

# **Snohomish County Drainage Manual**

## **Volume VI Stormwater Facility Maintenance**

**July 202~~6~~<sup>1</sup>**

## Contents

Maintenance Standards Tables .....	ii
Introduction.....	1
1. Catch Basins.....	4
2. Conveyance Storm Pipes .....	11
3. Debris Barriers (e.g., Trash Racks) .....	14
4. Control Structure/Flow Restrictors .....	18
5. Facility Discharge Points .....	26
6. Energy Dissipators and Outfall Systems .....	28
7. Pump Systems .....	37
8. Detention Ponds.....	41
9. Detention Tanks and Vaults.....	48
10. Infiltration Facilities.....	57
11. Wetponds .....	64
12. Wetvaults.....	76
13. Bioretention Facilities.....	82
14. Basic Biofiltration Swales .....	86
15. Wet Biofiltration Swales .....	93
16. Compost-Amended Vegetated Filter Strips (CAVFS).....	97
17. Media Filter Drain.....	101
18. Filter Strips.....	104
19. Sand Filters (above ground/open).....	107
20. Sand Filters (below ground/enclosed) .....	112
21. Permeable Pavement .....	117
22. Vegetated Roofs .....	121
23. Media Cartridge Filters .....	125
24. Hydrodynamic Separators .....	130
25. API Baffle Oil/Water Separators.....	134
26. Coalescing Plate Oil/Water Separators .....	138
27. Catch Basin Inserts .....	142
28. Access Gates and Fencing.....	146
29. Access Roads.....	150

## Maintenance Standards Tables

No. 1 – Catch Basins .....	7
No. 2 – Conveyance Storm Pipes.....	12
No. 3 – Debris Barriers (e.g., Trash Racks).....	17
No. 4 – Control Structure/Flow Restrictor .....	23
No. 5 – Facility Discharge Points.....	27
No. 6 – Energy Dissipators.....	35
No. 7 – Pump Systems .....	38
No. 8 – Detention Ponds .....	44
No. 9 – Detention Tanks and Vaults .....	54
No.10– Infiltration Facilities .....	61
No.11– Wetponds.....	73
No.12– Wetvaults.....	80
No.13 – Bioretention Facilities .....	84
No. 14 – Basic Biofiltration Swales .....	90
No. 15 – Wet Biofiltration Swales.....	96
No. 16 – Compost Amended Vegetated Filter Strip (CAVFS) .....	99
No. 17 – Media Filter Drain .....	103
No. 18 – Filter Strips .....	106
No. 19 – Sand Filters (above ground/open) .....	109
No. 20 – Sand Filters (below ground/enclosed).....	114
No. 21 – Permeable Pavement.....	119
No. 22 – Vegetated Roofs.....	123
No. 23 – Media Cartridge Filters .....	127
No. 24 – Hydrodynamic Separators.....	132
No. 25 – API Baffle Oil/Water Separators .....	136
No. 26 – Coalescing Plate Oil/Water Separators.....	140
No. 27 – Catch Basin Inserts .....	145
No. 28 – Access Gates and Fencing .....	148
No. 29 – Access Roads .....	151

## Introduction

### Overview

Volume VI is for stormwater facilities owners who generally are commercial property owners and Home Owner Associations (HOAs), but also includes individual homeowners. Stormwater facility owners have the responsibility to ensure their system functions properly, in order to reduce flooding and erosion and protect water quality. If you are reading Volume VI, it is probably because you are the owner or operator of a stormwater facility and would like to learn more about the maintenance standards. When properly maintained, your stormwater facility helps protect our local streams, lakes, and Puget Sound. The investment you make in your stormwater facility is contributing to a healthier environment for your neighborhood, Snohomish County and the greater Puget Sound region. We thank you!

### What is Stormwater?

Stormwater is created when rain falls on hard surfaces- such as roofs, driveways and roads. Rainwater mixes with anything on those surfaces including pollutants like oil, grease and soaps and becomes polluted stormwater runoff. Uncontrolled or untreated stormwater is known to cause harm to aquatic ecosystems, threatening public health and the environment. Therefore, stormwater is normally required to be channeled through a system of pipes, catch basins, flow control and water quality systems, to ensure it's clean and okay to be released into the local streams, wetlands and eventually Puget Sound.

### What Is a Stormwater Facility?

A stormwater facility is a "system of collecting, conveying, and storing stormwater runoff. Stormwater facilities include, but are not limited to, all stormwater conveyance systems and containment facilities including pipelines, channels, dikes, ditches, closed depressions, stormwater flow control facilities, stormwater treatment facilities, erosion and sedimentation control facilities, and other drainage structures and appurtenances, both natural and artificial." (Snohomish County Drainage Manual, Volume I). Each facility generally includes individual system parts, "components" that capture, detain, filter, and slowly release stormwater into the natural environment.

## How to Use Volume VI- Stormwater Facility Maintenance

Volume VI is a regulatory handbook that helps stormwater facility owners:

- Learn about your stormwater facility and its system parts (components)
- Understand inspection reports
- Implement maintenance actions
- Recognize if your facility is not working and needs attention

To view your stormwater facility, please visit Snohomish County's website- Interactive Maps- Drainage Inventory. You can access your facility number, aerial imagery, data tables, and other details on your stormwater facility and its components.

Please take the time to learn about your stormwater facility so that you can identify and address problems that might occur with it over time. That includes identifying and addressing erosion, water quality or pollution issues.

If you need assistance with Volume VI-Stormwater Facility Maintenance, please call Surface Water Management at 425-388-3464.

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July 2026~~4~~

## Stormwater Regulation

Municipalities that own and operate separate storm sewer systems (MS4s), such as Snohomish County are subject to regulations under the Federal Water Pollution Control Act (*Clean Water Act*) - National Pollutant Discharge Elimination System (NPDES Program). Authorized by the US Environmental Protection Agency, the ~~Washington~~ State Department of Ecology administers the NPDES program, by issuing permits to dischargers and regulating pollution generating activities. The goal of the NPDES program is to ensure stormwater discharges are managed in a way that maximizes the protection of public health and the environment. As a municipal stormwater permittee, Snohomish County is responsible to require stormwater activities are performed, including ensuring inspection and maintenance of regulated stormwater facilities. As noted, new development and redevelopment meeting certain thresholds require stormwater facilities that are designed to mitigate stormwater impacts on the environment.

## Maintenance Responsibility

Understanding the responsibilities and restrictions related to maintenance of your stormwater facility is important. For example, stormwater facilities in residential developments may be located on separate tracts that serve multiple lots with shared maintenance responsibility. Please review your development's plat documents, drainage maintenance covenants, as-built engineering plans, and other relevant documents to better understand your stormwater facility maintenance responsibilities. One source of some of these documents may be PDS's Interactive web map portal.

<http://gismaps.snoco.org/Html5Viewer/Index.html?viewer=pdsmapportal>

## Do I need a Permit?

Before performing maintenance, it's important to understand whether or not the planned activities require any permits. Many stormwater facilities are near critical areas, and therefore knowledge of your facility site boundaries is important. Depending on the type of work, location, and circumstances, permits may be required. For information on permits, please contact Snohomish County- Planning and Development Services (PDS) at 425-388-3311.

## Safety Precautions

It is important to understand potential hazards when accessing a stormwater facility. Inspecting a stormwater facility can require walking up and down steep slopes, being near standing or fast-moving water, or lifting heavy access lids. There can be uneven terrain, dense vegetation, and slippery surfaces. Catch basins and vaults are confined spaces and cannot be entered safely without specialized equipment and training.

## Professional Contractors

For most private stormwater facility owners, the best approach to completing the required maintenance is to hire a professional contractor that specializes in stormwater systems. SWM maintains a list of local stormwater service providers ~~which can be (direct link: storm drainage facility cleaning contractors (PDF), also found at~~ <https://snohomishcountywa.gov/892/Urban-Drainage>). Please be aware that Snohomish County does not endorse or certify these contractors and therefore we recommend seeking multiple quotes and checking references before hiring. For information on how to develop a maintenance plan, please reference the factsheet on *Developing a Maintenance Program*. For technical advice from a Snohomish County Drainage Inspector, contact Snohomish County-Surface Water Management at 425-388-3464.

## What this Volume Contains

The main content of Volume VI consists of the “Maintenance Standards” described in Tables 1-~~2730~~ in the following pages. ~~The Maintenance Standards were taken out of Volume V where they were in previous editions of the County Drainage Manual, and put into this Volume VI.~~ This volume has been organized for ease of reference and quick introduction to a particular type of stormwater facility and its maintenance. The Maintenance Standards are presented in tables along with descriptions and useful tips, given in the form of common maintenance considerations. The Maintenance Standards that are given in the tables are the criteria by which County Drainage Inspectors inspect to confirm that required maintenance is performed correctly under the authority of SCC 7.54.

The administrative rules associated with performing maintenance, such as the timelines and required record keeping, are given in Chapter 4.6 (Maintenance Requirements for Stormwater Facilities) from Volume V of the Drainage Manual. Chapter 4.6 implements the Maintenance Standards in this volume. ~~A copy of Chapter 4.6 is given in Appendix A for ready reference.~~

## Technical Resources

Further information on stormwater regulations and stormwater management in Snohomish County can be found at the following sources:

1. Snohomish County Drainage Manual: <https://snohomishcountywa.gov/1130/Drainage-Manual>
2. Snohomish County Engineering Design and Development Standards (EDDS):  
<https://snohomishcountywa.gov/492/Design-Standards-EDDS>
3. Snohomish County Code (SCC):
  - o 7.53–Water Pollution Control <https://snohomish.county.codes/SCC/7.53>
  - o 7.54 –Maintenance of Constructed Stormwater Control Facilities  
<https://snohomish.county.codes/SCC/7.54>
  - o 30.63A–Drainage <https://snohomish.county.codes/SCC/30.63A>
  - o 30.63B– Land Disturbing Activities <https://snohomish.county.codes/SCC/30.63B>
4. Surface Water Management information on programs and services: [www.surfacewater.info](http://www.surfacewater.info)
5. Washington Administrative Code (WAC): <https://apps.leg.wa.gov/wac/>
6. Revised Code of Washington (RCW) <https://apps.leg.wa.gov/rcw/>

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## Acknowledgements

The content of this ~~v~~volume was ~~derived~~ developed using information from the Washington Department of Ecology (20~~2449~~) Stormwater Management Manual for Western Washington ~~and other sources~~. Information from Pierce County's and Clark County's drainage manuals was ~~also~~ also used.

## 1. Catch Basins

### What is a Catch Basin?

Catch basins (CB-s) are typically rectangular or cylindrical, underground, concrete structures designed to collect stormwater runoff through a grate at the top and to route it through underground pipes attached to it. Most catch basins are associated with streets, highways, and parking lots. Many are also located in the back and side yards of private residential lots. Some CB-s are located on undeveloped property as access and maintenance points and at changes in direction of conveyance pipe systems.

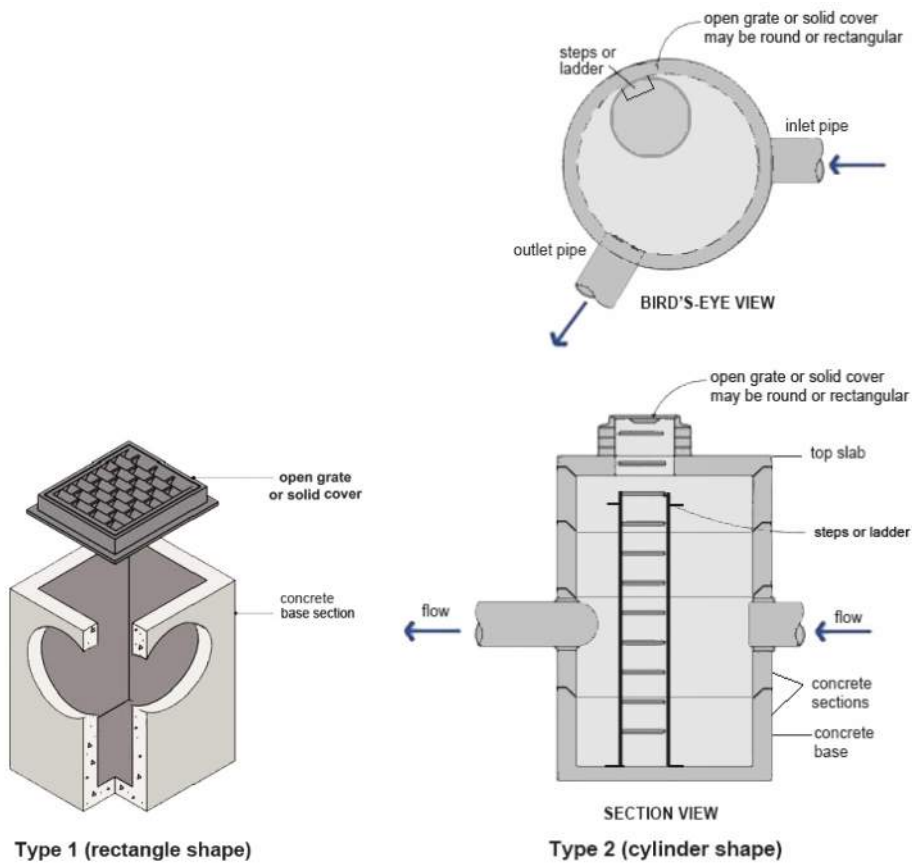
### Typical Catch Basin Design

There are many types of catch basins, varying in shape and dimension. Two commonly used catch basins are described here. The first is the Type 1 CB which is rectangular in shape and has approximately the same opening size as the grate or cover. These catch basins are typically only used in shallow applications and for small pipe sizes; 15-inch diameter or less. It is not common for these catch basins to have ladders or rungs inside for access. The other is the Type 2 CB which is circular in shape and has an inside diameter between 4 and 8 feet. These catch basins are used for deeper applications or for larger pipes; 18-inch diameter or greater. Typically, these catch basins will have a ladder or rungs inside for access. All catch basins contain a sump which is the open area located below the lowest pipe; providing for the collection of sediment and debris. Similar structures to catch basins do not have a sump but instead contain a channelized bottom which allows sediment and debris to flush through the structure.

A catch basin may ~~contain~~ be equipped with a solid cover or an open grate. A catch basin with a solid cover does not collect surface runoff directly. A catch basin with an open grate may collect surface runoff directly but not necessarily in all cases. The choice of a solid lid versus a grated cover is dependent on where the structure is located with respect to the surface runoff flow path.

See the photos and figures below for details.

## Type 1 and Type 2 Catch Basins





## Installation of Type 1 and Type 2 Catch Basins



Type 1 catch basin with vaned grate



Type 1 catch basin connecting concrete pipe



Type 1 catch basin with vaned grate



Type 2 catch basin



Type 2 catch basin connecting plastic pipe

### Common Maintenance Considerations

The most common equipment for cleaning catch basins is a heavy-duty, combination power-washing and vacuum truck, also known as a vactor truck. It provides high-pressure washing for the walls and the bottom of catch basins and a high-power vacuum for removing water that is mixed with sediment, oil, grease, gasoline, vegetation debris, and trash. Generally this is the best and most effective way to clean catch basins.

Refer to the table below titled No. 1 – Catch Basins for maintenance standards.

