may be planted on the basin bottom are provided in Appendix G.

Step 10 – Design Embankment Side Slopes

Design embankments to conform to State of California Division of Safety of Dams requirements, if the basin dimensions cause it to fall under the agency's jurisdiction. Interior slopes should be no steeper than 4:1, and exterior slopes no steeper than 3:1. Flatter slopes are preferable.

Step 11 – Inlet/Outlet Design

Basin inlet and outlet points should be provided with an energy dissipation structure and/or erosion protection.

Step 12 – Design Maintenance Access

Provide all-weather access for maintenance vehicles to the bottom and outlet works. Maximum grades of access ramps should be ten (10) percent and minimum width should be sixteen (16) feet. Ramps should be paved with concrete.

Step 13 – Design Diversion Structure

Provide stormwater runoff bypass or overflow for volumes in excess of the WQV. Spillway and overflow structures should be designed in accordance with the applicable City of Modesto Standard Specifications. See Appendix I for more information on diversion structure design.

Step 14 – Geotextile Fabric

Non-woven geotextile fabric used in conjunction with gravel packs around perforated risers shall conform to the specifications listed in Table 8-45.

Table 8-45. Non-woven Geotextile Fabric Specifications

Parameter	**Test Method**	**Specifications** (1)
Grab strength	ASTM D4632	90 lb
Elongation at peak load	ASTM D4632	50%
Puncture strength	ASTM D3787	45 lb
Permittivity	ASTM D4491	0.7 sec^{-1}
Burst strength	ASTM D3786	180 psi
Toughness	% Elongation x Grab Strength	5,500 lb
Ultraviolet resistance (percent strength retained at 500 Weatherometer hours)	ASTM D4355	70%

(1) Adapted from SSPWC, 1997.

Step 15 – Design Security Fencing

Provide aesthetic security fencing around the extended detention basin to protect habitat except when specifically waived by the City. Fencing design shall adhere to the City of Modesto Standard Specifications, and be approved by the City.

Volume Retention Calculation

No volume retention credit is provided for an extended detention basin because it does not fully retain the WQV. However, an extended detention basin may be used to meet treatment control requirements.

Construction Considerations

- Install seepage collars on outlet piping to prevent seepage through embankments.
- Clearly mark areas to be used for extended detention basins before site work begins to avoid soil disturbance and compaction during construction.

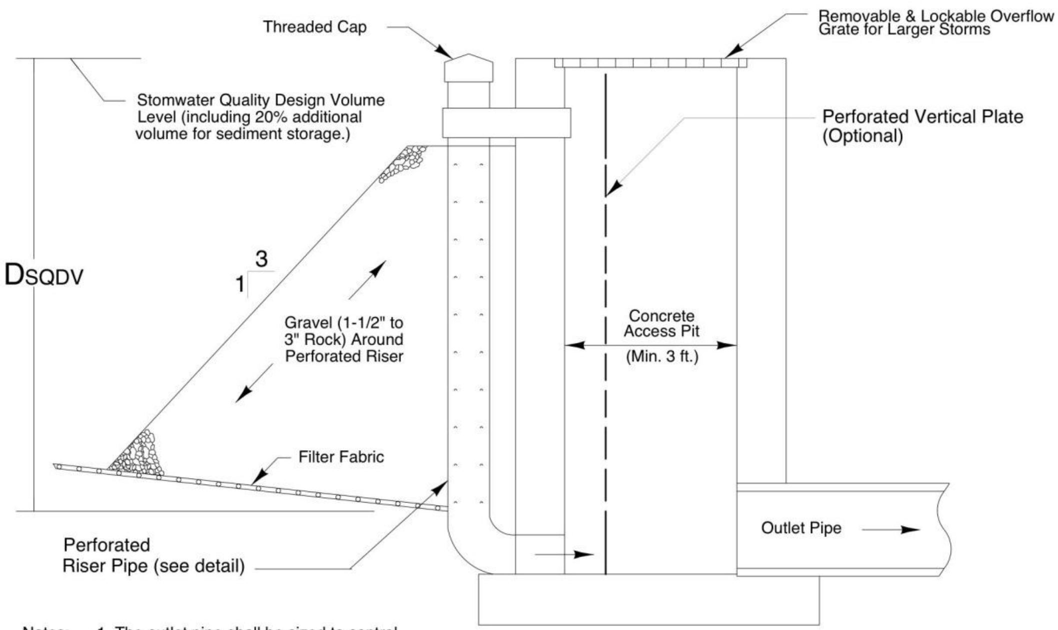
Long-Term Maintenance

The City requires execution of a maintenance agreement with the property owner prior to final acceptance of a private development project, which includes treatment control measures such as extended detention basins. Such agreements typically include requirements such as those outlined in Table 8-46. The property owner or property owner's designee is responsible for compliance with the agreement. The maintenance agreement must provide the City with complete access to the treatment control measure and its immediate vicinity at any time. Treatment control measure maintenance is the responsibility of the property owner. A sample maintenance agreement is presented in Appendix D.

