

DESIGN GUIDE NO. 2

WET POND DESIGN UNDER THE 2009 DRAINAGE DESIGN AND EROSION CONTROL MANUAL

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Purpose

The purpose of this design guide is to summarize in one location the requirements for designing wet ponds using the 2009 Drainage Design and Erosion Control Manual for Thurston County (DDECM). Wet pond design requirements are found in several locations within the DDECM including:

- Volume I, Section 2.4, *Minimum Requirements*
- Volume I, Section 3.8, *Drainage and Erosion Control Plan*
- Volume I, Chapter 4, Stormwater BMP Selection Process
- Volume I, Section 4.7.1, *Soil Type*
- Volume I, Section 4.7.3, *Other Physical Factors, Maximum Depth*
- Volume III, Section 2.1, *Minimum Computational Standards*
- Volume III, Section 3.6, *Easements, Access and Dedicated Tracts*
- Volume IV, *Source Control*
- Volume V, Chapter 4, Section 4.1.1, D.01, *Detention Ponds.*
- Volume V, Chapter 6, Section 6.1.2, WP.02, *Wet Ponds*
- Volume V, Appendix V-A, *Structures -- Control structures*
- Volume V, Appendix V-B, *Facility Liners and Geotextiles*
- Volume V, Appendix V-D, *Access Roads and Ramps*
- Volume V, Appendix V-E, *Site Design Elements* – Requirements for fencing, signage, setbacks, easements & planting/landscaping.

Hydrologic Design Criteria

Minimum Requirement #6, *Runoff Treatment*, requires projects to construct stormwater treatment facilities to reduce the water quality impacts of stormwater runoff from pollution generating surfaces. For wet pond design, the volume required to be treated is the 91st percentile, 24-hour runoff volume estimated by an approved continuous runoff model, or alternatively the 6-month, 24-hour storm volume as estimated by a single-event stormwater model per Volume III of the DDECM. If a large wet pond is proposed, the design volume is 1.5 times the volume determined by the above methods.

The continuous simulation hydrologic model used for designing wet ponds is generally the Western Washington Hydrologic Model, Version 3 (WWHM3) as developed for the Department of Ecology by Clear Creek Solutions, Inc.. The WWHM3 has also been modified with Thurston County specific data and the modified version shall be used for design of wet ponds facilities in Thurston County.

A runoff treatment facility (wet pond is one type of runoff treatment facility) is required for projects that:

1. Create 5,000 square feet or more of pollution generating impervious surfaces (PGIS) impervious surfaces in a threshold discharge area.

2. Have $\frac{3}{4}$ of an acre or more of pollution generating pervious surface in a threshold discharge area, and from which there is a surface water discharge to a natural or man-made conveyance system from the site.

A threshold discharge area is defined as an onsite area draining to a single natural discharge location or multiple discharge locations that combine within one-quarter mile downstream (as determined by the shortest flowpath).

Pollution generating impervious surfaces are those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those subject to: vehicular use; industrial activities, or storage of erodible or leachable materials and which receive direct rainfall or the run-on or blow-in of rainfall. Metal roofs are also considered PGIS unless they are coated with an inert, non-leachable material.

A surface, whether paved or not, shall be considered subject to vehicular use if it is regularly used by motor vehicles. This includes roads, unvegetated road shoulders, driveways, parking lots, unfenced fire lanes, and vehicular storage yards. Not considered PGIS are bicycle and pedestrian pathways separate from and not subject to drainage from roads, fenced fire lanes, and infrequently used maintenance access roads.

Pollution generating pervious surface (PGPS) is any non-impervious surface subject to the use of pesticides and fertilizers or loss of soil and includes lawns, landscaped areas, golf courses, parks, cemeteries and sports fields.

If runoff from new and replaced PGIS or PGPS cannot be separated from existing PGIS or PGPS runoff then treatment facilities shall be sized to treat all of the runoff.

Wet ponds provide basic treatment and provide phosphorous treatment when increased in size to a "large" wet pond. Wet ponds do not provide enhanced treatment unless combined with other treatment facilities such as a sand filter in a "treatment train."

Wet ponds are also a suggested or required BMP for several types of commercial or industrial activities as part of a Source Control Plan:

- A1.1: Cleaning or Washing of Tools, Engines, and Manufacturing Equipment – Wet pond is a suggested BMP
- A1.2: Cleaning or Washing of Cooking Equipment: Wet pond is a suggested BMP.
- A4.1: Storage or Transfer (Outside) of Solid Raw Materials, Byproducts, or Finished Products – Wet pond is a one of several alternative required BMPs.
- A4.10: Storage of Pesticides, Fertilizers, or Other Products That Can Leach Pollutants – Wet pond is a suggested BMP.
- A6.2: Dust Control at Manufacturing Sites – Wet pond is a suggested BMP.
- A7.4: Boat Building, Mooring, Maintenance, and Repair – Wet pond is a suggested BMP when paint chips or blasting grit is prevalent in the work area.