### Maintenance Standards

No. 1 – Catch Basins			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
General	Sediment & Debris	<ul style="list-style-type: none"> <li>Sediment, trash, and/or other debris material is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment or debris is located immediately in front of catch basin or on grate opening.</li> </ul>
		<ul style="list-style-type: none"> <li>Sediment, trash, and/or other debris material (located in the catch basin) exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height or pipe end blockage exceeds 33%.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment or debris is in the catch basin.</li> </ul>
		<ul style="list-style-type: none"> <li>Sediment, trash, and/or other debris material located in any inlet or outlet pipe is blocking more than 1/3 of its height.</li> </ul>	<ul style="list-style-type: none"> <li>Inlet and outlet pipes are free of sediment and debris.</li> </ul>

No. 1 – Catch Basins			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
		<ul style="list-style-type: none"> <li>Dead animals or vegetation that impair catch basin function or that could generate odors that could cause complaints or dangerous gases (e.g., methane).</li> </ul>	<ul style="list-style-type: none"> <li>No dead animals or vegetation are present within the catch basin.</li> </ul>
	Contaminants and Pollution	<ul style="list-style-type: none"> <li>Any evidence of oil, gasoline, contaminants or other pollutants</li> <li>Note: Coordinate removal/cleanup with local and/or state water quality response agency.</li> </ul>	<ul style="list-style-type: none"> <li>Contaminants or pollutants are removed.</li> </ul>
<b>Structure</b>	Structure Damage to Frame and/or Top Slab	<ul style="list-style-type: none"> <li>Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is seeping into the catch basin)</li> <li>Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached</li> </ul>	<ul style="list-style-type: none"> <li>Top slab is free of holes and cracks. No water and/or soil is seeping into the catch basin</li> <li>Frame is sitting flush on the riser rings or top slab and firmly attached.</li> </ul>
	Fractures or Cracks in Basin Walls/ Bottom	<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or qualified maintenance or inspection personnel determine that the vault is not structurally sound.</li> <li>Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Catch basin is replaced or repaired to design standards.</li> <li>Pipe is regouted and secure at basin wall.</li> </ul>

No. 1 – Catch Basins			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Access Hole Cover	Settlement/Misalignment	<ul style="list-style-type: none"> <li>Settlement or misalignment of the catch basin causes a safety, function, or design problem.</li> </ul>	<ul style="list-style-type: none"> <li>Catch basin is replaced or repaired to design standards.</li> </ul>
	Cover Not in Place	<ul style="list-style-type: none"> <li>Cover is missing or only partially in place. Any open catch basin requires maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>Catch basin cover is fully in place</li> </ul>
	Locking Mechanism Not Working	<ul style="list-style-type: none"> <li>Locking mechanism cannot be opened or lock bolts cannot be removed by one maintenance person with proper hand tools.</li> </ul>	<ul style="list-style-type: none"> <li>Mechanism or lock bolts open with proper hand tools.</li> </ul>
	Cover Difficult to Remove	<ul style="list-style-type: none"> <li>One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools. Intent is keep cover from sealing off access to maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>Cover can be removed and reinstalled by one maintenance person with proper hand tools.</li> </ul>
	<u>Unable to access due to vegetation</u>	<ul style="list-style-type: none"> <li><u>Inspector cannot reasonably access the lid or cannot remove lid for inspection of structure due to vegetation</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Remove vegetation to provide clear access and adequate workspace with lid removed.</u></li> </ul>
Ladder	Metal grate damaged or missing (if applicable)	<ul style="list-style-type: none"> <li>Grate missing or broken member(s) of the grate.</li> </ul>	<ul style="list-style-type: none"> <li>Grate is in place and meets design standards.</li> </ul>
	<u>Ladder installed blocking pipe</u>	<ul style="list-style-type: none"> <li><u>Ladder rungs impeding water flow and may contribute to debris blockage</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Reinstall ladder per design standards; accessible from lid opening and not blocking any pipes</u></li> </ul>
	Ladder Rungs Unsafe	<ul style="list-style-type: none"> <li>Ladder is unsafe due to missing rungs, cracked/broken rungs, rungs not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.</li> </ul>	<ul style="list-style-type: none"> <li>Ladder meets design standards and allows maintenance person safe access.</li> </ul>

July 202~~64~~

**CAUTION:** A catch basin may be considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these structures should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.

## 2. Conveyance Storm Pipes

### What are Conveyance Storm Pipes?

Stormwater runoff may be conveyed by a variety of means and mechanisms from initial collection at a catch basin or inlet, to final discharge at an outfall to a receiving water. Storm pipes, or stormwater pipes, are a common means of built conveyance. Conveyance storm pipes may be made from a variety of materials, including concrete, coated iron or steel, and PVC. Pipes may also be used for conveying flows to or from open channels, ponds, vaults, or another stormwater facility.

### How Do Conveyance Storm Pipes Work?

Stormwater runoff is conveyed through storm pipes set at defined slopes for the amount of flow expected. The size, slope, and material of pipe may also have been designed to achieve a particular velocity through the pipe or at the outlet of the pipe. Storm pipes typically increase in diameter from the upper end of a drainage system to the lowermost end, as they collect and convey increasing amounts of runoff. Where multiple pipes come together or changes in direction occur, either horizontally, vertically, or both, a catch basin, manhole, or other structure may have been constructed.

### Common Maintenance Considerations

Storm pipes may collect sediment and trash. Depending on the location and surrounding environment, storm pipes may also be susceptible to tree root penetration and growth, settling, or natural wear and age. These needs can be remedied with periodic inspection and maintenance.

Refer to the table below titled No. 2 – Conveyance Storm Pipes for specific maintenance standards.

## Maintenance Standards

No. 2 – Conveyance Storm Pipes			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
General	Obstructions, Including Roots	<ul style="list-style-type: none"> <li>Root enters or deforms pipe, reducing flow.</li> </ul>	<ul style="list-style-type: none"> <li>Use mechanical methods to remove root if possible. Use of chemicals to remove roots shall be done in accordance with applicable regulations. If necessary, remove the vegetation over the pipe.</li> </ul>
	<u>Pipe Dented or Broken</u>	<ul style="list-style-type: none"> <li><u>Pipe Dented or Broken</u> <u>Inlet/outlet piping damaged or broken and in need of repair.</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Inlet/outlet piping damaged or broken and in need of repair.</u> <u>Repair or replace as necessary to restore full function and capacity.</u></li> </ul>
	<u>Pipe Rusted or Deteriorated</u>	<ul style="list-style-type: none"> <li><u>Pipe Rusted or Deteriorated</u> <u>Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.</u> <u>Repair or replace as necessary to restore full function and capacity.</u></li> </ul>
	<u>Sediment &amp; Debris</u>	<ul style="list-style-type: none"> <li><u>Sediment &amp; Debris</u> <u>Sediment depth is greater than 20% of pipe diameter.</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Sediment depth is greater than 20% of pipe diameter.</u> <u>Remove sediment or debris.</u></li> </ul>
	<u>Debris barrier or Trash Rack Missing</u>	<ul style="list-style-type: none"> <li><u>Debris barrier or Trash Rack Missing</u> <u>A debris barrier or trash rack that had been installed on the end of a drainage pipe is missing</u></li> </ul>	<ul style="list-style-type: none"> <li><u>A debris barrier or trash rack that had been installed on the end of a drainage pipe is missing</u> <u>Repair or replace as necessary to restore full function and capacity.</u></li> </ul>
	<u>Joint/Seal Problems</u>	<ul style="list-style-type: none"> <li><u>Joint/Seal Problems</u> <u>The joint between pipe sections is separated and/or the seal at the joint is cracked or broken.</u></li> </ul>	<ul style="list-style-type: none"> <li><u>The joint between pipe sections is separated and/or the seal at the joint is cracked or broken.</u> <u>Repair or re-set pipe section(s) as necessary to prevent unintended inflow, outflow, or erosion.</u></li> </ul>

July 2026~~4~~



### 3. Debris Barriers (e.g., Trash Racks)

#### What is a Debris Barrier?

A debris barrier is a grate constructed of welded metal bars or tubes placed over the end of a stormwater pipe or catch basin which is part of a larger drainage network. The purpose for such a barrier is to prevent debris and people from entering an enclosed pipe system.

Horizontal debris barriers are installed on conveyance pipe ends except driveway and roadway culverts. Vertical debris barriers are installed on catch basins or vertical pipes that typically serve as overflow points for ponds or other stormwater features.

## Horizontal Debris Barrier



Aluminum horizontal debris barrier



Aluminum horizontal debris barrier with bent bar needing repair



Aluminum horizontal debris barrier



Aluminum horizontal debris barrier with metal flared end side walls and bottom flow pad



Aluminum horizontal debris barrier partially clogged with algae



Aluminum horizontal debris barrier with bars covered with leaf and twig debris but water flowing below the barrier

## Common Vertical Debris Barriers



Stormwater pond Type 2 catch basin overflow structure with vertical conical galvanized steel debris barrier



Stormwater pond Type 2 catch basin overflow structure with vertical conical galvanized steel debris barrier



Stormwater pond overflow structure with vertical top-hat aluminum debris barrier set in pea-gravel filtration cone



Stormwater pond with Type 1 catch basin with galvanized steel, bee-hive debris barrier

### Common Maintenance Considerations

The primary concern with debris barriers is excessive debris clogging the rack causing water to backup thereby flooding nearby roads and properties. Preventing clogging requires on-going and frequent maintenance. A potato fork or strong rake are effective tools for clearing debris from these barriers.

Refer to the table below titled No. 3 – Debris Barriers (e.g., Trash Racks) for specific maintenance standards.

### Maintenance Standards

No. 3 – Debris Barriers (e.g., Trash Racks)			
Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>  <b>Metal</b>	Trash and Debris	<ul style="list-style-type: none"> <li>• Trash or debris that is plugging more than 20% of the openings in the barrier</li> </ul>	<ul style="list-style-type: none"> <li>• Barrier cleared to design flow capacity</li> </ul>
	Damaged/ Missing Bars.	<ul style="list-style-type: none"> <li>• Bars are bent out of shape more than 3 inches</li> </ul>	<ul style="list-style-type: none"> <li>• Bars in place with no bends more than 3/4 inch</li> </ul>
		<ul style="list-style-type: none"> <li>• Bars are missing or entire barrier missing</li> </ul>	<ul style="list-style-type: none"> <li>• Bars in place according to design</li> </ul>
		<ul style="list-style-type: none"> <li>• Bars are loose and rust is causing 50% deterioration to any part of barrier</li> </ul>	<ul style="list-style-type: none"> <li>• Barrier replaced or repaired to design standards</li> </ul>
	Inlet/Outlet Pipe	<ul style="list-style-type: none"> <li>• Debris barrier missing or not attached to pipe</li> </ul>	<ul style="list-style-type: none"> <li>• Barrier firmly attached to pipe</li> </ul>

## 4. Control Structure/Flow Restrictors

### What Are Flow Control Structure/Flow Restrictors?

Flow control structures are also known as control structures or flow restrictors. Flow control structures regulate the discharge of stormwater flowing out of a stormwater facility and prevent flooding and/or destruction of stream habitat downstream by attenuating downstream flow rates. It is crucial that the flow of stormwater is released at the engineered design rate.

### Typical Control Structure/Flow Restrictor Design

In Snohomish County, the most commonly utilized design is the “tee” standpipe flow control structure. The structure is a Type 2 catch basin (CB) housing a vertical metal standpipe structure strapped to the interior face of the CB wall. There is at least one circular orifice cut into the bottom plate and an open top primary overflow on the standpipe. There may be multiple orifices or a combination of weirs and orifices on some standpipes. Functioning similarly, flow may be controlled by a solid baffle wall within a catch basin or open box structure. The weirs and orifices are in the baffle wall in these designs. A few proprietary devices exist that regulate flow to a constant discharge rate. One of these may be attached to the standpipe as well. See the photos and figures below for details.

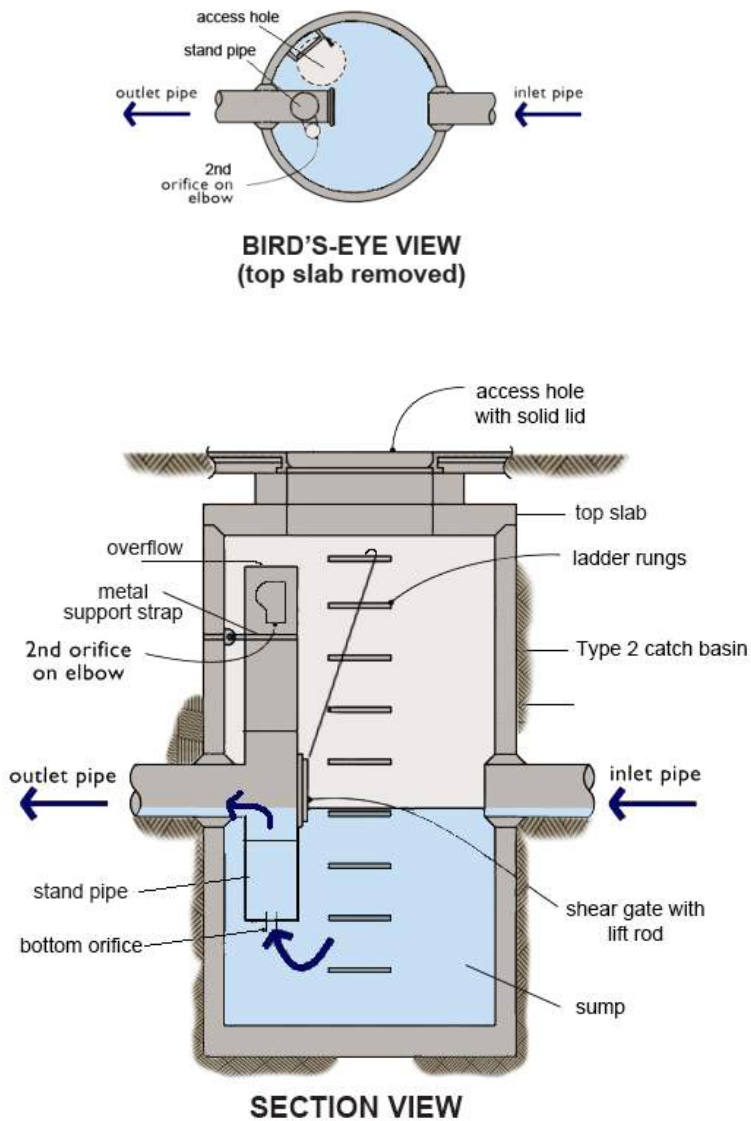
Weir flow control structures are also common. A weir is composed of a concrete, wood, or metal wall set in a pond perimeter berm or conveyance channel with a notch at the top which has been dimensioned to release stormwater runoff at a specific rate. The shape of a notch is either rectangular with one or more steps narrowing from top to bottom or a “v”. The shape affects the flow rates due to the changes in the physical flow of water through these different shapes. The choice of shape is a site-specific engineering consideration based on current design standards and the design engineer’s determination of how to best meet these standards. See the photos and figures below for details.

Primary overflow structures are most often designed as the open top of a “tee” standpipe. Secondary overflow structures are most often a rock or concrete hardened, trapezoid-shaped low point in a berm or a Type 2 catch basin with a birdcage-shaped trash rack over the top.

### Stormwater Facilities Which Typically Include a Control Structure/Flow Restrictor

- Detention Pond
- Detention Tank/Vault
- Wetpond
- Wetvault

## Stand-Pipe Flow Control Structure for Ponds, Tanks, and Vaults





## Type 2 Catch Basin Flow Control Structure



Typical location of a Type 2 catch basin with stand-pipe flow control structure for a stormwater pond



View from open round access hole showing the standpipe with orifice elbow and shear gate with its lift rod detached



View from rectangular access hole showing the access ladder and standpipe with orifice elbow and shear gate with attached lift rod



Type 2 catch basin stand-pipe flow control structure interior with debris- mostly tree limbs and fir needles



Type 2 catch basin stand-pipe flow control structure interior with debris (mostly paper and plastic cups and containers)



Hole in disk at bottom of standpipe is a flow regulating orifice

## Weir Flow Control Structure



Weir is metal plate with deep, rectangular notch



Weir is metal plate with a combination of a lower v-notch and upper, wide, rectangular notch



Weir is a v-notch in a concrete wall



## Type 2 Catch Basin Pond Overflow Structure



Stormwater pond Type 2 catch basin overflow structure with vertical conical debris barrier

### Common Maintenance Considerations

Sediment and debris accumulate inside of the control structure which creates the potential for plugging one of the flow regulating devices (e.g. orifice, weir, standpipe, etc.). Floating debris and trash such as vegetation, plastic bags or soccer balls can cause plugging of the orifices and openings of control structures. These materials can cover or partially block the flow especially when they are no longer buoyant and sink below the water surface. Routine maintenance is necessary to remove the sediment and debris. The most common equipment for cleaning inside a control structure is a heavy-duty, combination power-washing and vacuum truck, also known as a vactor truck. It provides high-pressure washing for the walls and bottom of the catch basin and a high-power vacuum for removing water laden with sediment, oil, grease, gasoline, vegetation debris and trash.

Control structures typically have a shear gate with a control rod which allows the shear gate to be opened without entering the control structure. The purpose of the shear gate is to allow draining of the stormwater facility for the purpose of maintenance or during emergencies. The shear gate should be closed for normal operation of the control structure. Check to ensure that the shear gate is fully closed and not stuck in an open position.

Refer to the table below titled No. 4 - Control Structure/Flow Restrictor for specific maintenance standards.