Table 8-46. Inspection and Maintenance Requirements for an Extended Detention Basin

Activity	Schedule
Remove litter and debris from banks and basin bottom.	As required
Inspect extended detention basin for the following items: clogging of outlet; differential settlement; cracking; erosion; leakage; tree growth on the embankment; the condition of riprap in the inlet, outlet, and pilot channels; sediment accumulation in the basin; trash and debris accumulation; damage from burrowing animals; and the health and density of grass turf on the basin side slopes and floor. Correct observed problems.	At beginning and end of wet season. Additional inspections after periods of heavy stormwater runoff are desirable.
If permitted by the California Department of Fish and Game or other regulatory agency, stock basin with mosquito fish to enhance natural mosquito and midge control.	As required
Remove sediment when accumulation reaches 25 percent of original design depth or if resuspension is observed. (Note: Sediment removal may not be required in the main basin for as long as 20 years.)	Clean in early spring so vegetation damaged during cleaning has time to reestablish.
Clean forebay to minimize frequency of main basin cleaning.	As required
Trim vegetation and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector purposes.	At beginning and end of wet season
Control mosquitoes.	As necessary

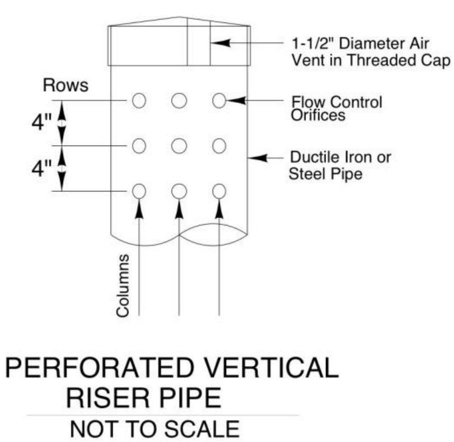
Figure 8-24. Perforated Pipe Outlet Structure



Notes: 1. The outlet pipe shall be sized to control overflow into the concrete riser.
2. Alternate designs include a Hydrobrake outlet (or orifice designs) as long as the hydraulic performance matches this configuration.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/4"
3. Maximum hole diameter = 2"