Treatment Processes

Wet pools treat stormwater by allowing particulates to settle during stilling conditions ("sedimentation"), by biological uptake of dissolved pollutants, and by vegetative filtration. The unit processes that occur in a functioning wet pond include:

- Physical: Sedimentation/settling & Flotation
- Chemical: Sorption to bottom soil and precipitation in the water
- Biological: Uptake and sorption by free floating algae and vegetation.

Note: Sorption is a unit process in which dissolved constituents are removed by the chemical attachment to media at the molecular level. There are three types of sorption: adsorption, absorption, and ion exchange.

Special Requirements

If a wet pond is located within the Well Head Protection Area of a public water system with over 1,000 connections a minimum of 3-feet of separation to the seasonal high groundwater level is required or the pond shall be lined.

If the wet pond includes a constructed berm above existing ground and the volume retained by the above grade portion of the berm exceeds 10 acre-feet then Dam Safety requirements of the Department of Ecology shall also be met.

Wet ponds shall be located within a separate stormwater tract (not an easement) with a minimum of 5-ft separation between the tract lines and any improvements (including fill or cut slopes) associated with the wet pond or other stormwater facilities within the tract.

If a wet pond is proposed in an area with porous soils (native soil infiltration rate greater than 0.5 inches per hour), the pond will be required to be lined to maintain a permanent wet pool. Lining requirements for wetponds are included in Appendix V-B of Volume V of the DDECM.

Design Process

The following generalized design process is suggested for wet pond design:

1. Evaluate project site for suitability including area available, depth to bedrock, native soil infiltration rates, depth to water table, etc. If a wet pond is deemed suitable to the site proceed with the design process.
2. Compute the water quality design volume (or 1.5 x design volume for large wet pool). If using the WWHM3 the following approach is suggested:
 - a. Using a hydrologic model (WWHM3) input all contributing basin information and setup model to route contributing basin(s) to the point of discharge from the site (point of compliance). Include any flow control facilities and other treatment facilities as required. Be sure to include the estimated area of the wet pond and detention pond as an impervious area.
 - b. Complete a preliminary design any flow control facilities, assuming a pond area for the wet pond.
 - c. In the analysis tab of WWHM3 select the "flow" data set and select the inflow to the point of compliance for the mitigated scenario. Select the water quality tab and right click on "Run Analysis." In the "On-Line BMP result the value for 24 hour Volume is provided in acre-feet. This is the design volume for the wet pond.
3. Layout a wet pond to meet multi-cell, depth, width to length ratio and other requirements on the site plan. Account for access roads, pond ramps, tract line setbacks, points of discharge, etc.
4. Once a wet pond layout is complete, revise any WWHM3 or Single Event model input parameters (replace assumed wet pond area with calculated area based pond layout and refine any flow control facility design and verify that the wet pond volume is still adequate. Be sure to account for the volume of any access ramps required, revise the original estimate of pond area assumed as impervious, and adjust the design accordingly.

5. Design the pond outlet pipe and determine primary overflow water surface elevation. The pond outlet pipe shall be placed on a reverse grade from the pond's wet pool to the outlet structure. Use the following procedure:
 - a. Use nomographs in Volume III, Appendix III-C to select a trial size for the pond outlet pipe sufficient to pass the online water quality design flow, Q_{wq} indicated by an approved continuous runoff model. Use nomographs to determine critical depth d_c at the outflow end of the pipe for Q_{wq} and the flow area, A_c at critical depth.
 - b. Calculate the flow velocity at critical depth using continuity equation ($V_c = Q_{wq} / A_c$).
 - c. Calculate the velocity head V_H ($V_H = V_c^2 / 2g$), where g is the gravitational constant, 32.2 feet / sec²).
 - d. Determine the primary overflow water surface elevation by adding the velocity head and critical depth to the invert elevation at the outflow end of the pond outlet pipe (i.e. overflow water surface elevation = outflow invert + $d_c + V_H$).
 - e. Adjust outlet pipe diameter as needed and repeat steps (a) through (d).
6. Design outlet structure. Set outlet pipe invert elevations and drain line elevations. The outlet structure shall include a second overflow of either a grated opening (jail house window) or birdcage grate. The elevation of the grated opening or birdcage grate shall be set at the overflow water surface elevation as calculated in step 5 above.
7. Conveyance modeling for the stormwater system leading to the wet pond must be performed to analyze for any backwater effects of a submerged inlet and to provide design flow rates for overflow structures. The 100-year, 24 hour event for spillway and overflow structure design shall be based on flows calculated from a single event model or the rational method per the conveyance design requirements of Volume III of the DDECM.
8. Design emergency spillway and calculate maximum water surface elevation based on a plugged outlet structure. Add required freeboard to get top of berm elevations.
9. Layout pond design and grading on drainage plans and be sure to address all applicable design details such as access roads, ramps, berm construction, fencing, control structure, inlets and outlets per detention pond design requirements. Show design and maximum water surface elevations on plan drawing.
10. Show in drainage plans and construction drawings at least one pond cross-section through control structure. Indicate design and maximum water surface elevations.
11. Provide details and specifications for control structures, inlet and outlet piping, slope treatments, emergency spillways, seeding or sodding, berms, etc.
12. Establish stormwater tract boundaries. Boundary should be no closer than 5-feet to grading catch points or structures.
13. Prepare a landscaping plan showing plantings within the stormwater tract.
14. Include all design calculations, assumptions, modeling parameters, etc. in the Drainage Report for the project.