### Maintenance Standards

No. 4 – Control Structure/Flow Restrictor			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Standpipe	Obstructions	<ul style="list-style-type: none"> <li>Any material blocking (or having the potential of blocking) the pipe overflow.</li> </ul>	<ul style="list-style-type: none"> <li>Pipe is free of all obstructions and works as designed.</li> </ul>
	Structural Damage	<ul style="list-style-type: none"> <li>Structure is not securely attached to manhole wall</li> </ul>	<ul style="list-style-type: none"> <li>Structure is securely attached to wall and outlet pipe</li> </ul>
		<ul style="list-style-type: none"> <li>Structure is not in upright position (allow up to 10% from plumb)</li> </ul>	<ul style="list-style-type: none"> <li>Structure is in correct position.</li> </ul>
		<ul style="list-style-type: none"> <li>Connections to outlet pipe are not watertight and show signs of rust</li> </ul>	<ul style="list-style-type: none"> <li>Connections to outlet pipe are watertight; structure repaired or replaced and works as designed</li> </ul>
		<ul style="list-style-type: none"> <li>Any holes other than designed holes in the structure</li> </ul>	<ul style="list-style-type: none"> <li>Structure has no holes other than designed holes</li> </ul>
Cleanout Gate	Damaged or Missing	<ul style="list-style-type: none"> <li>Cleanout gate is not watertight or is missing</li> </ul>	<ul style="list-style-type: none"> <li>Gate is watertight and works as designed</li> </ul>

No. 4 – Control Structure/Flow Restrictor			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Orifice Plate</b>	Damaged or Missing	• Gate cannot be moved up and down by one maintenance person	• Gate moves up and down easily and is watertight
		• Chain/rod leading to gate is missing or damaged	• Chain is in place and works as designed
		• Gate is rusted over 50% of its surface area	• Gate is repaired or replaced to meet design standards
		• Control device is not working properly due to missing, out of place, or bent orifice plate	• Plate is in place and works as designed
	Obstructions	• Any trash, debris, sediment, or vegetation blocking the plate	• Plate is free of all obstructions and works as designed
	Obstructions	• Any trash or debris blocking (or having the potential of blocking) the overflow pipe	• Pipe is free of all obstructions and works as designed
<b>Access Hole</b>	Cover Not in Place	• Cover is missing or only partially in place • Any open manhole requires maintenance	• Cover is in place
	Locking Mechanism Not Working	• Locking mechanism cannot be opened or lock bolts cannot be removed by one maintenance person with proper hand tools	• Mechanism or lock bolts open with proper hand tools
	Cover Difficult to Remove	• One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools. • Intent is to keep cover from sealing off access to maintenance	• Cover can be removed and reinstalled by one maintenance person with proper hand tools

No. 4 – Control Structure/Flow Restrictor			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Ladder Rungs Unsafe	<ul style="list-style-type: none"> <li>Ladder is unsafe due to missing rungs, cracked/broken rungs, misalignment, rungs not securely attached to structure wall, rust, or cracks</li> </ul>	<ul style="list-style-type: none"> <li>Ladder meets design standards and allows maintenance person safe access</li> </ul>

**CAUTION:** A catch basin may be considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these structures should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.

## 5. Facility Discharge Points

### What is a Stormwater Facility Discharge Point?

A Stormwater Facility Discharge Point (Facility Discharge Point) is the location where stormwater exits a stormwater facility.



(Source: USDA – Natural Resources Conservation Service – Illinois)

### Common Maintenance Considerations

Debris may accumulate or settling may occur to outfall protection rock. Common tools are hand tools to remove debris or to redistribute outfall protection rock.

Refer to the table below titled No. 5 – Facility Discharge Points for specific maintenance standards

## Maintenance Standards

No. 5 – Facility Discharge Points			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Monitoring</b>	Inspection of Discharge Water for Obvious Signs of Poor Water Quality.	<ul style="list-style-type: none"> <li>• Sheen, obvious oil or other contaminants present.</li> </ul>	<ul style="list-style-type: none"> <li>• Identify and eliminate pollution source AND report discharge to Snohomish County Surface Water Management Division.</li> <li>• Discharge from facility should be clear.</li> </ul>
	Receiving Area Saturated	<ul style="list-style-type: none"> <li>• Water in receiving area is causing area to become saturated and unstable.</li> </ul>	<ul style="list-style-type: none"> <li>• Take measures to decrease saturation in the receiving area to increase its stability</li> </ul>
<b>General</b>	Rock Pad - Missing or Moved Rock	<ul style="list-style-type: none"> <li>• Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil where pad was originally installed.</li> </ul>	<ul style="list-style-type: none"> <li>• Rock pad replaced to design standards.</li> </ul>
	Rock Pad - Erosion	<ul style="list-style-type: none"> <li>• Soil erosion in or adjacent to rock pad.</li> </ul>	<ul style="list-style-type: none"> <li>• Rock pad replaced to design standards.</li> </ul>
	Obstructions, Including Roots	<ul style="list-style-type: none"> <li>• Roots or debris enters pipe or deforms pipe, reducing flow.</li> </ul>	<ul style="list-style-type: none"> <li>• Use mechanical methods to remove root if possible. Use of chemicals to remove roots shall be done in accordance with applicable regulations. If necessary, remove the vegetation over the line</li> </ul>
	Pipe Rusted or Deteriorated	<ul style="list-style-type: none"> <li>• Any part of the pipe that is broken, crushed or deformed more than 20% or any other failure to the piping.</li> </ul>	<ul style="list-style-type: none"> <li>• Pipe repaired or replaced.</li> </ul>

## 6. Energy Dissipatoers and Outfall Systems

### What Is an Energy Dissipatoer and How Does It Work?

An energy dissipatoer is installed at the outlet end of an enclosed pipe system. It is designed to reduce the velocity of flowing stormwater in order to prevent erosion at the point of discharge. Energy dissipatoers are often associated with flow dispersion techniques to spread the water out and prevent erosion from re-concentrating flow downstream of drainage systems prior to entering the ground, a stream, lake or wetland.

### Energy Dissipatoer Designs

The rock splash pad is typically constructed of crushed rocks and the excavation for the pad may be lined with filter fabric. Gabion baskets contain large crushed rocks inside of a wire basket. Dispersion trenches may or may not be rock filled. Water enters the trench and fills the length before dispersing over a wider area than the original pipe diameter from which its was discharged. Stilling pools are often concrete structures where high velocity water entering the pool loses its energy in the turbulence created. Catch basins with or without stilling pools can aid in dissipating the energy of the moving water by slowing the velocity at each basin by both the turbulent action of the standing pool of water in the bottom and by causing the water to change direction to enter the downstream pipe.

### Types of energy dissipatoers:

- rock splash-pads
- rock-filled, wire gabion baskets
- dispersion trenches
- excavated stilling pools or basins
- catch basins with or without standing water
- slope drain diffuser tee

## Energy Dissipators and Outfall Systems



Example of slope drain diffuser tee



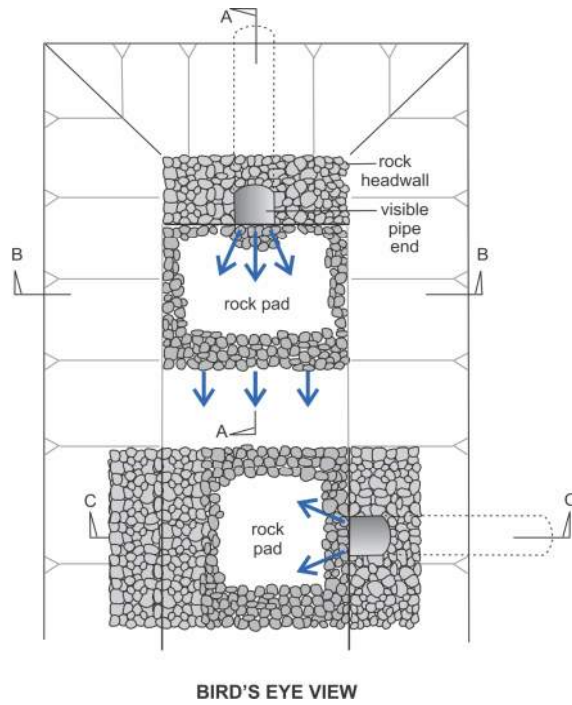
Example of slope drain diffuser tee



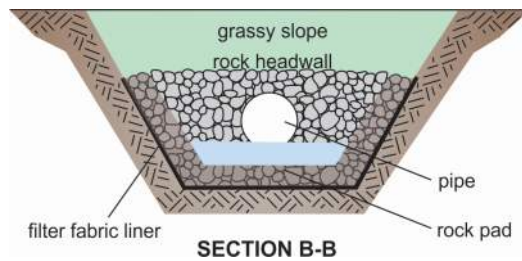
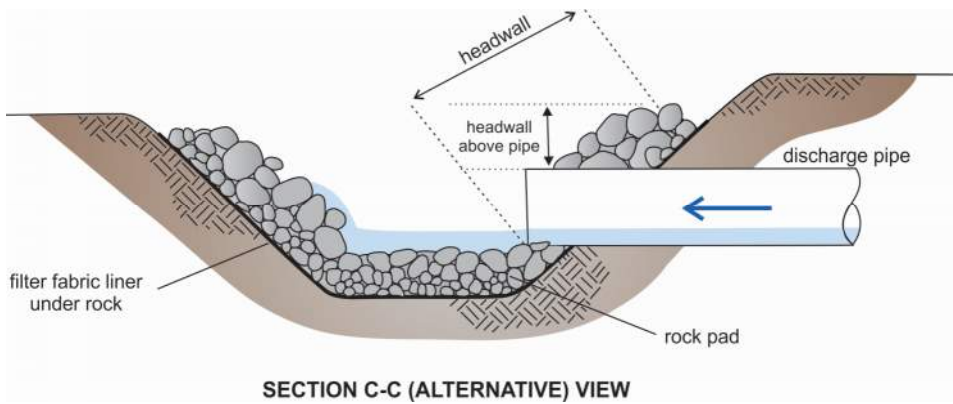
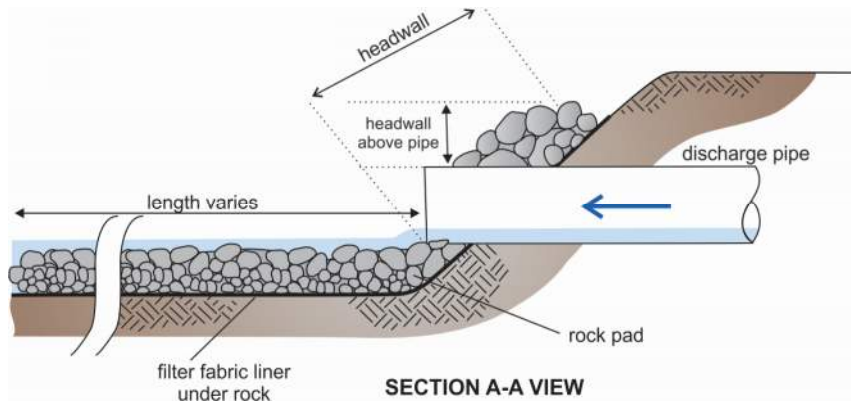
Example of rock splash pad



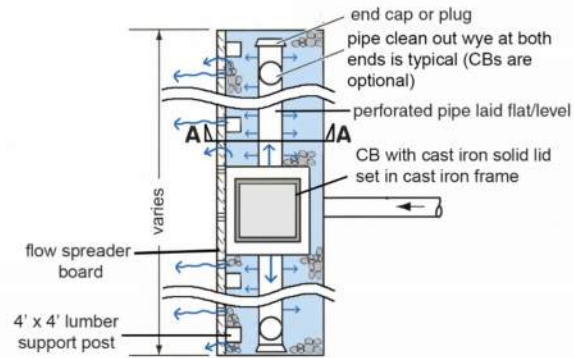
## Rock Energy Dissipation Pad and Headwall



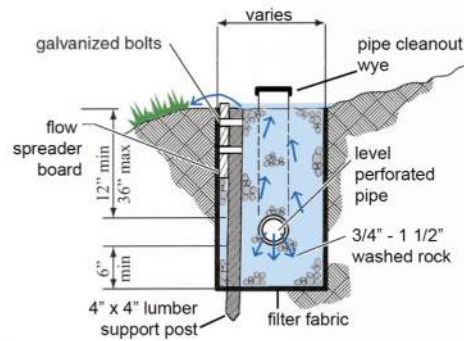
## Rock Energy Dissipation Pad and Headwall



## Energy Dispersion Trench

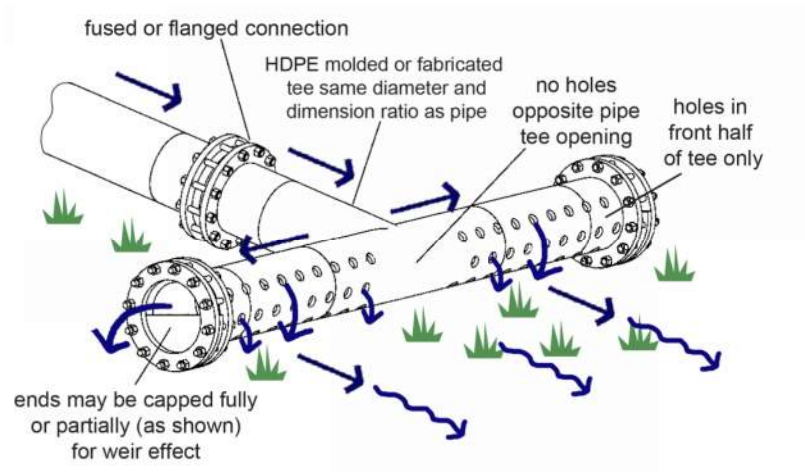


**BIRD'S-EYE VIEW**



**SECTION A-A**

## Slope Drain Diffuser Tee



### Common Maintenance Considerations

Remove sediment, vegetation debris and man-made trash to prevent blockage of flow out of outlet pipe-end so that the flow does not back up. The most common tools for maintenance are hand tools such as rakes to redistribute rocks as necessary. Also, periodic removal of sediment or debris from between the rocks may be necessary.

Refer to the table below titled No. 6 – Energy Dissipaters for specific maintenance standards.

## Maintenance Standards

## No. 6 – Energy Dissipaters

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Rock Pad	Missing or Moved Rock	<ul style="list-style-type: none"> <li>Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil where pad was originally installed</li> </ul>	<ul style="list-style-type: none"> <li>Rock pad replaced to design standards</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Soil erosion in or adjacent to rock pad</li> </ul>	<ul style="list-style-type: none"> <li>Rock pad replaced to design standards</li> </ul>
Rock Gabion Structures	Wire basket matrix deteriorated or broken	<ul style="list-style-type: none"> <li>Deterioration determined to be near to breaking</li> <li>Broken wire results in hole large enough to allow rocks to protrude out of basket</li> </ul>	<ul style="list-style-type: none"> <li>Rewire area of concern or replace basket and/or rocks as necessary</li> </ul>
	Wire basket misaligned	<ul style="list-style-type: none"> <li>Baskets have shifted and no longer providing full energy dissipations or may be prone to tipping or collapse</li> </ul>	<ul style="list-style-type: none"> <li>Realign or relocate as necessary to meet design intent</li> </ul>
Dispersion Trench	Perforated Pipe Plugged with Sediment	<ul style="list-style-type: none"> <li>Accumulated sediment that exceeds 20% of the design depth or over 1/3 of perforations in pipe are plugged</li> </ul>	<ul style="list-style-type: none"> <li>Pipe cleaned/flushed so that it matches design</li> </ul>
	Not Discharging Water Properly	<ul style="list-style-type: none"> <li><del>Water in receiving area is causing or has potential of causing landslide problems. Water is observed or reported to be flowing out of top of basin during any storm less than the design storm. Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.</del></li> </ul>	<ul style="list-style-type: none"> <li>Trench redesigned or rebuilt to standards</li> </ul>

July 2026~~4~~

	Receiving Area Over-Saturated Water Flowing Out Top of "Distributor" Catch Basin Overflows	<ul style="list-style-type: none"><li>• <del>Water in receiving area is causing or has potential of causing landslide problems. Water is observed or reported to be flowing out of top of basin during any storm less than the design storm.</del> Observation of water flowing out during any storm less than the design storm, or is causing or appears likely to cause damage.</li></ul>	<ul style="list-style-type: none"><li>• Facility rebuilt or redesigned to standards.</li></ul>
	Receiving Area Over-Saturated	<ul style="list-style-type: none"><li>• Water in receiving area is causing or has potential of causing landslide problems.</li></ul>	<ul style="list-style-type: none"><li>• No danger of landslides.</li></ul>

## 7. Pump Systems

### Stormwater Facility Pump Systems

- Many stormwater facilities have pumps as integral and critical parts of the outlet system.
- Pumps must function to the specifications dictated by the original design (typically found in the Drainage Report for the development). Pumps must be rated for continuous duty.