PERFORATED VERTICAL RISER PIPE
NOT TO SCALE

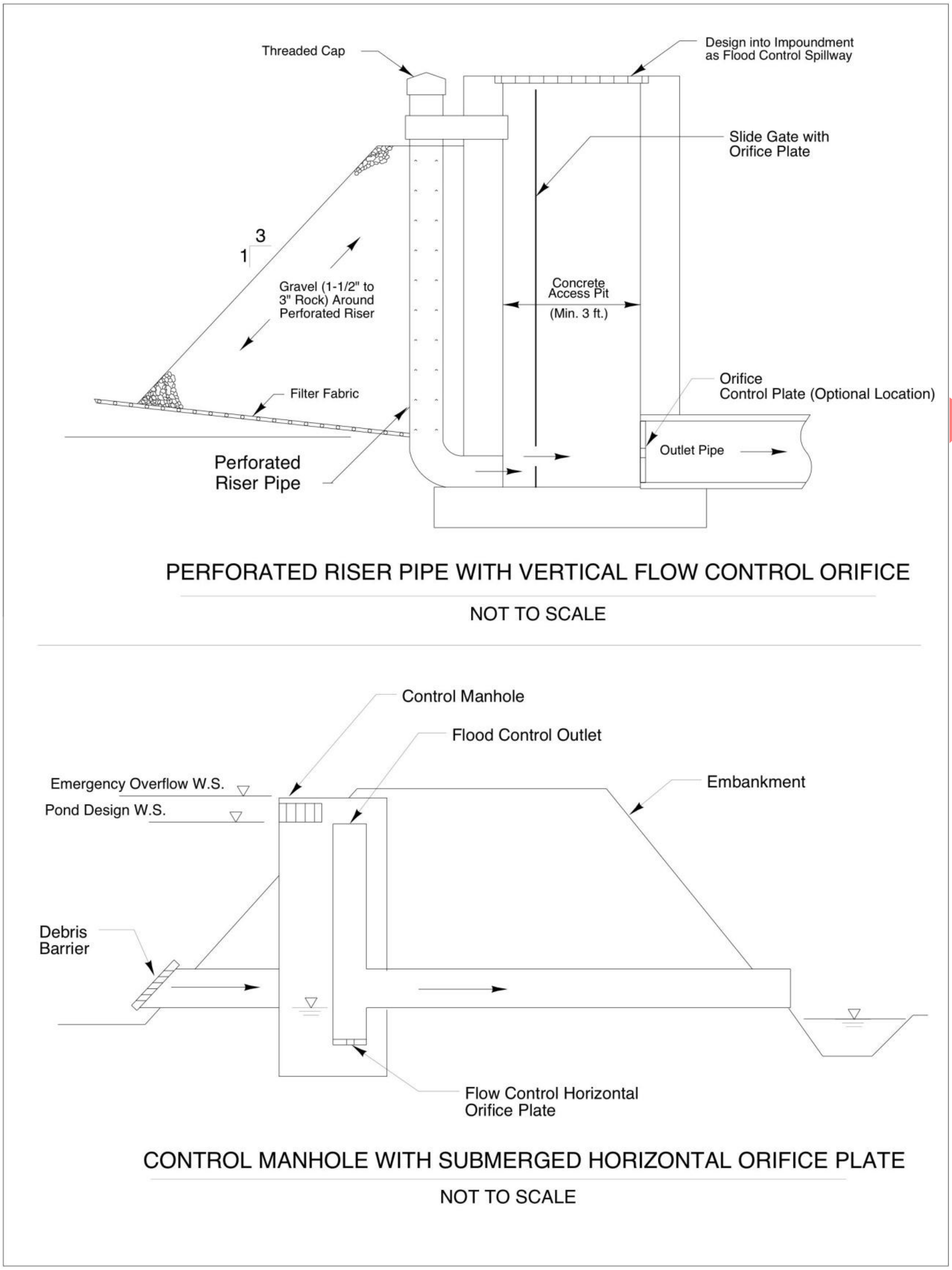
Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, in.			
	1/4"	1/2"	3/4"	1"
4	8	8	--	--
6	12	12	9	--
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter, in.	Area of Hole (in.)^2
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

ADAPTED FROM UDFCD, 1999

OUTLET CONFIGURATIONS USING MULTIPLE ORIFICE FLOW CONTROL

Figure 8-25. Orifice Plate Outlet Configuration



C-4: Wet Pond

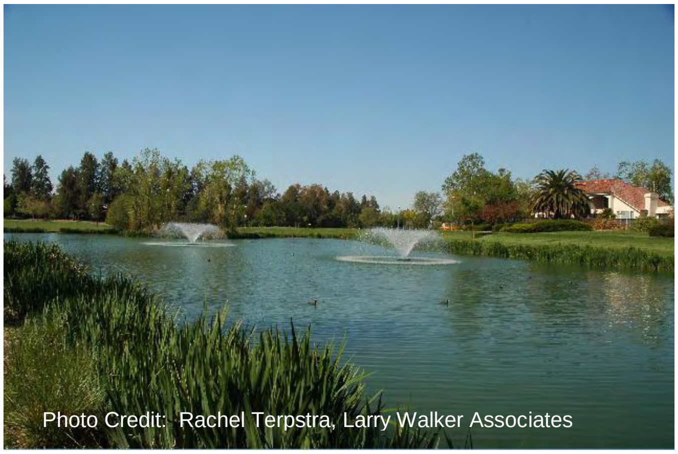


Photo Credit: Rachel Terpstra, Larry Walker Associates

Description

Wet ponds are open earthen basins that feature a permanent pool of water that is displaced by stormwater runoff, in part or in total, during storm events. Like extended detention basins, wet ponds are designed to temporarily retain stormwater runoff and slowly release this volume over a design drawdown period. Wet ponds differ from extended detention basins in that influent stormwater runoff mixes with and displaces the permanent pool as it enters the basin. The design drawdown time for wet ponds (12 hours) is shorter than that for extended detention basins (48 hours), because enhanced treatment is provided in the permanent pool. Wet ponds differ from constructed wetlands because wet ponds have a greater average depth. A dry weather base flow is required to maintain a permanent pool in the wet pond. The primary treatment mechanism is sedimentation as stormwater runoff resides in this pool, but pollutant removal, particularly nutrients, also occurs through biological activity in the pond. The basic elements of a wet pond are illustrated in Figure 8-26.