Site Design Elements

Wet ponds should be located to maximum their function and made an attractive feature of the urban environment. Site design considerations should be incorporated including:

- Tear drop shape rather than rectangular to avoid short circuiting and promote plug flow.
- Create flat areas adjacent to pond for picnic tables, etc.

- Orient pond along the direction of prevailing winds.
- Include fountains or waterfalls as a visual aesthetic and to help pond function.
- Curvilinear design (non rectangular)
- Provide landscape plantings above the water level of the pond (see landscaping & plantings discussion).
- Incorporate the wet pond into other on-site features such as walking trails, picnic area, etc.
- Provide wetland plants suitable to design water depths.

Pond Geometry & Structural Design

- Dissipate energy at inlet per outfall design criteria of Volume II, BMP C.209. The inlet pipe shall enter the wet pond a minimum of 2 feet from the pond bottom and have at least one foot of submergence, if possible. All inlets shall enter the first cell.
- Provide large L/W ratio (3:1 min, 5:1 or greater preferred) – Width is based on width at mid depth. If only single celled (i.e. <4,000 cf volume, then L/W shall be 4:1 minimum).
- If there are multiple pond inlets, the L/W shall be based on the average flow path length for all inlets.
- An 8 inches minimum diameter gravity drain line and control valve is required, where feasible. If a shear gate is used it shall be situated such that water pushes against the seal.
- The drain line invert shall be at least 6-inches below the top elevation of the dividing berm or baffle and no deeper than 18 inches above the pond bottom.
- Valve shall be accessible and well marked with 1 foot of paving placed around the box. A valve box is allowed to a maximum depth of 5 feet without an access manhole. If over 5 feet, an access manhole or vault is required.
- No galvanized materials shall be used unless unavoidable.
- Divide pond into two cells with first cell 25 to 35% of wet pool volume. Only one cell required if wet pool volume is less than 4,000 cubic feet. Both pond cells shall have level bottoms.
- Maximum depth of a cell shall not exceed 8 feet exclusive of sediment storage in first cell. For wet pool depth of greater than 6 feet, some form of recirculation shall be provided – fountain or aerator.
- Minimum depth of first cell is 4-feet, exclusive of sediment storage. Depth of 1st cell can be greater than the 2nd cell. Minimum sediment storage in first cell shall be 1-foot.
- Divider Berm:
 - Provide a divider berm between cells with a 5-foot minimum width set at design water surface or 1-ft below design water surface. A divider berm is

not required if L/W ratio is greater than 4:1 or pond volume <4,000 cf.
Extend divider berm full width of pond.

- 3:1 Side slopes if set at water surface, 2:1 ok if set 1-ft below water surface.
 - If barrier planting is provided then can use 2:1 for berm set at water surface.
 - If a retaining wall is used, shall be designed by civil engineer, and required to be submerged 1 foot below the design water surface.
 - If berm is greater than 4-ft in height it shall be keyed into the bottom and sides. Key to be 50% of berm height and width.
 - If the dividing berm is also used for access, it shall be built to sustain loads of up to 80,000 pounds.
- Pond Lining required if >0.5 in/hour infiltration rate estimated. Then lining shall meet requirements of Appendix V-B for either a treatment liner or impermeable liner.
 - Requirements for liners:
 - Line cell bottoms & sides to water quality design water surface.
 - First cell shall be either a treatment liner or low permeability liner.
 - Second cell shall be a treatment liner.
 - Low permeability liners include: till, clay, geomembrane and concrete liners. Till liners are 18-inch minimum thickness, clay liners are 12-inch minimum thickness, and geomembrane liners are 30 mil minimum thickness. Target infiltration rate for low permeability liners is less than 0.02 inches per hour. See Appendix V-B for details on liner construction.
 - Treatment liners are not defined in the DDECM, this was an oversight. Treatment liners are defined in Ecology's Stormwater Management Manual for Western Washington (February 2005) Volume V, Section 4.4. Generally treatment liners amend soils to provide treatment and have a target infiltration rate of 2.4 inches per hour or less.
 - The treatment liner thickness is 24-inches with a minimum organic content of 5% and a cation exchange capacity (CEC) of 5 milliequivalents/100 grams.
 - Pond Berm Embankments:
 - Exterior and interior side slopes steeper than 2H:1V shall be designed by geotechnical engineer.
 - Excavate "key" equal to 50% of the berm embankment cross-sectional height and width, except on till soils "key" can be reduced to 1-foot of excavation into the till.
 - Construct on suitable base soils either consolidated native soil or adequately compacted and stable fill soils as determined by a geotechnical engineer.
 - Place in 6-inch lifts and compact to 95% of maximum dry density. Soils as recommended by geotechnical engineer or alternatively: 30% clay minimum, 60% sand maximum, and 60% silt maximum.