### Common Maintenance Considerations

- Regularly service the pump.
- Keep the pump and surrounding area clean and free of debris.
- Inspect the pump for any signs of wear or damage.
- Service or replace common parts like the check valve, float switches, impeller, and electrical connections.
- Check function of electrical service and overflow alarm.

Refer to the table below titled No. 7 – Pump Systems for specific maintenance standards.

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## Maintenance Standards

No. 7 – Pump Systems			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Pump	Failure to turn on	<ul style="list-style-type: none"> <li>System overfull or in overflow despite lack of recent rainfall</li> </ul>	<ul style="list-style-type: none"> <li>Repair or replace pump to restore proper function</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>
	Constant vibrating or unusual noises	<ul style="list-style-type: none"> <li>Debris in pump; bearing failure; damaged impeller</li> </ul>	<ul style="list-style-type: none"> <li>Repair or replace pump to restore proper function</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>
	Damaged, visible wear	<ul style="list-style-type: none"> <li>Observable indications of physical damage or wear</li> </ul>	<ul style="list-style-type: none"> <li>Repair or replace pump to restore proper function</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>
	Pump running continuously	<ul style="list-style-type: none"> <li>Blocked outlet pipe reducing flow</li> <li>Worn pump/impeller reducing capacity</li> </ul>	<ul style="list-style-type: none"> <li>Inspect pump and outlet system</li> <li>Repair or replace pump to restore proper function</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>

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## No. 7 – Pump Systems

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Discharge pipe	Plugged	<ul style="list-style-type: none"> <li>Blocked outlet pipe reducing flow</li> </ul>	<ul style="list-style-type: none"> <li>Inspect and clear or replace pipe to restore proper function</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>
	Not operating correctly	<ul style="list-style-type: none"> <li>Failure to switch power based on specified water surface elevations</li> </ul>	<ul style="list-style-type: none"> <li>Repair or replace float switch to restore proper function</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>
Electrical service & control panel	No power	<ul style="list-style-type: none"> <li>Lack of service power to control panel</li> </ul>	<ul style="list-style-type: none"> <li>Inspect and repair power source</li> <li>Maintenance may require working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>
	Overflow alarm malfunctioning	<ul style="list-style-type: none"> <li>Overflow alarm constantly on or failure to alarm during overflow</li> </ul>	<ul style="list-style-type: none"> <li>Inspect and repair alarm, control panel and/or level sensor</li> <li>Maintenance may require both entry into confined spaces and working with high-voltage electrical supply; work should only be performed by properly trained persons.</li> </ul>

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## 87. Detention Ponds

### What is a Detention Pond?

A stormwater detention pond is a constructed, open, earthen basin with a control structure and temporary storage volume designed to regulate the discharge rate of stormwater runoff from surfaces such as streets, sidewalks, driveways, parking lots and roofs. The pond can either be entirely excavated into the ground, or partially excavated with the remainder of the pond's perimeter formed by a compacted earthen berm which functions to impound the water inside. There are some detention ponds with walls completely or partially constructed of poured-in-place concrete, concrete blocks, or large quarry rock.

### How Does a Detention Pond Work?

A detention pond temporarily stores runoff and slowly discharges the runoff through a flow control structure outlet. The detention pond is designed to completely drain after a storm event, although some water may remain in the bottom of the system that does not drain out.

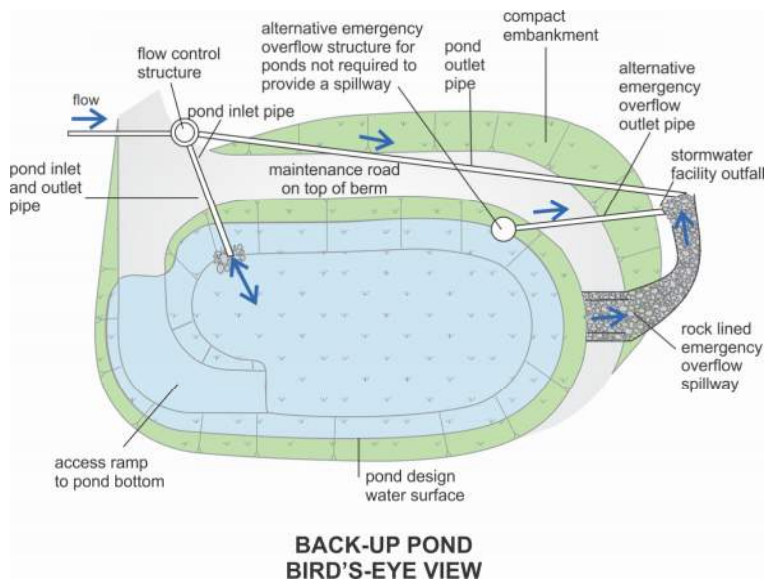
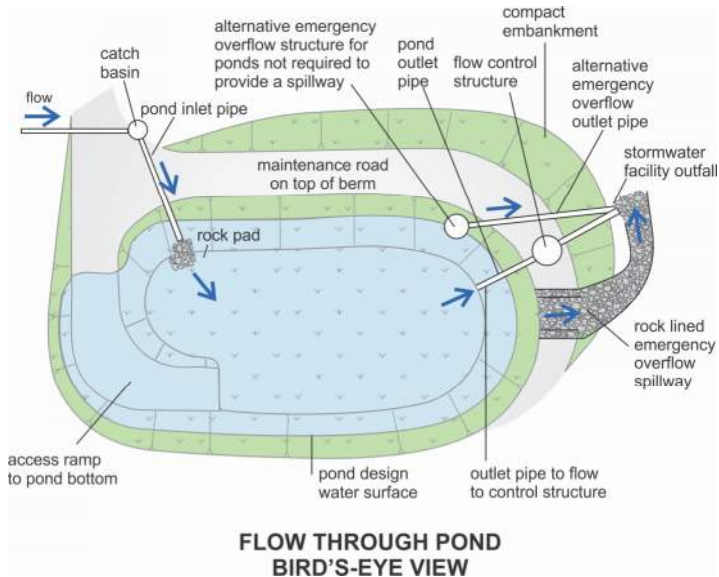
### Typical Detention Pond Designs

Two general types of detention pond designs are found in Snohomish County, which include the flow-through system and the back-up system. In the flow-through system stormwater runoff flows into one end of the detention pond and flows out the other through the flow control structure. See the flow-through detention pond drawing below.

In the back-up system stormwater runoff enters the flow control structure directly. The water backs up through the flow control structure into the pond where it is detained until the storm subsides. The detention pond functions as an expansion reservoir in this system. As the storm subsides and the inflow rate decreases the water stored in the pond is released back through the flow control structure and the outlet pipe. See the back-up detention pond drawing below.

Ponds can vary greatly in size, shape and depth as well as appearance. Appearances can range from little or no vegetation to well-manicured, managed or unmanaged, native or non-native vegetation. Generally, native vegetation is preferred to reduce maintenance, frequency of irrigation, pruning, noxious weed suppression, and grass mowing. Some facilities are designed to appear as natural water bodies (e.g. a pond or stream) or designed to integrate into an existing or new park.

## Detention Ponds



## Detention Ponds



Pond with wall made of gabion basket (wire mesh rectangular baskets filled with rock)



Pond berm with Type 2 Catch Basin flow control structure at top of berm

### Common Maintenance Considerations

Over time detention ponds accumulate sediment, trash and vegetation debris which reduces the storage capacity for water runoff from storms. It is important to revegetate eroded areas after re-grading, filling and/or compacting. Mowing grass regularly helps suppress unwanted vegetation and keeps tree saplings from growing on constructed earthen berms.

It is important to remove all trash and debris from the top and on the inside of the banks regularly. This creates more access on the embankment for inspection and helps prevent debris and trash from entering the water and clogging the stormwater conveyance system.

Refer to the table below titled No. ~~78~~ - Detention Ponds for specific maintenance standards.

## Maintenance Standards

No. <del>87</del> – Detention Ponds			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Trash & Debris	<ul style="list-style-type: none"> <li>Function of facility is impaired by or likely to be impaired by trash and debris.</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris is removed.</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>Function of facility is impaired by vegetation.</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation is removed or managed to restore proper function of facility.</li> <li>Use of herbicides shall be in accordance with applicable regulations.</li> </ul>
	Contaminants and Pollution	<ul style="list-style-type: none"> <li>Any evidence of oil, gasoline, contaminants or other pollutants</li> <li>Coordinate removal/cleanup with local and/or state water quality response agency.</li> </ul>	<ul style="list-style-type: none"> <li>Contaminants or pollutants are removed</li> </ul>
	Beaver Dams	<ul style="list-style-type: none"> <li>Dam results in change of <del>of</del> function of the facility.</li> </ul>	<ul style="list-style-type: none"> <li>Facility is returned to design function.</li> <li>Contact Snohomish County Surface Water Management if removal of beavers is contemplated.</li> </ul>
	Insects	<ul style="list-style-type: none"> <li>When insects such as wasps and hornets interfere with maintenance activities.</li> </ul>	<ul style="list-style-type: none"> <li>Insects destroyed or removed from site.</li> <li>Apply insecticides in compliance with adopted Integrated Pest Management policies</li> </ul>

## No. 87 – Detention Ponds

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Berm</b>	Tree Growth and Hazard Trees	<ul style="list-style-type: none"> <li>Function of facility is impaired by trees.</li> <li>Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove.</li> <li>Hazard trees (i.e., dead, diseased, or dying trees) need to be identified.</li> </ul>	<ul style="list-style-type: none"> <li>Trees are removed or managed to restore proper function of facility.</li> <li>Trees do not hinder maintenance activities.</li> <li>Hazard trees are identified and those that pose an imminent danger are removed.</li> <li>A certified Arborist may be needed to determine health of trees or removal requirements.</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.</li> </ul>	<ul style="list-style-type: none"> <li>Slopes are stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.</li> </ul>
	Liner (If Applicable)	<ul style="list-style-type: none"> <li>Liner is visible and has more than three 1/4-inch holes in it.</li> </ul>	<ul style="list-style-type: none"> <li>Liner is repaired or replaced. Liner is fully covered.</li> </ul>
	Settling	<ul style="list-style-type: none"> <li>Any part of a berm which has settled at least 4 inches lower than the design elevation.</li> <li>If settlement is apparent, measure berm to determine amount of settlement.</li> <li>Settling can be an indication of more severe problems with the berm or outlet works.</li> </ul>	<ul style="list-style-type: none"> <li>Berm is repaired and restored to the design elevation.</li> <li>A licensed civil engineer may be needed to determine the cause of the settlement.</li> </ul>



No. ~~87~~ – Detention Ponds

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Erosion	<ul style="list-style-type: none"> <li>Any erosion observed on a compacted structural berm embankment.</li> </ul>	<ul style="list-style-type: none"> <li>Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.</li> <li>If erosion is occurring on compacted berms a licensed engineer in the state of Washington should be consulted to resolve source of erosion.</li> </ul>
	Piping	<ul style="list-style-type: none"> <li>Discernable water flow through a compacted structural berm. Ongoing erosion with potential for erosion to continue.</li> <li>Tree growth on a compacted structural berm over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.</li> <li>Evidence of rodent holes in berm, and/or water piping through berm via rodent holes.</li> </ul>	<ul style="list-style-type: none"> <li>Piping eliminated. Erosion potential resolved.</li> <li>Rodents destroyed and <del>+</del> berm repaired.</li> <li>A geotechnical engineer may be needed to inspect and evaluate condition and recommend repair of condition.</li> </ul>
Storage Area	Sediment	<ul style="list-style-type: none"> <li>Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.</li> </ul>	<ul style="list-style-type: none"> <li>Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.</li> </ul>
Emergency Overflow/Spillway	Tree Growth	<ul style="list-style-type: none"> <li>Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.</li> </ul>	<ul style="list-style-type: none"> <li>Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored.</li> <li>A licensed civil engineer may be needed to determine proper berm/spillway restoration.</li> </ul>

No. ~~87~~ – Detention Ponds

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Rock Armoring	<ul style="list-style-type: none"> <li>Rock layer on subgrade is less than 1.0 feet deep and/or subgrade is exposed</li> <li>Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway. (Rip-rap on inside slopes need not be replaced.)</li> </ul>	<ul style="list-style-type: none"> <li>Rocks and pad depth are restored to a minimum depth of 1.0 feet.</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.</li> </ul>	<ul style="list-style-type: none"> <li>Slopes are stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.</li> </ul>

## 98. Detention Tanks and Vaults

### What is a Detention Tank or Vault?

A detention tank or vault is an enclosed system with a control structure and temporary storage volume designed to regulate the discharge rate of stormwater runoff from surfaces such as streets, sidewalks, driveways, parking lots and roofs. Detention tanks, sometimes referred to as detention pipes, are constructed of large pipes typically 4 to 10 feet in diameter. Detention vaults are large rectangular concrete structures. Detention tanks and vaults are typically located underground although on some sites a portion of a detention vault may be exposed if it is located adjacent to sloping ground.

### How Does a Detention Tank or Vault Work?

A detention tank or vault temporarily stores water runoff from storm events and slowly releases the runoff through a flow control structure outlet. The system is designed to completely drain after a storm event, although some water may remain in the bottom of the system that does not drain out.

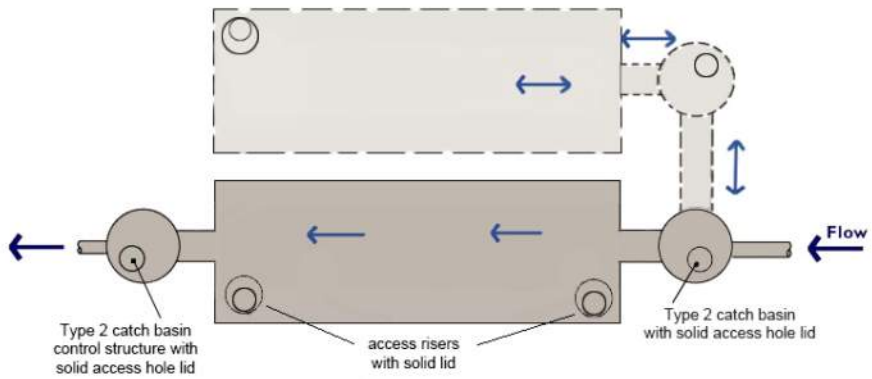
### Typical Detention Tank or Vault Designs

Two general types of detention tank designs are found in Snohomish County, which include the flow-through system and the back-up system. In the flow-through system stormwater runoff flows into one end of the detention pipe and flows out the other through the flow control structure. See the flow-through detention tank system drawing below.

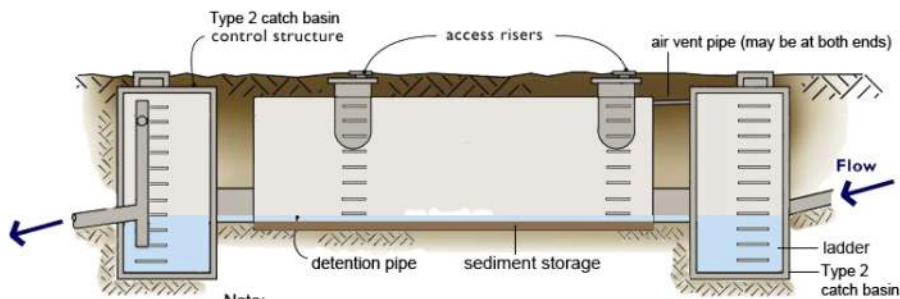
In the back-up system stormwater runoff enters the flow control structure directly. The water backs up through the flow control structure into the tank where it is detained until the storm subsides. The detention tank functions as an expansion reservoir in this system. As the storm subsides and the inflow rate decreases the water stored in the tank is released back through the flow control structure and the outlet pipe.

Detention tanks typically have pipes entering directly into the side of the concrete structure. The inlet pipes are often located on the opposite end from where the control structure is located but not always. The control structure on a detention tank may be located inside of the tank, either attached directly to the wall or inside of a separate compartment, or it may be inside of a catch basin located outside of the tank as depicted in the drawing below.