Advantages

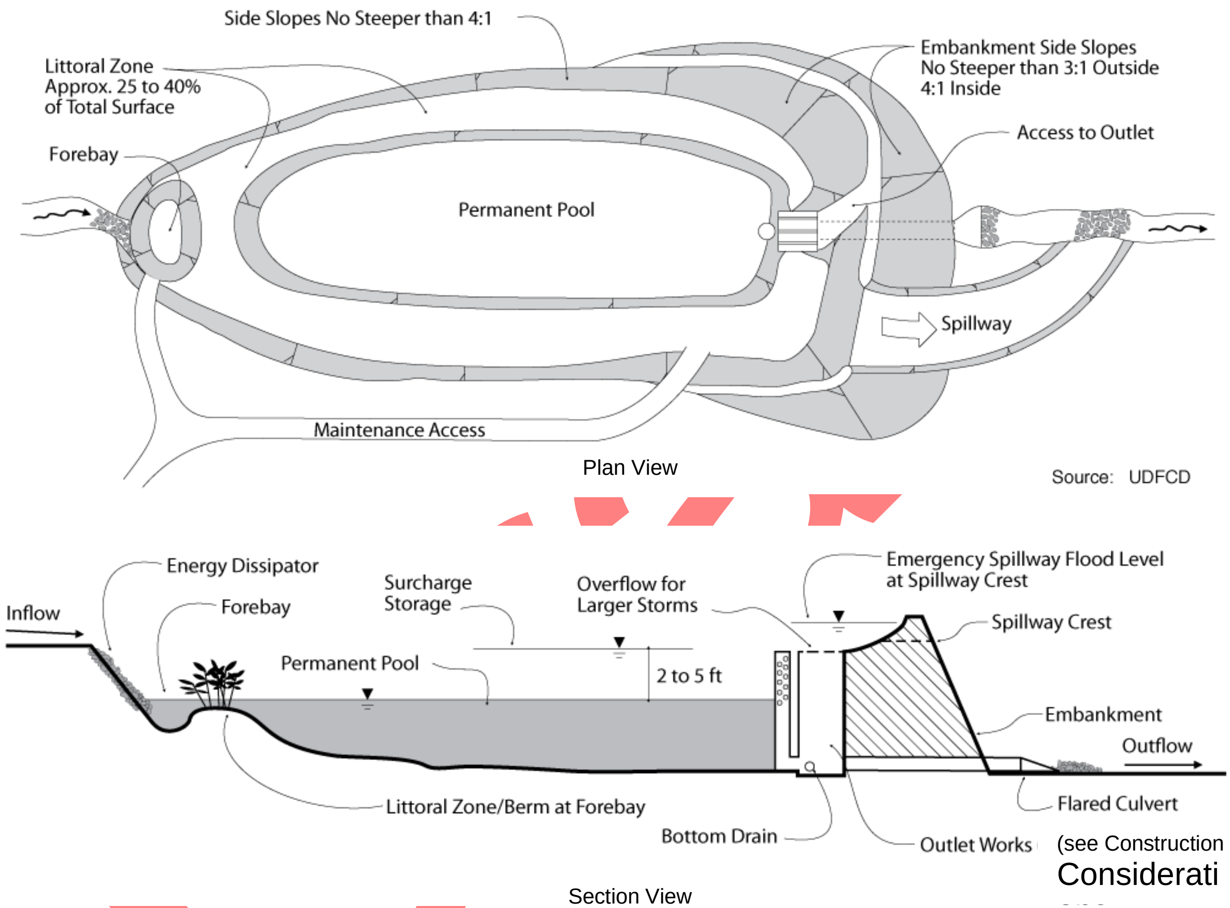
- Wet ponds can be designed to provide other benefits such as recreation, wildlife habitat, and open space.
- Wet ponds are often viewed as a public amenity when integrated into a park or open-space setting.
- The permanent pool can provide significant water quality improvement across a relatively broad spectrum of pollutants including dissolved nutrients.
- Wet ponds can serve essentially any size tributary area.

Disadvantages

- Public safety must be considered with respect to access and use.
- Potential for mosquito and midge breeding exists due to permanent pool.
- Discharge from wet ponds may pose a risk to cold-water receiving waters because stormwater runoff retained in the permanent pool is typically heated over time.
- Base flow or supplemental water is required if water level is to be maintained, although wet ponds may be allowed to dry out during the dry season if non-stormwater runoff is negligible.

- Algae growth may be a potential issue if a permanent water pool is maintained during the summer dry season.
- Wet ponds require a relatively large footprint.
- Depending on volume and depth, wet pond design may require approval from the California Division of Safety of Dams.