- Provide anti-seepage collars on pipes through embankments ponding greater than 8-feet of water.
- Exposed earth on embankment shall be sodded or seeded. No trees or shrubs shall be planted on berms taller than 4 feet. Trees or shrubs planted on berms 4 feet or smaller shall not exceed 20 feet mature height and have a fibrous root system.
- Minimum berm width is 15-feet where maintenance access is provided, otherwise minimum top width is 6-feet or as recommended by professional engineer.
- Pond berm embankments greater than 6-ft in height require design by a geotechnical engineer.

Setbacks

Setbacks for wet ponds are the same as for detention ponds. Setbacks from the maximum water surface (pond elevation when emergency spillway is passing the 100-year event):

- 1-foot vertical clearance to structures within 25 feet.
- 10-feet horizontal to:
 - Property lines and onsite structures
 - Building sewer lines
 - Tract property boundary line
- 30-feet horizontal to:
 - Septic tank or distribution box
 - Septic drainfield and drainfield reserve areas for single family septic systems.
- 50-feet horizontal to slopes steeper than 15% and greater than 10 feet high.
- 100-feet horizontal to:
 - Septic drainfields and reserve areas for community septic systems.
 - From a drinking water well.

Access Roads & Ramps

Requirements for access roads and ramps for wet ponds are found in Volume V, Appendix V-D of the DDECM. These requirements include:

- A 15-foot wide access easement shall be provided from a public street or right-of-way to the pond. Access shall be surfaced with a 12-foot width of crushed rock or lattice block pavement or other acceptable surface. The easement shall include easement markers at each corner of easement, at angle points and at least every 100-ft along the easement length.
- An access road shall be provided to the control structure and other drainage structures associated with the pond (e.g, inlet or bypass structures).
- If pond maintenance will be provided from the access road, the access road shall extend around the pond perimeter for access to each pond cell.
- Access road design criteria include:
 - 15% maximum grade. (12% maximum grade to control structure)

- Outside turning radius of 40-feet minimum.
 - 15-feet width minimum.
 - Provide paved apron where access road connects to paved public roadway.
 - Provide asphalt, gravel, or modular grid pavement surface.
 - When length of road exceeds 75-feet a vehicle turnaround must be provided for a design vehicle with a 31 foot length and inside wheel path radius of 40-ft.
 - Vehicle access shall be limited by a locking gate or bollards. Gates are required if pond is fenced and shall meet WSDOT standard plans and be located only on a straight section of road.
- Access ramps provide access to the bottom of a pond for maintenance, repair and sediment removal. They are required unless the pond is small enough that a trackhoe with a maximum reach of 20-ft can reach all areas of the pond from a perimeter access road.
 - Access ramp design criteria include:
 - 15-feet width minimum.
 - 15% maximum grade if surfaced to access road standard.
 - 12% maximum grade for alternative ramp surface using geotextile over native soils, 6-inches of quarry spalls (2"-4"), and 2 inches of crushed rock surface.
 - Extend ramp to bottom of pond if pond bottom is greater than 1,500 square feet, otherwise ramp may end 4 feet above the pond bottom.

Control Structure

The control structure for a wet pond is typically a Type 2 Catch Basin structure (54-inch minimum diameter) with either a grated opening (jail house window) or a manhole with a cone grate (birdcage) sized to pass the 100-year, 24-hour storm.

The bottom of the grate opening in the outlet structure shall be set at or above the height needed to pass the water quality design flow through the pond outlet pipe.

Overflow Protection

- The primary overflow protection for a wet-pond is either a grated opening to the control structure (jail house window) or a "birdcage" overflow structure. A grated opening shall be designed to pass the 100-year, 24-hour developed peak flow. Vertical bars spaced 4-inches on center shall be provided within the window opening.
- Provide an emergency spillway sized to pass the 100-year, 24-hour developed peak flow. As an alternative to an emergency overflow spillway for constructed berms over 2-feet in height, or ponds located on grades in excess of 5%, emergency overflow may be provided by an emergency overflow structure separate from the control structure such as a Type II manhole fitted with a birdcage. The emergency spillway shall meet the following design criteria:
 - A minimum of 6 inches of freeboard shall be provided above the maximum water surface elevation.
 - Comply with details of Figure 4.2 of Volume V for emergency spillway.
 - Discharge directly to the downstream conveyance system or another acceptable discharge point.