## Detention Tank



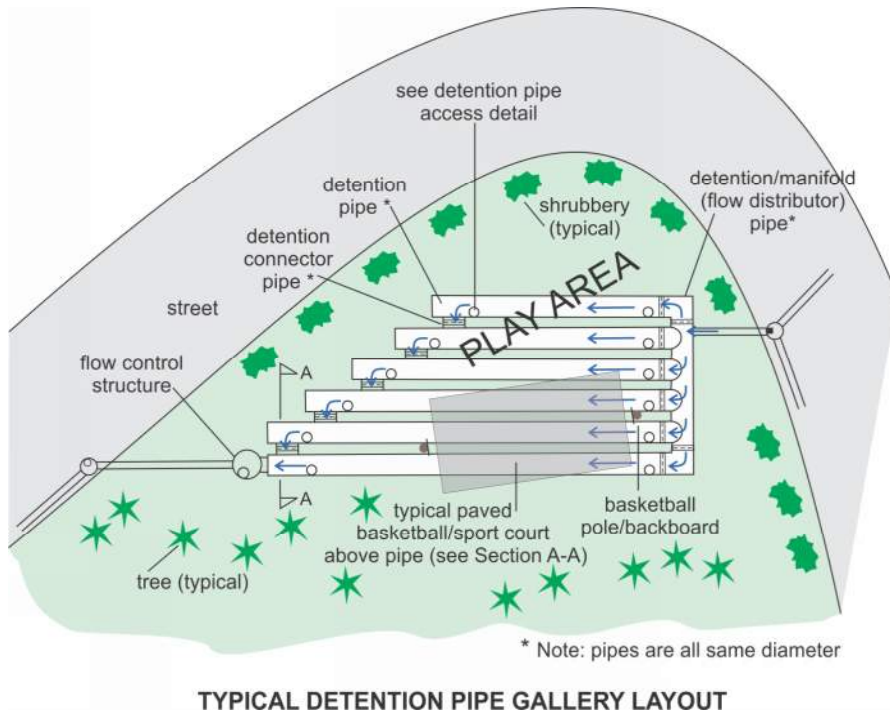
**BIRD'S-EYE VIEW  
PARALLEL PIPE SYSTEM OPTION**



Note:  
Closed detention systems will contain water during rainfall events, but should be mostly empty during dry periods.

**LENGTH SECTION VIEW**

## Detention Tank



## Detention Tank Installation



Detention tank in place and being covered up with compacted soil



Detention tank with view of access risers

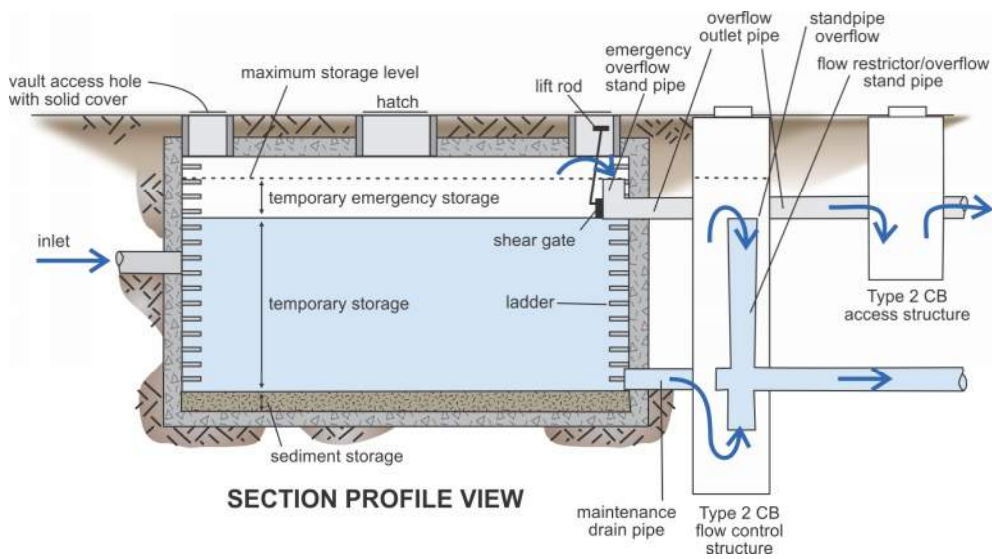
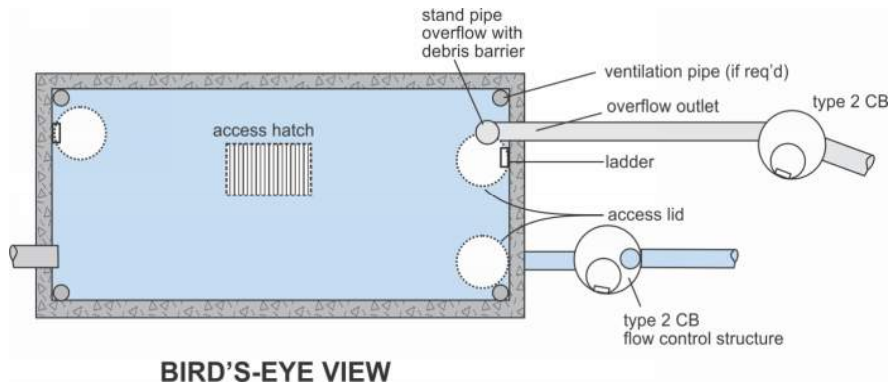


Looking at downstream end of a detention tank with end caps and connection pipe manifolds connected to adjacent detention pipes



Looking at upstream end of detention tank connecting to pipe manifold (closest pipe in view running perpendicular to the rows of detention pipe)

## Detention Vault



## Detention Vault Installation



Detention vault installation (access hole and ventilation pipes visible)



Detention vault interior

Over time detention tanks and vaults accumulate sediment, trash and vegetation debris which reduces the storage and treatment capacity for water runoff from storms.

The most common equipment for cleaning detention tanks and vaults is a heavy-duty, combination power-washing and vacuum truck, also known as a vactor truck. It provides high-pressure washing for the walls and bottom of the structure and a high-power vacuum for removing water laden with sediment, oil, grease, gasoline, vegetation, debris, and trash.

Refer to the table below titled No. ~~89~~ - Detention Tanks and Vaults for specific maintenance standards.



## No. 98 – Detention Tanks and Vaults

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Storage Area	Plugged Air Vents	<ul style="list-style-type: none"> <li>One-half of the cross section of a vent is blocked at any point or the vent is damaged.</li> </ul>	<ul style="list-style-type: none"> <li>Vents open and functioning.</li> </ul>
	Debris and Sediment	<ul style="list-style-type: none"> <li>For vaults, accumulated sediment depth exceeds 10% of the vertical dimension of the storage area for ½ of the bottom of the vault, or exceeds 15% of the vertical dimension at any point.</li> <li>For tanks, Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2-½ of the length of the storage vault tank, or any point depth exceeds 15% of diameter. Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.</li> <li>Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.</li> </ul>	<ul style="list-style-type: none"> <li>All sediment, debris, and organic matter removed from storage area.</li> </ul>
	Joints Between Tank Section	<ul style="list-style-type: none"> <li>Any openings or voids at section joint allowing material to seep into or water to leak out of facility.</li> <li>This may need an engineering analysis to assess the structural stability.</li> </ul>	<ul style="list-style-type: none"> <li>All joints between tank sections are sealed.</li> </ul>
	Tank Bent Out of Shape	<ul style="list-style-type: none"> <li>Any part of tank is bent out of shape more than 10% of its design shape.</li> <li>This may need an engineering analysis to assess the structural stability.</li> </ul>	<ul style="list-style-type: none"> <li>Tank section is repaired or replaced to design.</li> </ul>

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No. ~~98~~ – Detention Tanks and Vaults

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<u>Vault Perimeter</u>	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	<ul style="list-style-type: none"> <li>Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.</li> <li>Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.</li> </ul>	<ul style="list-style-type: none"> <li>Vault replaced or repaired to design specifications and is structurally sound.</li> <li>No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.</li> </ul>
	<u>Woody vegetation near vault</u>	<ul style="list-style-type: none"> <li><u>Trees above or within 5 feet of vault structure</u></li> </ul>	<ul style="list-style-type: none"> <li><u>Remove trees</u></li> </ul>
Access Hole	Cover Not in Place	<ul style="list-style-type: none"> <li>Cover is missing or only partially in place. Any open manhole requires maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>Cover is in place.</li> </ul>
	Locking Mechanism Not Working	<ul style="list-style-type: none"> <li>Locking mechanism cannot be opened or lock bolts cannot be removed by one maintenance person with proper hand tools.</li> </ul>	<ul style="list-style-type: none"> <li>Mechanism or lock bolts open with proper hand tools.</li> </ul>
	Cover Difficult to Remove	<ul style="list-style-type: none"> <li>One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools. Intent is to keep cover from sealing off access to maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>Cover can be removed and reinstalled by one maintenance person with proper hand tools.</li> </ul>
		<ul style="list-style-type: none"> <li>Ladder is unsafe due to missing rungs, cracked/broken rungs, and misalignment, rungs not securely attached to structure wall, rust, or cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Ladder meets design standards and allows maintenance person safe access.</li> </ul>

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| July 202~~64~~

**CAUTION:** A detention tank or vault is considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.

## 109. Infiltration Facilities

### What Are Infiltration Facilities?

Infiltration facilities temporarily store stormwater runoff in ponds, vaults or trenches and rely on the ability of the underlying soils to infiltrate the stormwater into the ground. Infiltration facilities are intended to reduce stormwater runoff flow rates and may also be used as treatment facilities if the soil is suitable for removing pollutants. Additionally, infiltration facilities assist groundwater recharge.

Infiltration facilities may have an overflow component that direct excess runoff to a safe location.

### How Do Infiltration Facilities Work?

Infiltration facilities rely on the capacity of the temporary storage area and the infiltration rates of the native, underlying soil. In open systems, vegetated growth assists in improving infiltration rates and pollutant removal. Water that has infiltrated the soil surface migrates down to the ground water table which contributes to maintaining base flows in streams, wetlands and lakes through the dry season. Since infiltration facilities are designed to pass water into the ground, anything that can cause clogging in the base will impair performance.

Pollutants are removed from the runoff by the process of filtration, adsorption to soil particles, and biological properties of native soils. One condition that limits the use of infiltration is the potential adverse impact on ground water quality.

### Typical Infiltration Facility Designs.

Infiltration ponds are earthen basins excavated out of permeable soil. Infiltration ponds are open facilities that either drain rapidly to a dry, vegetated bottom or have a permanent pool where water levels rise and fall with stormwater runoff events. Infiltration ponds may be lined with a filter material such as coarse sand or a suitable geosynthetic material to help prevent the buildup of impervious deposits on the soil surface. These facilities often have an associated pre-settling basin with a permanent pool of water. The permanent pool allows finer particulates to settle thereby protecting the infiltration pond.

Infiltration vaults or tanks are underground closed facilities. Tanks typically are plastic or metal pipes with end caps. Vaults are most often rectangular in shape and constructed of concrete. Each may be surrounded with an aggregate and filter fabric that increases the storage area, disperses the stormwater over a larger area thereby improving infiltration, and prevent surrounding soil from entering the temporary storage area. The base of vaults may have a filter layer, such as sand, to separate large pollutants, prevent clogging, and ease the cleaning process.

Infiltration trenches are linear, below ground facilities. They may be closed basins or have an open top. Open top trenches may be used to capture and disperse runoff, such as along parking or road areas; or, they may be used to disperse excess water as sheet flow across adjacent areas when the trench is full. Trenches are most often filled with evenly graded rock and surrounded by a filter fabric. The void space between the rocks temporarily stores runoff whereas the filter fabric prevents the voids from becoming filled with adjacent soil. Infiltration trenches often use perforated pipe to distribute stormwater throughout the aggregate or collect excess water within the trench and send it to a safe location. Trenches with perforated pipe are classified as “underground injection control well” which are regulated as described in Chapter 173-218 of the Washington Administrative Code (WAC) which pertains to the “Underground Injection Control Program.”

July 202~~64~~

Drywells are subsurface, perforated structures that also have an open bottom. The structures are surrounded with evenly graded rock and filter fabric. The void space in the rock disperses the water over a larger surface area with the adjacent soil whereas the filter fabric prevents the voids between the rocks from becoming filled from the adjacent soil. Drywells are a special type of infiltration facility that are classified as “underground injection” which are regulated as described in Chapter 173-218 of the Washington Administrative Code (WAC) which pertains to the “Underground Injection Control Program.”

### Common Maintenance Considerations

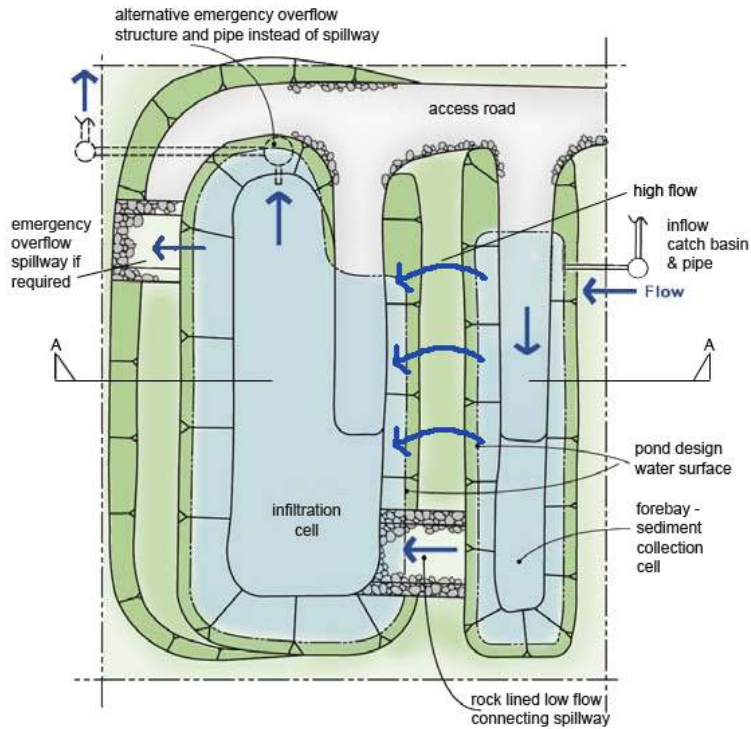
Standing water and frequent overflows is generally an indicator that the ~~BMP-facility~~ is not infiltrating adequately.

The principal maintenance objective is to prevent clogging of soils, pipes, and rock-filled temporary water storage areas within infiltration facilities. Clogging is associated with fine sediment, trash, and other debris and can lead to premature facility failure. Maintaining upstream catch basins, pipes, and any associated settling bay can extend the functional life of the facility. The removal of sediment and debris is dependent on the rate at which loading occurs. Observation wells can be used to determine if the facility is draining correctly and, possibly, sedimentation depth.

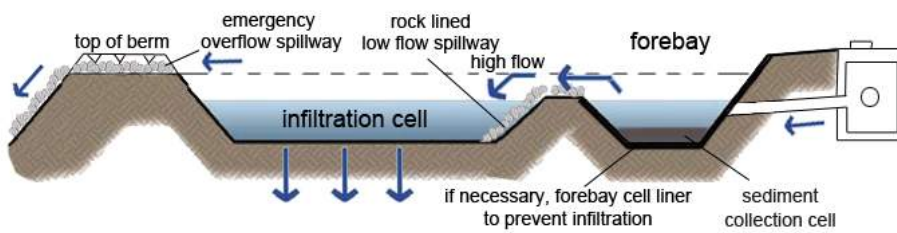
Pedestrian, bicycle, and machinery traffic can cause soil compaction, poor vegetation growth, side slope slumping, and lead to premature facility failure. Heavy machinery is especially prone to causing soil compaction and should not be used in, or on top of these ~~BMPs~~ facilities. Machinery fluid spills within an infiltration facility can cause groundwater contamination. Care should be taken when using machinery in and around this environment. The most common tool for cleaning closed infiltration facilities is a truck with a tank and vacuum hose to remove sediment and debris from the facility.

Refer to the table below titled No. 910 - Infiltration Facilities for specific maintenance standards. Refer to the development plans, permit, and other development documents which specify the engineered design of the facility.