Figure 8-26. Wet Pond Conceptual Layout



Planning and Site Considerations

- Wet ponds are appropriate for use in the following settings:
  - Where there is a need to achieve a reasonably high level of dissolved pollutant removal and/or sediment capture;
  - Where base flow rates or other channel flow sources are relatively consistent year-round; or
  - In residential settings where aesthetic and wildlife habitat benefits can be appreciated and maintenance activities are likely to be consistently undertaken.
- Wet ponds are not suitable for:

- Dense urban areas;
- Sites with steep, unstable slopes; or
- Areas with long dry periods and high evaporation rates without a perennial groundwater base flow or supplemental water supply to maintain the permanent pool.

- Tributary drainage areas are typically small to medium-sized regional areas greater than approximately ten (10) acres with available open space.
- Land area requirements are approximately two (2) to three (3) percent of the tributary development area.
- Most appropriate for sites with low-permeability soil (Type C or D soil).

Design Criteria

Principal design criteria for wet ponds are listed in Table 8-47.

Table 8-47. Wet Pond Design Criteria

Design Parameter	Design Criteria	Notes
Design volume	WQV	80% annual capture. Use Figure 6-1.
Drawdown time for WQV	12 hr (maximum)	Based on WQV
Permanent pool volume	100-150% WQV (minimum)	Percentage of WQV
Inlet/outlet erosion control	–	Provide energy dissipaters to reduce velocity
Forebay		
- Volume	5-10%	Percentage of WQV
- Drain time	< 45 min	
- Depth	2-4 ft	
Littoral zone		
- Area	25-40%	Percentage of permanent pool surface area
- Depth	6-18 in	
Deeper zone		
- Area (including forebay)	55-65%	Percentage of permanent pool surface area
- Depth	4-8 ft (average) 12 ft (maximum)	
Pond length to width ratio	2:1 (minimum)	Larger preferred
Bottom width	30 ft (minimum)	
Pond freeboard	1 ft (minimum)	
Embankment side slope (H:V)	≥ 4:1	Inside
	≥ 3:1	Outside (without retaining walls)
Maintenance access ramp slope (H:V)	10:1 or flatter	
Maintenance access ramp width	16 ft (minimum)	Approach paved with asphalt concrete

Design Procedure

Step 1 – Calculate WQV

Using Fact Sheet C-2, calculate the effective tributary drainage area and WQV based on a 12-hour drawdown period.

Step 2 – Determine Minimum Volume for Permanent Pool (V_{pp})

The volume of the permanent pool (V_{pp}) shall not be less than 100% and up to 150% of the WQV.

$$V_{pp} = 1.0 \; to \; 1.5 \times WQV$$

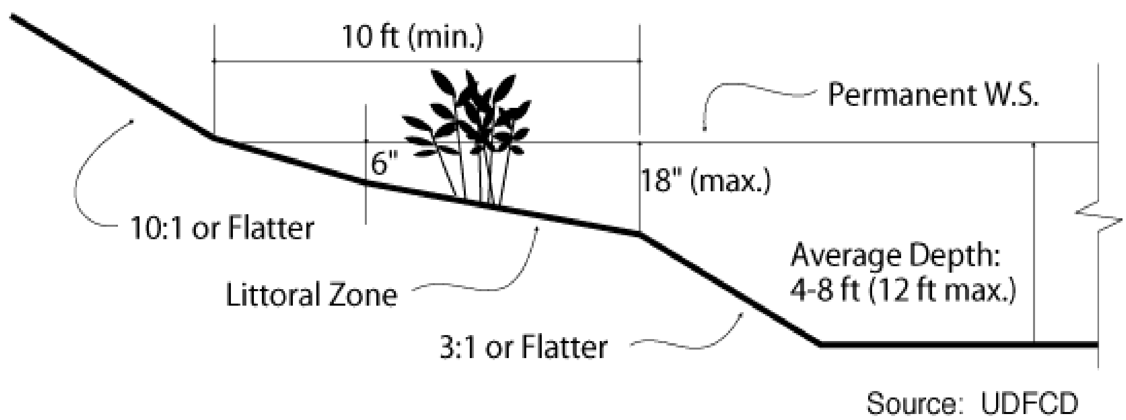
Where:

WQV = water quality volume (ft^3).

Step 3 – Determine Depth Zones

Distribution of the permanent pool area is needed to achieve desired biodiversity. In addition to the forebay, two depth zones are required (see Figure 8-27). The littoral zone provides for aquatic plant growth along the perimeter of the pool. The deeper zone covers the remaining wet pond area and promotes sedimentation and nutrient uptake by phytoplankton.