- Armored per Outlet Protection BMPs to full width, beginning at a point midway across the berm embankment and extending downstream to where the emergency overflow reenters the conveyance system.
- Alternative armoring may of 2" asphalt concrete pavement may be provided for spillways on access roads.
- Design the spillway as a broad-crested weir. A broad-crested weir equation is provided in Appendix V-A of the DDECM.

Signage & Fencing

- Fence required where slopes greater than 3H:1V above the emergency overflow water surface elevation or higher or where there is a wall greater than 30-inches in height.
- Public stormwater pond tracts shall be fenced. Place fence 1-foot inside the tract boundary or a minimum of 5 feet from the top slope catch point.
- Public drainage pond fences shall be 6-ft WSDOT Type 1 chain link.
- Wood fence allowed in subdivisions. Use pressure treated posts and cedar, pressure treated fir, or hemlock rails and fence boards.
- Pond shall have an information sign. Applicant shall submit sign design and proposed location for County acceptance. Sample sign specifications are included in Appendix V-E.

Plantings & Landscaping

- Planting requirements for detention ponds apply to wet ponds.
- Large wet ponds for phosphorous control shall not be planted within the cells. Also, shrubs that form a dense cover should be planted on slopes above the WQ surface on at least 3 sides.
- Plantings on berms shall be in conformance with requirements for embankment berms listed previously.
- If 2nd cell <3 feet in depth, plant emergent wetland species per Table 6.2 of Volume V of the DDECM.
- As required by Minimum Requirement No. 5, *Onsite Stormwater Management*, all disturbed areas of the project to be landscaped shall implement BMP LID.02 to restore soil quality and depth.
- Except as noted above, all disturbed or exposed soils shall be seeded, sodded, and/or landscaped. Table E-2 of Volume V, Appendix V-E gives an appropriate seed mix. Seed should be applied at 2.5 to 3 pounds per 1,000 square feet.
- Pond interior side slopes and bottom shall be sodded or seeded with an appropriate seed mixture.
- All remaining areas of the tract should be planted with grass or landscaped and mulched with 4-inch cover of hog fuel or shredded wood mulch.

- Other than the above requirements, a specific landscape plan for ponds is not specified. However, if landscaping is provided, the following general criteria should be considered:
 - Plant no trees or shrubs within 25-feet of inlet or outlet pipes or drainage structures. Species with roots that seek water such as willow or poplar shall be avoided within 50-ft of structures.
 - Plant evergreen or columnar deciduous trees along the west and south side to reduce thermal heating. Tree should be setback so branches don't extend over the pond. Trees and shrubs also discourage waterfowl use.
 - Trees and shrubs should be planted in clumps to form "*landscape islands*." Landscape islands should be a minimum of 6 feet apart and 6 feet from any fences or other barriers. The 6-feet allows a mower to pass between the landscape islands.
 - Plant evergreen trees or trees with relatively little leaf fall in areas draining to the pond.
 - Two naturalistic planting schemes are suggested: "Open Woodland" or "Northwest Savannah or Meadow." See Volume V, Appendix V-E for details on these two planting schemes. The "Open Woodland" design recommends a minimum of 30% (excluding the pond area) of the tract be in landscape islands (when mature). The "Northwest Savannah or Meadow" design recommends that a minimum of 10% of the tract (excluding the pond area) be in landscape islands (when mature), the remainder of the area being seeded or sodded. Creation of emergent vegetation in shallow areas of the pond is recommended. Use native wetland plants.

Submittal Information

Include the following in any submittal documentation for the project:

- Show on the work map included in the Drainage Report the following:
 - Limits of contributing drainage basins per threshold discharge area for pre-development and developed conditions
 - Summary of areas by type (impervious, native, landscape).
 - Location of clear path of overflow to downstream collection point.
 - Natural drainage channels.
- Include in the construction plans and specifications:
 - Catch point for cuts and fills.
 - Tract boundaries and easements & location of easement markers.
 - Max design water level, water quality level, overflow level in plan view & pond cross-section.
 - Planting plan showing plant species, quantity, location and any special planting requirements.
 - Channel protection from path of overflow to downstream collection point.
 - Outfalls & energy dissipation at outfalls
 - Inlet and outlet pipe invert elevations, slopes and pipe lengths.
 - Details, construction notes and specifications for all structures and materials.
 - Pond cross-section through control structure.
 - Cross-sections – access roads, ramps, and spillway.
 - Proposed design & location for the stormwater facility information sign.

- Include in the Drainage Report for the project:
 - Design calculations for overflow structures, piping and emergency spillway.
 - Document facility meets any setback requirements.
 - If the pond is located within 300 feet of the top of a slope designated a landslide hazard area or within the minimum setback distance of 50-feet to a slope of greater than 15% and 10-ft height a geotechnical analysis and report shall be submitted.
 - Hydrologic modeling results including a schematic of the model setup referencing model basin identifiers to basins and sub-basins shown in the work map.
 - Justify use of wetpond instead of treatment wetland.
 - Document soil infiltration of <math><0.5\text{''}</math> per hour if lining not proposed.
 - Design calculations for outlet pipe, see design procedure above. Include nomographs marked up with design calculations.
 - Conveyance modeling accounting for any backflow effect of any submerged inlet.