## Infiltration Pond



**BIRD'S-EYE VIEW**



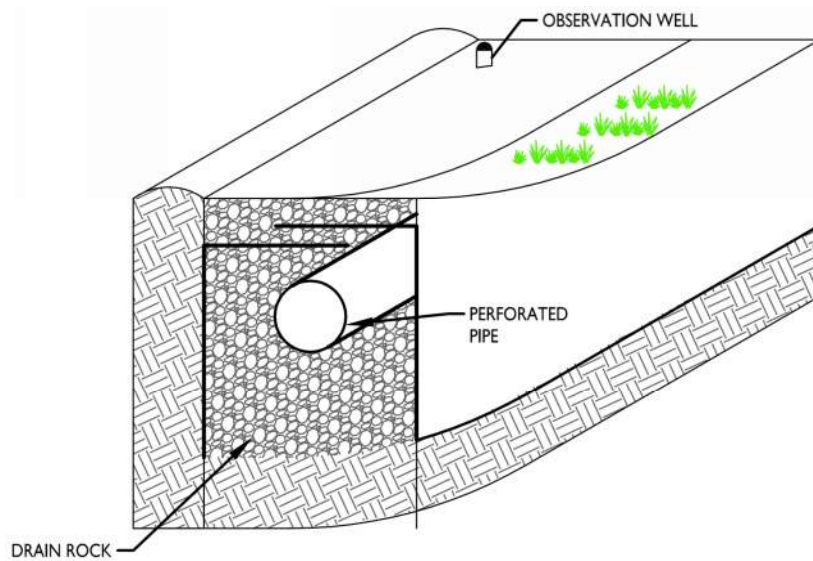
**SECTION A-A VIEW**

## Infiltration Pond



Infiltration Pond

## Infiltration Trench



## No. 9-10 – Infiltration Facilities

Component	Potential Defect	Condition: When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Trash & Debris	<ul style="list-style-type: none"> <li>Function of facility is impaired by or likely to be impaired by trash and debris</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris is removed</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>Function of facility is impaired by vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation is removed or managed to restore proper function of facility.</li> <li>Use of herbicides shall be in accordance with applicable regulations.</li> </ul>
	Contaminants and Pollution	<ul style="list-style-type: none"> <li>Any evidence of oil, gasoline, contaminants or other pollutants</li> <li>Coordinate removal/cleanup with local and/or state water quality response agency</li> </ul>	<ul style="list-style-type: none"> <li>Contaminants or pollutants are removed</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion</li> </ul>	<ul style="list-style-type: none"> <li>Slopes are stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction</li> </ul>
<b>Storage Area</b>	Sediment	<ul style="list-style-type: none"> <li>Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration</li> <li>A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove</li> </ul>	<ul style="list-style-type: none"> <li>Sediment is removed and/or facility is cleaned so that infiltration system works according to design</li> </ul>
<b>Rock Filters</b>	Sediment and Debris	<ul style="list-style-type: none"> <li>By visual inspection little or no water flows through filter during heavy rain storms</li> </ul>	<ul style="list-style-type: none"> <li>Gravel in rock filter is replaced</li> </ul>
<b>Side Slopes of Pond</b>	Erosion	<ul style="list-style-type: none"> <li>Eroded damage over 2 inches deep where cause of damage is still present <u>or where</u> there is potential for continued erosion-</li> </ul>	<ul style="list-style-type: none"> <li>Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction</li> </ul>



## No. 9-10 – Infiltration Facilities

Component	Potential Defect	Conditions When Maintenance is Needed	Maintenance Action and Expected Results
<b>Berms</b>	Settling	<ul style="list-style-type: none"> <li>Any part of a berm which has settled at least 4 inches lower than the design elevation</li> <li>If settlement is apparent measure berm to determine amount of settlement</li> <li>Settling can be an indication of more severe problems with the berm or outlet works</li> <li>A licensed civil engineer may be needed to determine the cause of the settlement</li> </ul>	<ul style="list-style-type: none"> <li>Berm is repaired and restored to the design elevation</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Any erosion observed on a compacted structural berm embankment</li> <li>A licensed civil engineer may be needed to inspect, evaluate and recommend a repair plan</li> </ul>	<ul style="list-style-type: none"> <li>Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction</li> </ul>
	Piping	<ul style="list-style-type: none"> <li>Discernable water flow through a compacted structural berm</li> <li>Ongoing erosion with potential for erosion to continue</li> <li>Tree growth on a compacted structural berm over 4 feet in height may lead to piping through the berm which could lead to failure of the berm</li> <li>Evidence of rodent holes in berm, and/or water piping through berm via rodent holes</li> <li>A geotechnical engineer may be needed to inspect and evaluate condition and recommend repair of condition</li> </ul>	<ul style="list-style-type: none"> <li>Piping eliminated</li> <li>Erosion potential resolved</li> </ul>

## No. 9-10 – Infiltration Facilities

Component	Potential Defect	Condition: When Maintenance is Needed	Maintenance Action and Expected Results
<b>Emergency Overflow Spillway</b>	Tree Growth	<ul style="list-style-type: none"> <li>Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping</li> </ul>	<ul style="list-style-type: none"> <li>Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise, the roots should be removed and the berm restored</li> <li>A licensed civil engineer may be needed to determine proper berm/spillway restoration</li> </ul>
	Rock Armoring	<ul style="list-style-type: none"> <li>Rock layer on subgrade is less than 1.0 feet deep and/or subgrade is exposed</li> </ul>	<ul style="list-style-type: none"> <li>Rocks and pad depth are restored to a minimum depth of 1.0 feet</li> </ul>
<b>Pre-settling Ponds and Vaults</b>	Erosion	<ul style="list-style-type: none"> <li>Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion</li> </ul>	<ul style="list-style-type: none"> <li>Slopes are stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction</li> </ul>
	Facility or sump filled with Sediment and/or debris	<ul style="list-style-type: none"> <li>The settling area or sump contains sediment/debris up to a depth of either 6 inches or the sedimentation design depth</li> </ul>	<ul style="list-style-type: none"> <li>Sediment/debris is removed</li> </ul>

**CAUTION:** Closed vaults are considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.

## 1011. Wetponds

### What Is a Wetpond?

A wetpond is a constructed pond that retains a permanent pool of water throughout the year or at least through the wet season. It removes suspended, particulate pollutants from stormwater. The pond can either be entirely excavated into the ground, or partially excavated with the remainder of the pond's perimeter formed by a compacted earthen berm which functions to impound the water inside. There are some wetponds with walls completely or partially constructed of poured-in-place concrete, concrete blocks, or large quarry rock.

### How Does a Wetpond Work?

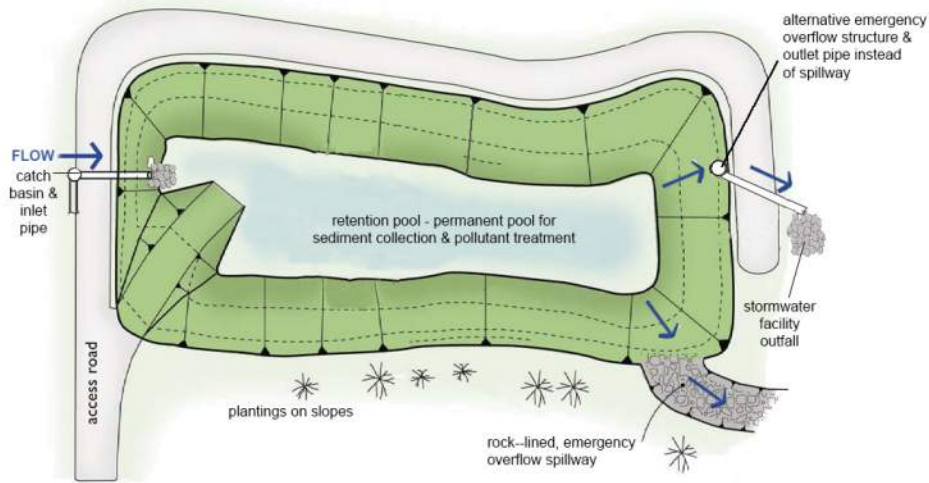
Pollutants such as trace metals, nutrients, sediments and organic compounds are suspended or dissolved in the water runoff entering a wetpond. The particulate material suspended in the water settles out as the velocity of the stormwater decreases upon entering the permanent pool. The greater the length of the residence time of the contaminated stormwater in the pond the more effective pollutant removal due to settling. There are several other pollutant removal processes that occur in wetponds. There are also natural ~~occurring~~ physical and chemical processes that occur in the stormwater runoff. Breakdown of ~~the~~ organic compounds may occur if ~~runoff water~~ resides in the wetpond long enough. Precipitation of dissolved compounds in the water may also occur. Additionally, bacterial processing of organic compounds and nutrients may occur if the conditions are correct. Some nutrients such as nitrogen, phosphorus and potassium which are found in fertilizers become dissolved in stormwater runoff. Some of the nutrient load in stormwater can be settled and/or removed through chemical reactions in wetponds. This capability helps reduce the impact of elevated concentrations of nutrients on the downstream, receiving waterbody. Nutrient loading can trigger an increase in algae and other plant growth which later dies. The decomposition of this dead plant material results in a depletion of dissolved oxygen in the water. Lack of oxygen in the water of rivers, streams, wetlands and lakes can deter fish from entering these waters and may kill the fish if they cannot escape.

### Wetpond Design

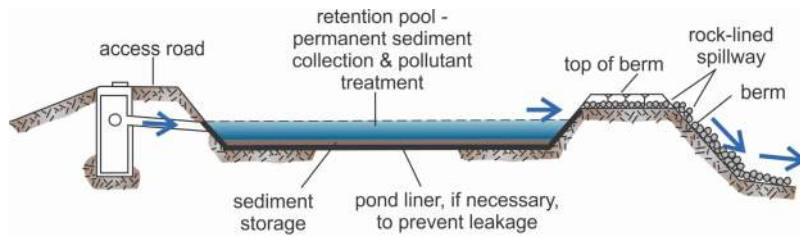
Wetponds have a single cell or two or more cells. When two or more cells exist, the first cell in line receives the storm runoff before the other cells and calms the turbulence of the flow, ~~capturing it~~. The bulk of ~~the transported~~ sediment ~~transported by the runoff settles in the first cell~~. Settling of sediment continues in the subsequent cells. The permanent pool of a wetpond ~~may exist in~~ has an intended purpose in the design of a detention pond - ~~the permanent pool provides the pollution removal function, and the storage of water from in~~ storm events, ~~the area~~ above the permanent pool provides detention capacity. The water stored above the elevation of the permanent pool level is designed to ~~completely~~ drain away, typically within a few days after a storm event.

Ponds can vary greatly in size, shape, and depth, as well as appearance. Appearances can range from little or no vegetation to well-manicured, managed or unmanaged, native or non-native vegetation. Generally, native vegetation is preferred to reduce maintenance, frequency of irrigation, pruning, noxious weed suppression, and grass mowing. Some facilities are designed to appear as natural waterbodies (e.g. a pond or stream) or designed to integrate into an existing or new park.

## Single-cell Wetpond (Retention Pool)

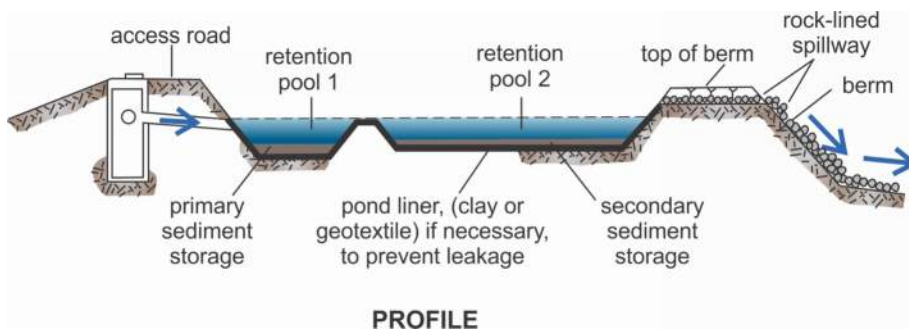
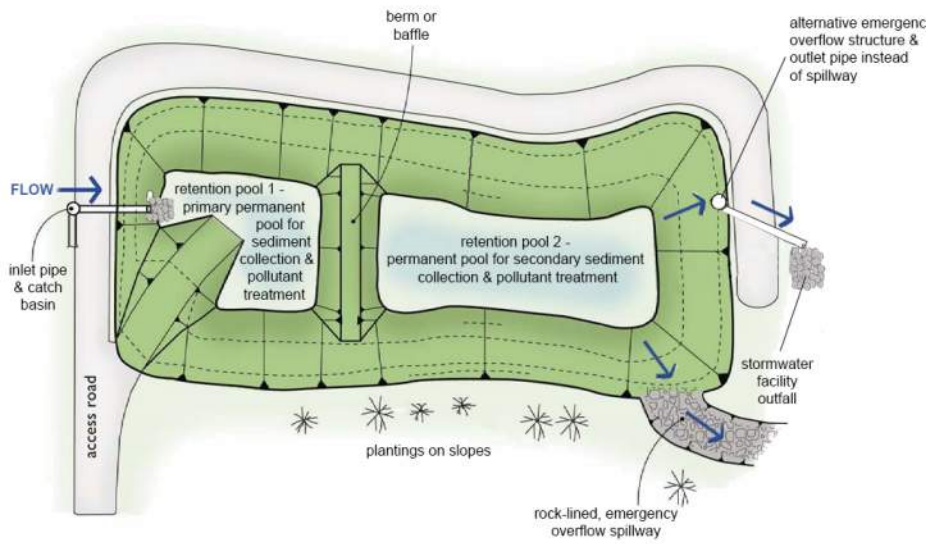


**BIRD'S-EYE VIEW**

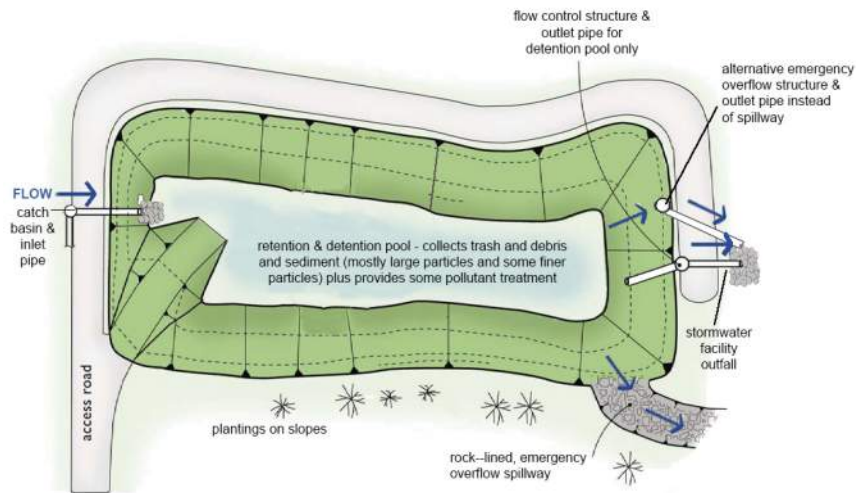


**PROFILE**

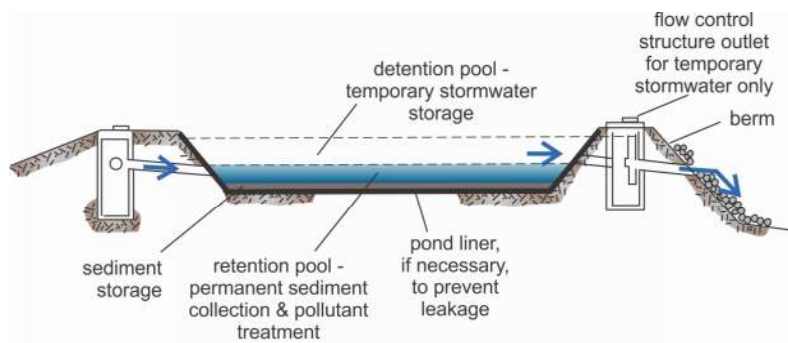
## Two-cell Wetpond (two retention pools)