Figure 8-27. Wet Pond Depth Zones



Distribute component areas as follows:

Component	Percent of Permanent Pool Surface Area	Design Water Depth
Forebay	5-10%	2-4 ft
Littoral zone	25-40%	6-18 in
Deeper zone	55-65%	4-8 ft (average) 12 ft (maximum)

Estimate average depth of permanent pool (D_{avg}) including all zones.
Estimate water surface area of the permanent pool (A_{pp}) based on actual V_{pp}.

$$A_{pp} = \frac{V_{pp}}{D_{avg}}$$

Where:

V_{pp} = minimum volume of permanent pool (ft^3); and
D_{avg} = average depth of permanent pool (ft).

Estimate water surface elevation of the permanent pool (WS $Elev_{pp}$) based on site elevations.

Step 4 – Determine Inflow Requirement (Q_{in})

A net inflow of water must be available through a perennial base flow or supplemental water source. Use the following equation and parameters to estimate the quantity of monthly inflow required at various times of the year. The maximum monthly requirement will govern the design requirement.

$$Q_{in} = Q_{E-P} + Q_S + Q_{ET}$$

Where:

$Q_{E\text{-}P}$ = Loss due to evaporation minus the gain due to precipitation (acre-ft/mo);
Q_s = Loss or gain due to seepage to groundwater (acre-ft/mo); and
Q_{ET} = Loss due to evapotranspiration (additional loss through plant area above water surface not including the water surface) (acre-ft/mo).