REVIEW CHECKLIST WET PONDS

Applicant Use	REVIEW CHECKLIST	Staff Use Only
HYDROLOGIC DESIGN		
	Verify input to WWHM3 & Single Event models for pre-development and developed land use, soil type and areas are consistent with site plan and other documentation.	
	If WWHM3 used to size wet pond, verify Thurston County customized version used in design. Alternatively a single event model may be used and the design volume is the volume of the 6-month, 24 hour storm event.	
	Verify wet pond volume calculations, if pond will be a "large" pond for phosphorous control, volume is 150% of volume calculated for basic wet pond.	
	If impervious areas are not included in model because they are considered ineffective, verify that dispersion criteria are met per appropriate BMP to designated impervious area as ineffective.	
	Verify that WWHM3 and/or single event model reports are submitted and verify that design water quality volume and flow meets requirements.	
	Verify that WWHM3 model computer file is submitted with project, consider running model to verify report conclusions.	
	Check that layout of wet pond design shown on site plans/drainage plans is consistent with results of WWHM3 model.	
	A schematic of the hydrologic modeling parameters (network diagram of model, or equivalent) should be provided with basin designations matching basin designations on drainage work map required to be included in the Drainage Report.	
SPECIAL REQUIREMENTS		
	Is project located within the Well Head Protection Area of a public water system with over 1,000 connections? If so is proposed pond bottom at least 3-feet above seasonal high groundwater level or is the pond lined with an impermeable liner per Volume V, Appendix V-B	
	Is an above grade berm proposed that impounds more than 10 acre-feet of water at the maximum water surface? If so, verify that Dam Safety requirements of WAC 173-175 are complied with and applicant has applied to Ecology for Dam Safety review.	
	Is a separate tract established that encompasses the wet pond, access roads, and associated appurtenances and structures and is there is at least a 5-ft separation between any facility, the catch point of fill or cut slopes, or access road to the tract line.	
	Are native soils in vicinity of pond porous (infiltration rate <0.5 inches per hour)? If so, is pond lined per requirements of Appendix V-B of Volume V.	
SITE DESIGN ELEMENTS (Not Requirements)		
	Tear drop, curvilinear, other non-rectangular shape proposed that avoids short circuiting and promotes plug flow?	
	Wet pond incorporated into other on-site features such as trails, picnic area, etc.	
	Pond oriented along direction of prevailing wind, where possible.	
	Landscape plantings above water level of pond & wetland plants suitable to design water depths within pond.	
	Fountains or waterfalls considered for aesthetics and to help pond function. Required if pond depth greater than 6-feet.	
POND GEOMETRY & STRUCTURAL DESIGN		
	Inlet pipe enters pond a minimum of 2 feet from pond bottom and at least one foot of submergence?	
	Energy dissipation provide at pond inlets.	
	All inlets enter first cell of wet pond.	
	Length to Width Ration at least 3:1, 4:1 if pond volume is less than 4,000 cubic feet. Length to width ratio based on mid pond depth.	
	For multiple inlets, pond L/W ration based on average flow path length for all inlets.	
	Gravity drain line provided (8-inch minimum diameter) with control valve.	
	Drain line invert at least 6-inches below the top elevation of the dividing berm or baffle and no deeper than 18-inches above pond bottom.	