## Single-cell Wet/Detention Pond (Retention Pool Combined with a Det. Pool)

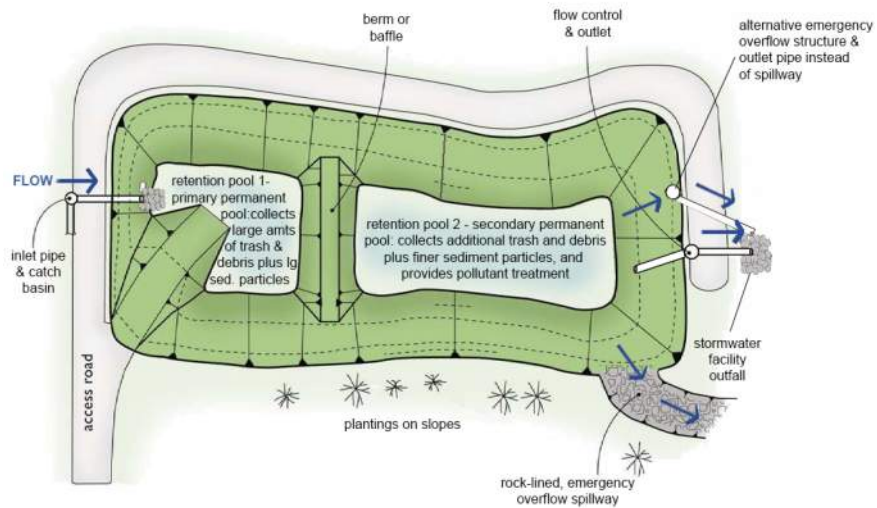


**BIRD'S-EYE VIEW**

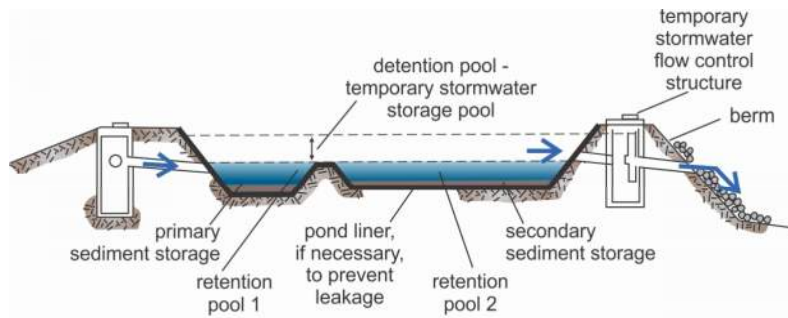


**PROFILE**

## Two-cell Wet/Detention Pond (Two Retention Pools Combined with Detention Pool)



**BIRD'S-EYE VIEW**



**PROFILE**



## Water Quality Treatment / Detention Pond



2-celled, deep water quality pond with cell dividing berm - cell 1 is on left for sediment collection



**Before Maintenance:** 2-celled, shallow water quality pond with cell dividing berm- cell 1 is on right of berm for sediment collection



**After maintenance:** cell 1 on left



2-celled, deep water quality pond  
cell 1 in the back is for sediment collection  
cell 2 in front has access road to cell 1 running through it and over the cell dividing berm



2-celled, water quality pond- cell for sediment collection is undergoing dredging for removal of sediment and cattail root mass



July 202~~64~~

## Water Quality Treatment / Detention Pond



2-celled, deep water quality pond with concrete cell divider and perimeter walls- cell 1 in the front is for sediment collection



Close-up of submerged concrete block (known as "ecology block") cell divider wall



2-celled, deep water quality pond with concrete cell divider and perimeter walls. Non-routine maintenance of dredging and cattail removal shown.



After maintenance



2-celled, deep water quality pond with concrete perimeter walls and ecology block cell divider

### Common Maintenance Considerations

Over time, wetponds accumulate sediment, trash, and vegetation debris, which reduces the storage and treatment capacity for water runoff from storms.

It is important to revegetate eroded areas after re-grading, filling and/or compacting. Mowing grass regularly helps suppress unwanted vegetation and keeps tree saplings from growing on constructed earthen berms. Trimming vegetation when necessary, keeps the pond free of leaves and maintains the aesthetic appearance of the site. Slope areas that have become bare should be revegetated and eroded areas should be re-graded prior to being revegetated. Planting with native vegetation is preferred for enhanced wildlife habitat and reduced site maintenance. Some ponds are designed to have plants that grow in the “permanent pool”, which provide additional pollutant removal. Replant if plants on the original designed planting plan are not maintaining the designed density. Recommended plant species for replanting are in the table below.

Common tools for cleaning wetponds are small bulldozers and excavators to remove built-up sediment and debris from the bottom of the pond.

Emergent Wetland Plant Species Recommended for Wetponds			
Species	Common Name	Notes	Maximum Depth
<b>INUNDATION TO 1-FOOT</b>			
<i>Agrostis exarata</i> <sup>(1)</sup>	Spike bent grass	Prairie to coast	to 2 feet
<i>Carex stipata</i>	Sawbeak sedge	Wet ground	
<i>Eleocharis palustris</i>	Spike rush	Margins of ponds, wet meadows	to 2 feet
<i>Glyceria occidentalis</i>	Western mannagrass	Marshes, pond margins	to 2 feet
<i>Juncus tenuis</i>	Slender rush	Wet soils, wetland margins	
<i>Oenanthe sarmentosa</i>	Water parsley	Shallow water along stream and pond margins; needs saturated soils all summer	
<i>Scirpus atrocinctus</i> (formerly <i>S. cyperinus</i> )	Woolgrass	Tolerates shallow water; tall clumps	
<i>Scirpus microcarpus</i>	Small-fruited bulrush	Wet ground to 18 inches depth	18 inches
<i>Sagittaria latifolia</i>	Arrowhead		
<b>INUNDATION 1 TO 2 FEET</b>			
<i>Agrostis exarata</i> <sup>(1)</sup>	Spike bent grass	Prairie to coast	
<i>Alisma plantago-aquatica</i>	Water plantain		
<i>Eleocharis palustris</i>	Spike rush	Margins of ponds, wet meadows	

July 2026~~4~~

Emergent Wetland Plant Species Recommended for Wetponds			
Species	Common Name	Notes	Maximum Depth
<i>Glyceria occidentalis</i>	Western mannagrass	Marshes, pond margins	
<i>Juncus effusus</i>	Soft rush	Wet meadows, pastures, wetland margins	
<i>Scirpus microcarpus</i>	Small-fruited bulrush	Wet ground to 18 inches depth	18 inches
<i>Sparganium emmersum</i>	Bur reed	Shallow standing water, saturated soils	
<b>INUNDATION 1 TO 3 FEET</b>			
<i>Carex obnupta</i>	Slough sedge	Wet ground or standing water	1.5 to 3 feet
<i>Beckmania syzigachne</i> <sup>(1)</sup>	Western sloughgrass	Wet prairie to pond margins	
<i>Scirpus acutus</i> <sup>(2)</sup>	Hardstem bulrush	Single tall stems, not clumping	to 3 feet
<i>Scirpus validus</i> <sup>(2)</sup>	Softstem bulrush		
<b>INUNDATION GREATER THAN 3 FEET</b>			
<i>Nuphar polysepalum</i>	Spatterdock	Deep water	3 to 7.5 feet
<i>Nymphaea odorata</i> <sup>(1)</sup>	White waterlily	Shallow to deep ponds	to 6 feet
<p>Notes:</p> <p><sup>(1)</sup> Non-native species. <i>Beckmania syzigachne</i> is native to Oregon. Native species are preferred.</p> <p><sup>(2)</sup> <i>Scirpus</i> tubers must be planted shallower for establishment, and protected from foraging waterfowl until established. Emerging aerial stems should project above water surface to allow oxygen transport to the roots.</p> <p>Primary sources: Municipality of Metropolitan Seattle, Water Pollution Control Aspects of Aquatic Plants, 1990. Hortus Northwest, Wetland Plants for Western Oregon, Issue 2, 1991. Hitchcock and Cronquist, Flora of the Pacific Northwest, 1973.</p>			

Refer to the table below titled No. ~~4011~~ - Wetponds for specific maintenance standards.

## Maintenance Standards

No. <del>10</del> <u>11</u> – Wetponds			
Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Water level	<ul style="list-style-type: none"> <li>First cell is empty, doesn't hold water</li> </ul>	<ul style="list-style-type: none"> <li>Line the first cell to maintain water per the original design</li> <li>Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension</li> </ul>
	Inlet/Outlet Pipe	<ul style="list-style-type: none"> <li>Inlet/Outlet pipe clogged with sediment and/or debris material</li> </ul>	<ul style="list-style-type: none"> <li>No clogging or blockage in the inlet and outlet piping</li> </ul>
	Sediment Accumulation in Pond Bottom	<ul style="list-style-type: none"> <li>Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6 inches, usually in the first cell</li> </ul>	<ul style="list-style-type: none"> <li>Sediment removed from pond bottom</li> </ul>
	Oil Sheen on Water	<ul style="list-style-type: none"> <li>Prevalent and visible oil sheen</li> </ul>	<ul style="list-style-type: none"> <li>Oil removed from water using oil-absorbent pads or vacuor truck</li> <li>Source of oil located and corrected</li> <li>If chronic low levels of oil persist, plant wetland plants such as <i>Juncus effusus</i> (soft rush) which can uptake small concentrations of oil</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Erosion of the pond's side slopes and/or scouring of the pond bottom that exceeds 6 inches, or where continued erosion is prevalent</li> </ul>	<ul style="list-style-type: none"> <li>Slopes stabilized using proper erosion control measures and repair methods</li> </ul>

No. ~~10-11~~ – Wetponds

Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Berms</b>	Settling	<ul style="list-style-type: none"> <li>Any part of a berm which has settled at least 4 inches lower than the design elevation</li> <li>If settlement is apparent, measure berm to determine amount of settlement</li> <li>Settling can be an indication of more severe problems with the berm or outlet works</li> <li>A licensed civil engineer may be needed to determine the cause of the settlement</li> </ul>	<ul style="list-style-type: none"> <li>Berm is repaired and restored to the design elevation</li> </ul>
	Internal Berm	<ul style="list-style-type: none"> <li>Berm dividing cells should be level</li> </ul>	<ul style="list-style-type: none"> <li>Berm surface is leveled so that water flows evenly over entire length of berm</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Any erosion observed on a compacted structural berm embankment</li> <li>A licensed civil engineer may be needed to inspect, evaluate and recommend a repair plan</li> </ul>	<ul style="list-style-type: none"> <li>Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.</li> </ul>
	Piping	<ul style="list-style-type: none"> <li>Discernable water flow through a compacted structural berm</li> <li>Ongoing erosion with potential for erosion to continue</li> <li>Tree growth on a compacted structural berm over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.</li> <li>Evidence of rodent holes in berm, and/or water piping through berm via rodent holes</li> <li>A geotechnical engineer may be needed to inspect and evaluate condition and recommend repair of condition</li> </ul>	<ul style="list-style-type: none"> <li><u>Trees removed</u></li> <li><u>Rodents removed</u></li> <li>Piping eliminated</li> <li>Erosion potential resolved</li> </ul>

## No. 10-11 – Wetponds

Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Emergency Overflow/Spillway	Tree Growth	<ul style="list-style-type: none"> <li>Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping</li> </ul>	<ul style="list-style-type: none"> <li>Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place; otherwise the roots should be removed and the berm restored.</li> <li>A licensed civil engineer may be needed to determine proper berm/spillway restoration</li> </ul>
	Rock Armoring	<ul style="list-style-type: none"> <li>Rock layer on subgrade is less than 1.0 feet deep and/or subgrade is exposed</li> </ul>	<ul style="list-style-type: none"> <li>Rocks and pad depth are restored to a minimum depth of 1.0 feet.</li> </ul>
	Erosion	<ul style="list-style-type: none"> <li>Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion</li> </ul>	<ul style="list-style-type: none"> <li>Slopes-Damaged areas are stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction</li> </ul>

## 11.12. Wetvaults

### What Is a Wetvault?

A wetvault is an underground reinforced concrete tank which collects and removes pollutants from stormwater runoff. Wetvaults are typically located underground, although on some sites, a portion of a vault may be exposed if it is located adjacent to sloping ground.

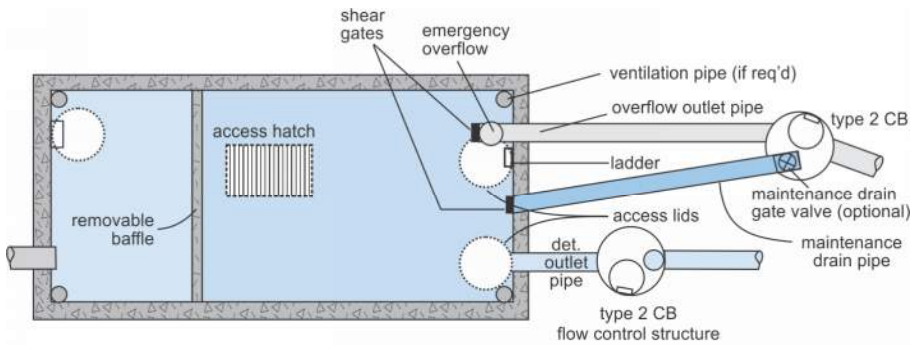
### How Does a Wetvault Work?

Pollutants such as trace metals, nutrients, sediments and organic compounds are suspended or dissolved in the water runoff entering a wetvault. The wetvault removes only sediment and some trace metals as storm runoff mixes with the water in a vault's permanent pool. It does not remove nutrients as it has no biological component to perform this function. The particulate material suspended in the water settles out as the velocity of the stormwater decreases upon entering the permanent pool. The greater the length of the residence time of the contaminated stormwater in the vault the more effective the pollutant removal is due to settling.

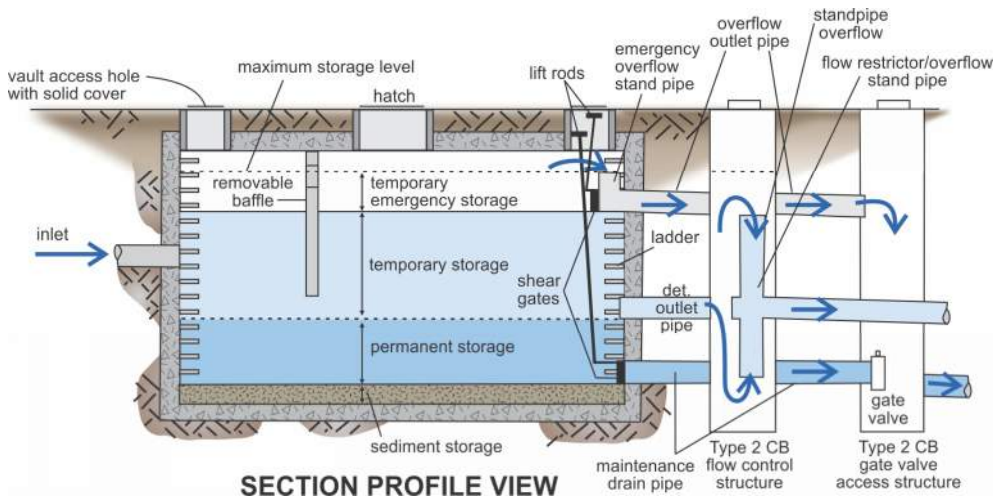
### Wetvault Design

Wetvaults may have a single cell or two or more cells. When two or more cells exist, the first cell in line receives the storm runoff before the other cells and calms-reduces both the turbulence and velocity of the flow. This allows capturing the bulk of sediment transported by in the runoff to settle out in the bottom of the vault. Settling of sediment continues in the subsequent cells. The permanent pool of a wetvault has an intended purpose in may exist in the design of a detention vault. The permanent pool provides the pollution removal function. In storm events, and the storage of water the area above the permanent pool provides detention capacity. The water stored from storm events above the elevation of the permanent pool is designed to completely drain away, typically within a few days after a storm event. Vaults are a convenient structure on which to place an outdoor sports court, play field or play equipment.

## Wetvault



**BIRD'S-EYE VIEW**



**SECTION PROFILE VIEW**



July 202~~64~~

## Wetvault with Sport Court on Top



Normal dual use of a water quality vault with an asphalt game court, play set and lawn placed on top; all four photos are of the same vault

### Common Maintenance Considerations

Over time, wetvaults accumulate sediment, trash and vegetation debris which reduces the storage and treatment capacity for water runoff from storms. Sediment, trash, and vegetation should be managed per the maintenance standards presented in the table below. Sediments and standing water which are removed during maintenance operations must be disposed of in accordance with requirements of the Snohomish County Code and Washington State laws.

The most common equipment for cleaning wetvaults is a heavy-duty, combination power-washing and vacuum truck, also known as a vactor truck. It provides high-pressure washing for the walls and bottom of the structure and a high-power vacuum for removing water laden with sediment, oil, grease, gasoline, vegetation, debris, and trash.

A wetvault is an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering one of these detention systems, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Refer to the table below titled No. ~~44~~12 - Wetvaults for specific maintenance standards.