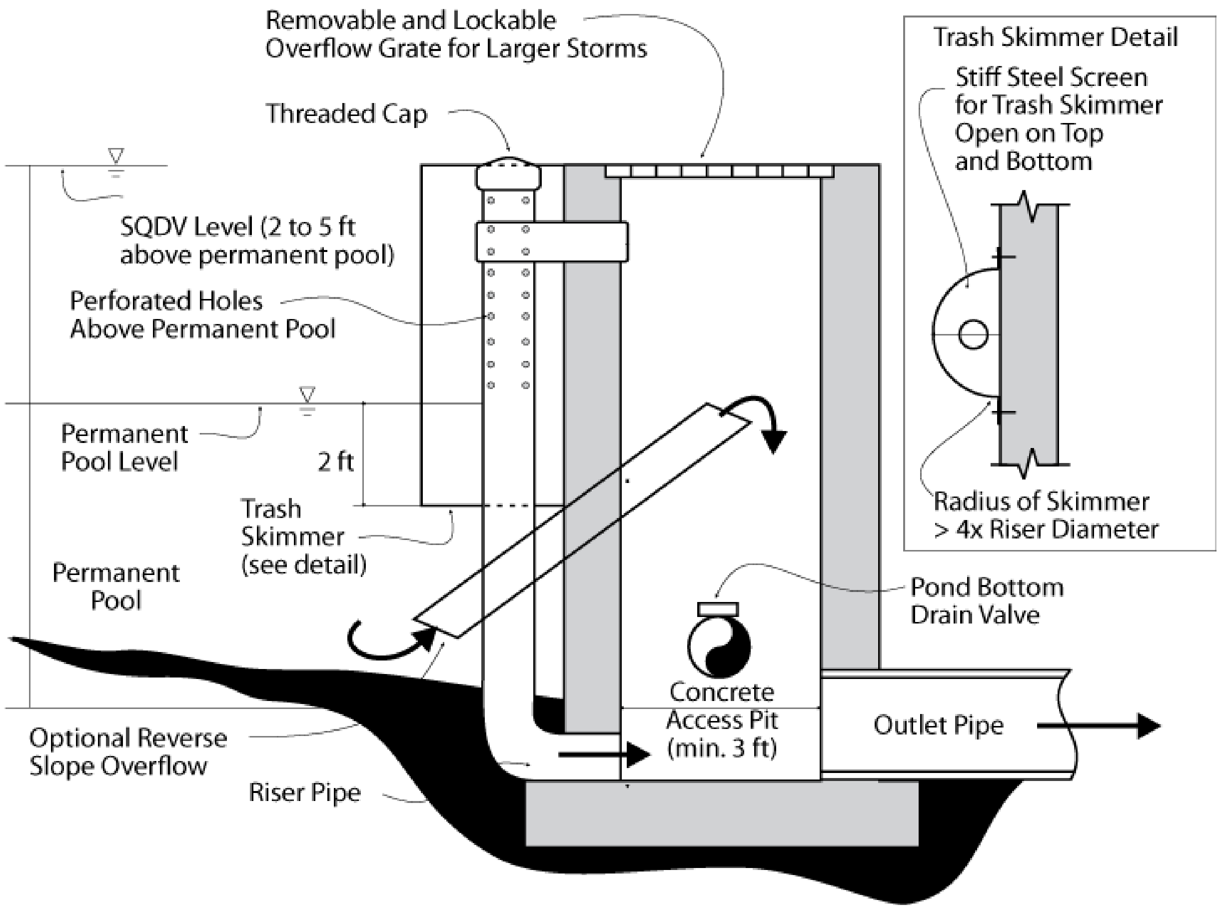
Step 5 – Design Pond Forebay

The forebay provides a location for sedimentation of larger particles and has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay is part of a permanent pool, and has a volume comprising of five (5) to ten (10) percent of the WQV. The depth of the permanent pool in the forebay should be two (2) to four (4) feet. Provide forebay inlet with an energy dissipation structure and/or erosion protection. A berm consisting of rock and topsoil mixture should be part of the littoral bench to create the forebay and have a minimum top width of eight (8) feet and side slopes no steeper than 4:1. Trash screens at the inlet are recommended to reduce dispersion of large trash articles throughout the basin.

Step 6 – Design Outlet Works

The outlet works are designed to release the WQV over a 12-hour period. Protect the outlet from clogging with a trash rack and a skimmer shield that extends below the outlet and above the maximum WQV depth. An outlet works for a wet pond is depicted in Figure 8-28.

Figure 8-28. Wet Pond Outlet Works



Notes: 1. Alternate designs are acceptable as long as the hydraulics provides the required emptying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft below the permanent pool level.

Source: UDFCD

For single orifice outlet control or single row of orifices at the permanent pool elevation (WS $Elev_{pp}$) (see Figure 8-25), use the Orifice Equation based on the WQV (ft^3) and depth of water above orifice centerline D (ft) to determine orifice area (in^2):

$$Q = C \times A \times \sqrt{2gD}$$

Where:

C = orifice coefficient (use 0.61);
A = area of orifice (in^2);
g = acceleration due to gravity (32.2 ft/sec^2); and
D = depth of water above orifice centerline (D_{WQV}, ft).

The equation can be solved for A based on the WQV and design drawdown time (t) using the following conversion of the Orifice Equation:

$$A = \frac{WQV}{61.19 \times D^{0.5} \times t}$$

Where:

WQV = water quality volume (ft^3);
D = depth of water above orifice centerline (D_{WQV}, ft); and
t = drawdown period (hr) = 12 hours.

For perforated pipe outlets or vertical plates with multiple orifices (see Figure 8-24), use the following equation to determine required area per row of perforations, based on the WQV (acre-ft) and depth of water above centerline of the bottom perforation, D (ft).

$$A_r = \frac{WQV}{K_{12}}$$

Where:

WQV = water quality volume (acre-ft); and
$K_{12} = 0.008 \times D^2 + 0.056 \times D - 0.012.$

Select appropriate perforation diameter and number of perforations per row (columns) with the objective of minimizing the number of rows and using a maximum perforation diameter of two (2) inches. Rows are spaced at four (4) inches on center from the bottom perforation. Thus, there will be three (3) rows for each foot depth plus the top row. The number of rows (n_r) may be determined using the following equation:

$$n_r = 1 + (D \times 3)$$

Where:

D = depth of water above orifice center line (ft).

Calculate total outlet area by multiplying the area per row by the number of rows.

$$Total\ Orifice\ Area = A_r \times n_r$$

Where:

A_r = required area per row of perforations; and
n_r = number of rows.

Step 7 – Design Basin Shape

Whenever possible, shape the basin with a gradual expansion from the inlet and a gradual contraction toward the outlet. The length to width ratio should be between 2:1 to 4:1, with 3:1 recommended. Internal baffling with berms or modification of inlet and outlet points may be necessary to achieve this ratio.

Step 8 – Design Embankment Side Slopes

Side slopes should be stable and sufficiently gentle to limit rill erosion and to facilitate maintenance. Interior slopes should be no steeper than 4:1 and exterior slopes no steeper than 3:1. Flatter slopes are preferable.

Side slopes above the permanent pool should be no steeper than 4:1, preferably 5:1 or flatter. The littoral zone should be very flat (40:1 or flatter) with the depth ranging from six (6) inches near the shore and extending to no more than twelve (12) inches at the furthest point from the short.

The side slope below the littoral zone shall be 3:1 or flatter.

Step 9 – Inlet/Outlet Design

Basin inlet and outlet points should be provided with an energy dissipation structure and/or erosion protection.

Step 10 – Design Maintenance Access

Provide for all-weather access for maintenance vehicles to the bottom and outlet works. Maximum grades of access ramps should be ten (10) percent and minimum width should be 16 feet. Ramps should be paved with concrete.