	Drain line valve located in valve box or structure. Structure required if depth is greater than 5-feet.	
	No galvanized materials used unless avoidable.	
	Pond divided into two cells with first cell 25 to 35% of wet pond volume. Only one cell required if volume is less than 4,000 cubic feet.	
	Maximum cell depth 8-feet (exclusive of sediment storage).	
	Minimum depth of first cell is 4-feet, exclusive of sediment storage. Depth of 1 st cell may be greater than 2 nd cell.	
	Minimum sediment storage volume of 1-foot provided in first cell.	
	Recirculation or aeration provided if cell depth exceeds 6-feet.	
	Pond bottoms (both cells) level.	
	Divider berm set at design water surface or 1-ft below design water surface. Not required if L/W ratio is greater than 4: 1.	
	Divider berm slopes 3H: 1V maximum if set at water surface, 2H: 1V ok if set 1-ft below water surface or if barrier planting is provided around to prevent access.	
	Retaining wall for divider berm allowed, shall be designed by civil engineer and required submergence of 1-ft below design water surface.	
	Divider berm keyed into bottom if greater than 4-ft in height. Key to be 50% of berm height & width.	
	If divider berm used for access, shall be built to sustain loads of up to 80,000 pounds and 15-ft top width.	
	Porous native soils? If so provide pond lining per Appendix V-B. Line cell bottoms and sides to water quality design surface. Impervious or treatment liner in first cell, treatment liner in 2 nd cell.	
	Treatment liner per Ecology SWMMM, V – 24-inch thickness, minimum organic content of 5% and cation exchange capacity (CEC) of 5 milliequivalents/100 grams.	
	Impermeable liners minimum thicknesses: Till liner – 18-inches, Clay liner – 12-inches, geomembrane liner – 30 mil. See appendix V-B of DDECM for details on liner construction.	
	Interior side slopes steeper than 3H: 1V are provided with protective fencing.	
	If interior or exterior side slopes steeper than 2H: 1V are proposed, is the design addressed in the geotechnical report by a licensed professional engineer with geotechnical expertise.	
	If retaining walls or rockeries are proposed have they been designed by a licensed professional engineer.	
	Is the flow path from pond inlet to outlet maximized to the extent feasible to promote sedimentation.	
	Is a debris barrier (trash rack) provided for the pond outlet and for any pond inlet pipes that are 18-inches in diameter or greater.	
	If a berm embankment is proposed (i.e. berm construction above existing grade) to impound water a geotechnical engineer is required to design the embankment for embankments with slopes steeper than 2H: 1V or 6-ft in height.	
	Is a pond berm embankment “key” equal to 50% of the berm embankment cross-sectional height and width included in the design? If in till soils, Pond berm embankment “key” can be reduced to 1-foot of excavation into till soils.	
	Is the pond berm embankment constructed on fill soils? If so, a geotechnical engineer shall provide design and design should be included in geotechnical report.	
	Are anti-seepage collars provided on pipes through embankments ponding greater than 8-ft of water.	
	Is any pond berm embankment soils and compaction specified? Either as recommended by a geotechnical engineer, or alternatively, if geotechnical engineer design is not required the following specification is allowed: Soil placed in 6-inch lifts and compacted to 95% of maximum dry density and embankment soils are 30% clay minimum, 60% sand maximum and 60% silt maximum, per USDA soil triangle.	
	Is all exposed earth on embankment either sodded or seeded? No trees or shrubs are allowed to be planted on berms taller than 4 feet. Trees or shrubs planted on berms 4 feet or smaller shall not exceed 20 feet mature height and have a fibrous root system.	
	Is the top of berm width at least 6-feet, or as recommended by a geotechnical engineer? If the top of berm is to be used for maintenance access, minimum width is 15-feet.	
SETBACKS		
	Is the maximum water surface elevation shown on the drainage plan and also shown in the pond cross-section?	
	Is there at least a 1-foot vertical clearance from the maximum water surface to any structures (buildings) within 25-feet?	
	Is there at least a 10-foot horizontal separation from the maximum water surface to property lines, structures, sewer lines and the tract property boundary line?	

	Is there at least a 30-foot horizontal separation from the maximum water surface to any septic tank or distribution box or any septic drainfield or reserve area for single family septic systems? The location of nearby septic systems (on-site and off-site) and drainfields should be shown on the site plan if they are in proximity to the wet pond.	
	Is there at least a 50-foot horizontal separation from the maximum water surface to slopes steeper than 15% and greater than 10 feet high? If not, a geotechnical engineer shall evaluate for stability and include recommendations in the geotechnical report. In no case shall setback be less than the height of the slope greater than 15%.	
	Is there at least a 100-foot horizontal separation from the maximum water surface to any septic drainfields or reserve areas for a community septic system or drinking water well?	
ACCESS ROADS		
	Is access to the wet pond provided from a public street or right-of-way?	
	For access to the wet pond outside of the public right-of-way is a minimum 15-foot easement provided? Is the easement provided with a minimum 12-foot width all weather surface such as crushed rock or lattice block pavement?	
	Is an access road provided to the control structure and other drainage structures associated with the wet pond? If pond maintenance is to be performed from the access road (i.e. no ramp to pond bottom) the access road should extend around the pond perimeter.	
	Is the pond access road grade less than 15% and less than 12% to the control structure?	
	Minimum horizontal curve radius 40-feet.	
	If access road length exceeds 75-ft a turnaround must be provided for a 31-ft length design vehicle with an inside wheel path radius of 40-ft.	
	Is paved apron provided where access road connects to paved public roadway?	
	Is a gate or are bollards provided for the access road? If the pond is fenced, a double posted fence gate meeting WSDOT standards is required. Gate should be located on a straight section of access road. If bollards are proposed, fixed bollards shall be set at the road edges and two removable bollards equally spaced between the fixed.	
ACCESS RAMPS		
	Access ramp required unless applicant demonstrated that a 20-ft reach trackhoe can access all areas of the pond from the perimeter access road? Perimeter access road shall be extended around entire perimeter of pond (see above).	
	Access ramp grade less than 15%.	
	Access ramp width at least 15-feet.	
	Access ramp section of suitable design to provide year round access? Standard section of geotextile over native soils with 6-inches of quarry spalls and 2 inches of crushed rock allowed, but slope limited to 12% maximum for this design.	
	Ramp extended to bottom of pond for bottom area greater than 1,500 square feet? Otherwise ramp may end 4 feet (measured horizontally) from pond bottom.	
CONTROL STRUCTURE		
	Control structure diameter suitable to pipe sizes (54" minimum).	
	Control structure detail provided in plans.	
	Secondary overflow provided: Grated opening (jail house window) or cone grate (birdcage) provided and sized to pass the 100-year, 24-hour storm.	
	Secondary overflow elevation set at design water quality water surface.	
	Backwater affects possible for outlet pipe? If so, have they been analyzed for.	
	Grated bar inlet bar spacing 4".	
EMERGENCY SPILLWAY		
	Emergency spillway provided and designed to pass 100-year developed peak flow? Or alternative emergency overflow structure (separate from control structure) provided. Design calculations included in Drainage Report.	
	Minimum freeboard above maximum water surface elevation of 6-inches.	
	Discharge from spillway or overflow directly to downstream conveyance system or other acceptable discharge point.	
	Spillway armored to full width beginning at least midway across the berm embankment and extending downstream to where overflow reenters conveyance system. Armoring design per outlet protection of Volume II BMP C.209 or channel protection requirements of Table 3.8 of Volume III.	
SIGNAGE AND FENCING		
	Fencing provided where pond slope greater than 3H:1V above emergency overflow water surface, or where there are walls greater than 30-inches in height.	