Step 11 – Design Diversion Structure

Provide for stormwater runoff bypass or overflow for volumes in excess of the WQV. Spillway and overflow structures should be designed in accordance with applicable City of Modesto Standard Specifications. See Appendix I for more information on diversion structure design.

Step 12 – Provide Underdrain Trenches

Provide underdrain trenches near the edge of the wet pond. The trenches should be no less than twelve (12) inches wide filled with ASTM C-33 sand to within two (2) feet of the wet pond's permanent pool water surface, and with an underdrain pipe connected through a valve to the outlet. These underdrain trenches will permit the drying out of the pond when it has sediment must be removed to restore the pond's volume.

Step 13 – Select Vegetation

Bottom vegetation provides erosion protection and sediment entrapment. Berms and side slopes may be planted with native grasses or with irrigated turf. The shallow littoral bench should have a four (4) to six (6) inch thick organic topsoil layer, and be vegetated with aquatic species.

Step 14 – Design Security Fencing

Provide aesthetic security fencing around the wet pond to protect habitat except when specifically waived by the City. Fencing design shall adhere to the City of Modesto Standard Specifications, and be approved by the City.

Volume Retention Calculation

No volume retention credit is provided for a wet pond because it does not fully retain the WQV. However, wet ponds may be used to meet treatment control requirements.

Construction Considerations

- An impermeable liner may be required to prevent infiltration and maintain permanent pool levels in areas with porous soils.
- Install seepage collars on outlet piping to prevent seepage through embankments.

Long-Term Maintenance

The City requires execution of a maintenance agreement with the property owner prior to final acceptance of a private development project, which includes treatment control measures such as wet ponds. Such agreements typically include requirements such as those outlined in Table 8-48. The property owner or property owner's designee is responsible for compliance with the agreement. The maintenance agreement must provide the City with complete access to the treatment control measure and its immediate vicinity at any time. Treatment control measure maintenance is the responsibility of the property owner. A sample maintenance agreement is presented in Appendix D.

Table 8-48. Inspection and Maintenance Requirements for Wet Ponds

Activity	Schedule
Remove litter and debris from banks and pond bottom.	As required
Inspect wet pond for the following items: clogging of outlet; differential settlement; cracking; erosion; leakage; tree growth on the embankment; the condition of riprap in the inlet, outlet, and pilot channels; sediment accumulation in the pond; trash and debris accumulation; damage from burrowing animals; and the health and density of grass turf on the side slopes and floor. Correct observed problems as necessary.	At beginning and end of wet season. Additional inspections after periods of heavy stormwater runoff are desirable.
If permitted by the California Department of Fish and Game or other regulatory agency, stock pond with mosquito fish to enhance natural mosquito and midge control.	As required
Harvest vegetation for vector control and to maintain effective permanent pool volume	Annually or more frequently if required
Remove sediment when accumulation reaches 25 percent of original design depth or if resuspension is observed. (Note: Sediment removal may not be required in the main basin for as long as 20 years.)	Clean in early spring so vegetation damaged during cleaning has time to reestablish.
Clean forebay to minimize frequency of main pond cleaning.	As required

P-1: Proprietary Treatment Control Measures

The 2001 Guidance Manual provided information for selecting and designing the more common on-site stormwater treatment control measures for development projects. The standard treatment control measures included in this section (R-1 to R-14 and C-1 to C-4) are non-proprietary (public domain) designs that have been reviewed and evaluated by the City and determined generally acceptable. Because the performance of these control measures has already been demonstrated and reviewed by the City, the plan check review and approval process will be routine for development projects that have selected one or more of these control measures.

However, the City recognizes that these non-proprietary treatment control measures may not be appropriate for all projects due to physical site constraints. Thus, if the volume retention requirement has been met through the use of LID control measures, the City will allow the use of proprietary control measures that have been approved for general use by the City in those projects where the use of non-proprietary treatment controls have been demonstrated by the applicant to the satisfaction of the City to be impractical. Proprietary devices that are approved by the City for general use are listed in Appendix J along with the sizing criteria and criteria used for approval. This list will be updated periodically when additional proprietary devices are added to the approved list.

In general, any proprietary device must be designed to treat the WQF or WQV. Procedures to calculate the WQF and WQV are provided in Fact Sheet C-2. Stormwater runoff in excess of the WQF or WQV may be diverted around or through a treatment device. However, use of alternative sizing criteria is allowed for certain devices as indicated in Appendix J. Any proposed device must include all maintenance, operation, and construction requirements, as indicated in Appendix D and as recommended by the manufacturer.