	If a public facility – pond tract fenced with 6-ft WDOT Type 1 chain link.	
	Wood fence or other alternative fencing/shrubbery screening allowed for private facilities.	
	Information sign provided. Comply generally with sign specifications of Appendix V-E.	
PLANTINGS & LANDSCAPING		
	Disturbed soil quality and depth restored per BMP LID.02.	
	Pond interior side slopes and bottom sodded or seeded with appropriate seed mixture (Table E-2 of Volume V, Appendix V-E give appropriate seed mix). Except for ponds for phosphorous treatment.	
	If large pond proposed for phosphorous control no plantings within cells and shrubs that form a dense cover planted on slopes above water quality design water level on at least 3 sides (to discourage waterfowl).	
	If 2 nd cell depth is <3-feet plant emergent wetland species (Table 6.2 of Volume V of DDECM).	
	All remaining areas of storm pond tract seeded, sodded or landscaped with 4-inches mulch in landscape areas.	
	Landscape plan includes pond tract. Note: Landscaping (beyond soil restoration & seeding/Sodding) of wet pond area is recommended but not required. If landscaping is proposed, apply the following criteria to review:	
	No trees or shrubs within 25-feet of inlet or outlet pipes or drainage structures.	
	No water seeking plants such as willow or poplar within 50-ft of structures.	
	Plant evergreen or columnar deciduous trees along the west and south side to reduce thermal heating. Trees should be setback so branches don't extend over pond.	
	Trees and shrubs planted in clumps to form landscape island a minimum of 6-feet apart and 6-feet to fences and other barriers.	
	Evergreen trees or trees with little leaf fall in areas draining to pond.	
	Deciduous tree set back from pond so branches do not extend over pond.	
	Emergent (wetland) type vegetation planted in shallow areas of pond.	
SUBMITTAL INFORMATION		
DRAINAGE REPORT		
	Hydrologic modeling results including schematic of model setup referencing model basin identifies to basins and sub-basins shown in the work map and hydrologic model.	
	Work map showing sub-basins and basins contributing to the wet pond with basin identifies corresponding to the nomenclature used in the hydrologic model.	
	Summary table of contributing sub basins identifying soil type and areas of impervious, landscape, forest, etc. corresponding to hydrologic model inputs.	
	Document how all required facility setbacks are met.	
	Geotechnical report including analysis of embankment berms, slope stability for steep slopes located within setback distances or within 300-ft of the top of a slope designated a landslide hazard area, retaining wall design, and any other analysis required by geotechnical engineer.	
	Document native soils infiltration rate of less than 0.5 inches/hour if pond lining is not proposed.	
	Design calculations for overflow structures, emergency spillway, outlet pipe, outfalls provided.	
	Show on work map the location of natural drainage channels and show a clear path of overflow to downstream collection point from emergency spillways.	
CONSTRUCTION DRAWINGS		
	Show existing topography based on field verified survey.	
	Show proposed topography and extend proposed topography to catch points.	
	Show tract boundaries and easements with widths and location of easement markers.	
	Planting plan showing plant species, quantity, location and any special planting requirements.	
	Design and maximum water surface shown in plan view.	
	Design and maximum water surface shown in pond cross-section	
	Provide at least one pond cross-section through the control structure.	
	Details of emergency spillway, access roads, ramps and outfalls.	
	Details of control structure shown – including invert elevation of pond outlet, elevation of secondary overflow and top of structure.	
	Proposed design and location of information sign including sign specifications.	