## Maintenance Standards

No. <del>11</del> <u>12</u> — Wetvaults			
Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Vault Chamber(s)	Floating debris accumulation	<ul style="list-style-type: none"> <li>Any debris accumulated in vault, pipe or inlet/outlet.</li> </ul>	<ul style="list-style-type: none"> <li>All floating debris removed.</li> </ul>
	Sediment and non-floating debris accumulation	<ul style="list-style-type: none"> <li>Sediment accumulation in vault bottom <del>exceeds the depth of the</del> <u>completely fills the</u> sediment zone <del>plus 6 inches, or the</del> <u>sediment depth exceeds 10% of the interior vertical dimension of the vault across the entirety of the vault.</u></li> </ul>	<ul style="list-style-type: none"> <li>All sediment and debris removed from bottom.</li> </ul>
	Plugged or damaged pipes	<ul style="list-style-type: none"> <li>Inlet/outlet pipe(s) plugged, damaged or broken and needs repair.</li> </ul>	<ul style="list-style-type: none"> <li>Pipe unplugged, repaired and/or replaced.</li> </ul>
Vault Concrete Lid	Access hole cover damaged/not working or missing	<ul style="list-style-type: none"> <li>Cover cannot be opened or removed, especially by one person. Missing cover is <u>a</u> safety hazard.</li> </ul>	<ul style="list-style-type: none"> <li>Cover repaired or replaced.</li> </ul>
	Ventilation not adequate	<ul style="list-style-type: none"> <li>Ventilation area blocked or plugged.</li> </ul>	<ul style="list-style-type: none"> <li>Blocking material removed or cleared from ventilation area. Specified % of the vault surface area provides ventilation to the vault interior (see design specifications).</li> </ul>
Vault Bottom, Walls & Lid	Cracks, holes, scaling & steel structural reinforcement bars (rebar) exposed	<ul style="list-style-type: none"> <li>Professional inspection determines that vault is not structurally sound or leaks are present.</li> </ul>	<ul style="list-style-type: none"> <li>Vault repaired or replaced <del>made</del> so that it meets design specifications and is structurally sound.</li> </ul>
		<ul style="list-style-type: none"> <li>Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Cracks repaired and no cracks exist wider than 1/4-inch.</li> </ul>

## No. 11-12 – Wetvaults

Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Baffles</b>	Signs of structural failure	<ul style="list-style-type: none"> <li>Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.</li> </ul>	<ul style="list-style-type: none"> <li>Baffles repaired or replaced to specifications.</li> </ul>
<b>Ladder</b>	Damaged or detached	<ul style="list-style-type: none"> <li>Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned</li> </ul>	<ul style="list-style-type: none"> <li>Ladder repaired or replaced to specifications, and is safe to use as determined by inspection personnel.</li> <li>Ladder complies with OSHA standards.</li> </ul>

**CAUTION:** A wetvault is considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.

## 1213. Bioretention ~~Systems~~Facilities

### What are Bioretention ~~Systems~~Facilities?

Bioretention ~~systems-facilities~~ are shallow landscaped depressions, with a designed soil mix and plants adapted to the local climate and moisture conditions, which provide pollutant removal and reduction of stormwater runoff flow rates.

### How do Bioretention ~~Systems-Facilities~~ work?

Bioretention ~~systems-facilities~~ are engineered facilities that store and treat stormwater by filtering it through a specified soil profile. Plants and other soil biota are also instrumental in pollutant removal.

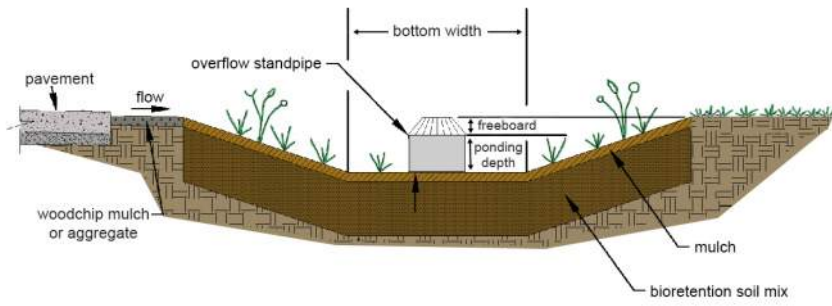
Water that enters the facility ponds in an earthen depression or other basin (e.g., concrete planter) before it infiltrates into the underlying bioretention soil. Stormwater that exceeds the surface storage capacity overflows to an adjacent drainage system. Treated water is either infiltrated into the underlying native soil or collected by an underdrain and discharged.

### Typical Bioretention ~~System-Facility~~ designs

There are three different types of bioretention systems. All three types have shallow depressions, an engineered soil mix, and an appropriate suite of plants. All three may have an underdrain.

- **Bioretention cells:**  
Bioretention cells are not designed as a linear conveyance system but rather as a single point of treatment. Treated water leaves the facility by infiltration into native soils or an underdrain; untreated water may leave through an overflow feature.
- **Bioretention swales:**  
Bioretention swales are designed ~~the~~ similarly to bioretention cells; ~~however, except that~~ they tend to have a linear design that conveys stormwater when a certain depth is reached.
- **Bioretention planters and planter boxes:** have a vertical walled container often made of concrete, but could include other materials. Planters have an open bottom so ~~that~~ water infiltrates into the surrounding soil, while planter boxes have bottoms and must have an underdrain. Both require designed soil mix and some form of vegetation.

## Bioretention System Facility (Typical Section)



### Common Maintenance Considerations

If the water drawdown time is more than 48 hours or mulch is compacted, removing and replacing the mulch is effective. Mulch performs best when between 2 and 3 inches thick.

Refer to the table below titled No. ~~42~~13 – Bioretention Facilities for specific maintenance standards.

### Maintenance Standards

No. <del>42</del> <u>13</u> – Bioretention Facilities			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Inlet	Energy dissipat <del>o</del> ers are damaged	<ul style="list-style-type: none"> <li>Visible soil, missing rock, or other evidence of damage</li> </ul>	<ul style="list-style-type: none"> <li>Replace or rebuild energy dissipat<del>o</del>ers to design specifications</li> </ul>
	Inlet is blocked	<ul style="list-style-type: none"> <li>Flow into bioretention bed is impeded</li> </ul>	<ul style="list-style-type: none"> <li>Remove blockage to restore flow</li> </ul>
Bioretention bed/plants	Sediment accumulation	<ul style="list-style-type: none"> <li>Sediment depth exceeds 1 inch</li> </ul>	<ul style="list-style-type: none"> <li>Remove sediment to restore permeability</li> </ul>
	Trash or debris accumulation	<ul style="list-style-type: none"> <li>Trash or debris are accumulated on bed</li> </ul>	<ul style="list-style-type: none"> <li>Remove trash and debris</li> </ul>
	Excessive drawdown time	<ul style="list-style-type: none"> <li>Drawdown time &gt; 48 hours</li> </ul>	<ul style="list-style-type: none"> <li>Remove and replace mulch or bioretention soil mix to restore permeability, and/or clean underdrain</li> </ul>
	Uneven ponding	<ul style="list-style-type: none"> <li>Water does not pond evenly on bed</li> </ul>	<ul style="list-style-type: none"> <li>Remove, replace, or reposition mulch to restore even ponding</li> </ul>
	Bioretention plants	<ul style="list-style-type: none"> <li>Bioretention plants are missing, diseased, or dead</li> </ul>	<ul style="list-style-type: none"> <li>Replace plants with healthy bioretention plants selected per the planting plan</li> </ul>
	Weeds or invasive plants	<ul style="list-style-type: none"> <li>Weeds or invasive plants growing in bioretention facility</li> </ul>	<ul style="list-style-type: none"> <li>Remove weeds and invasive plants, replace with bioretention plants, or cover affected areas with mulch, as appropriate.</li> </ul>
	Mulch is inadequate	<ul style="list-style-type: none"> <li>Mulch is missing <u>or not thick enough</u></li> <li><u>There is excessive mulch</u></li> </ul>	<ul style="list-style-type: none"> <li>Replace mulch to maintain 2-<u>inch to 3-</u>inch depth in</li> </ul>

## No. 12-13 – Bioretention Facilities

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
			mulched areas of bioretention system
	Bed compaction	<ul style="list-style-type: none"> <li>Bed is compacted due to foot or vehicle traffic or other reason</li> </ul>	<ul style="list-style-type: none"> <li>Loosen compacted bed material, or replace as needed, to restore permeability</li> </ul>
<b>Sidewalls, check dams, weirs</b>	Visible damage or erosion	<ul style="list-style-type: none"> <li>Sidewalls, check dams, or weirs have visible erosion or other structural damage</li> </ul>	<ul style="list-style-type: none"> <li>Repair to bring into conformance with facility design</li> </ul>
	Flow over check dams or weirs is blocked	<ul style="list-style-type: none"> <li>Flow is blocked so that design ponding depth is exceeded</li> </ul>	<ul style="list-style-type: none"> <li>Clear blockage to restore design ponding depth</li> </ul>
	Flow around check dams or weirs	<ul style="list-style-type: none"> <li>Flow is going around check dams or weirs so that design ponding depth is not attained</li> </ul>	<ul style="list-style-type: none"> <li>Repair check dams, weirs, and sidewalls to restore design ponding depth</li> </ul>
	Grade board or weir top not level	<ul style="list-style-type: none"> <li>Uneven flow over check dams or weirs so that design ponding depth is not attained</li> </ul>	<ul style="list-style-type: none"> <li>Repair check dams and weirs to restore design ponding depth</li> </ul>
<b>Overflow</b>	Energy dissipaters are damaged	<ul style="list-style-type: none"> <li>Visible soil, missing rock, or other evidence of damage</li> </ul>	<ul style="list-style-type: none"> <li>Replace or rebuild energy dissipaters to design specifications</li> </ul>
	Overflow is blocked	<ul style="list-style-type: none"> <li>Flow is blocked so that standing pool depth is above design depth</li> </ul>	<ul style="list-style-type: none"> <li>Clear overflow structure to restore design ponding depth</li> </ul>
<b>Underdrain system</b>	Underdrain is blocked or damaged	<ul style="list-style-type: none"> <li>Flow does not pass as designed through underdrain system</li> </ul>	<ul style="list-style-type: none"> <li>Clean or repair underdrain system to restore design flow capacity</li> </ul>





## ~~13~~14. Basic Biofiltration Swales

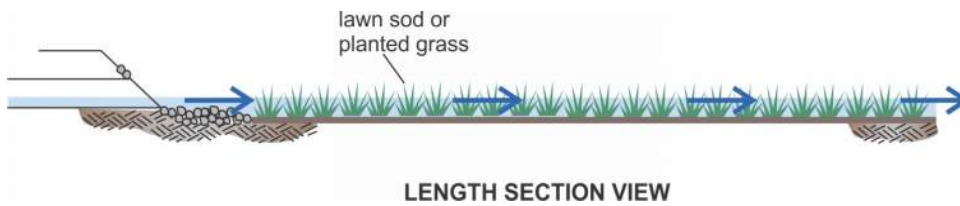
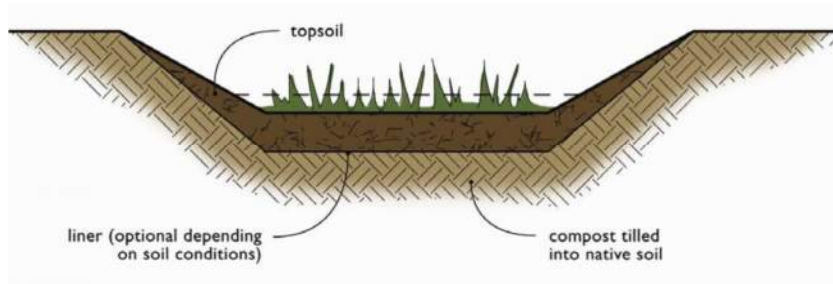
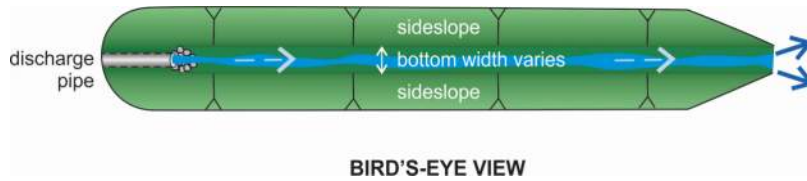
### What Is a Basic Biofiltration Swale?

A basic biofiltration swale is a vegetation-lined channel with a moderate centerline slope similar in appearance to a ditch. Basic biofiltration swales convey and treat stormwater. They are often used in series with other stormwater management facilities.

### How Does a Basic Biofiltration Swale Work?

Basic biofiltration swales use dense, water-tolerant vegetation in conjunction with slow and shallow depth flow to remove pollutants by the combined effects of sedimentation, filtration, infiltration, soil adsorption, and/or plant uptake. They remove low concentrations of pollutants. Basic bioswales remain dry except immediately during and after a storm event.

## Basic Bioswale (straight swale shown, may also be curved)



## Basic Bioswales



In residential lot back yard



Along residential street



In retail strip mall parking area median



Church parking area

### Common Maintenance Considerations

The most common tools for maintenance of biofiltration swales are mowers and hand tools such as rakes to remove built up sediment and debris from the swale.

Fertilizing a biofilter should be avoided, if possible. If use of a fertilizer cannot be avoided, it is best to use a slow-release fertilizer formulation in the least amount needed. It may be necessary to consult with a landscape professional that can test the soils to determine nutrient levels and fertilizer needs.

Suitable plants for vegetation maintenance are given below.

Refer to the table below titled No. 134 – Basic Biofiltration Swales for specific maintenance standards.

Groundcovers and Grasses Suitable for the Upper Side Slopes of a Biofiltration Swale in Western Washington	
Groundcovers	
kinnikinnick	<i>Arctostaphylos uva-ursi</i>
Epimedium	<i>Epimedium grandiflorum</i>
creeping forget-me-not	<i>Omphalodes verna</i>
--	<i>Euonymus lanceolata</i>
yellow-root	<i>Xanthorhiza simplissima</i>
--	<i>Genista</i>
white lawn clover	<i>Trifolium repens</i>
white sweet clover	<i>Melilotus alba</i>
-----	<i>Rubus calycinoides</i>
strawberry	<i>Fragaria chiloensis</i>
broadleaf lupine	<i>Lupinus latifolius</i>
Grasses (drought-tolerant, minimum mowing)	
dwarf tall fescues	<i>Festuca</i> spp. (e.g., Many Mustang, Silverado)
hard fescue	<i>Festuca ovina duriuscula</i> (e.g., Reliant, Aurora)
tufted fescue	<i>Festuca amethystine</i>
buffalo grass	<i>Buchloe dactyloides</i>
red fescue	<i>Festuca rubra</i>
tall fescue grass	<i>Festuca arundinacea</i>
blue oatgrass	<i>Helictotrichon sempervirens</i>

Seed Mixes Suitable for Biofiltration Swale Treatment Areas			
Mix 1		Mix 2	
75-80 percent	tall or meadow fescue	60-70 percent	tall fescue
10-15 percent	seaside/colonial bentgrass	10-15 percent	seaside/colonial bentgrass
5-10 percent	Redtop	10-15 percent	meadow foxtail
		6-10 percent	alsike clover
		1-5 percent	marshfield big trefoil
		1-6 percent	Redtop
Note: all percentages are by weight.			

## Maintenance Standards

No. 134 – Basic Biofiltration Swales			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
General	Sediment Accumulation on Grass	<ul style="list-style-type: none"> <li>Sediment depth exceeds 2 inches.</li> </ul>	<ul style="list-style-type: none"> <li>Remove sediment deposits on grass treatment area of the swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased. Reseed any bare spots as needed in loosened, fertile soil.</li> </ul>
	Standing Water	<ul style="list-style-type: none"> <li>When water stands in the swale between storms and does not drain freely.</li> </ul>	<ul style="list-style-type: none"> <li>Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.</li> </ul>

## No. 134 – Basic Biofiltration Swales

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Flow spreader	<ul style="list-style-type: none"> <li>Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.</li> </ul>	<ul style="list-style-type: none"> <li>Level the spreader and clean so that flows are spread evenly over entire swale width.</li> </ul>
	Constant Baseflow	<ul style="list-style-type: none"> <li>When small quantities of water continually flow through the swale, even when it has been dry for weeks and an eroded, muddy channel has formed in the swale bottom.</li> </ul>	<ul style="list-style-type: none"> <li>Add a low-flow pea-gravel drain the length of the swale or bypass the baseflow around the swale.</li> </ul>
	Poor Vegetation Coverage	<ul style="list-style-type: none"> <li>When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.</li> </ul>	<ul style="list-style-type: none"> <li>Determine why grass growth is poor and correct that condition. Replant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or reseed into loosened, fertile soil.</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.</li> </ul>	<ul style="list-style-type: none"> <li>Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.</li> </ul>
	Excessive Shading	<ul style="list-style-type: none"> <li>Grass growth is poor because sunlight does not reach swale.</li> </ul>	<ul style="list-style-type: none"> <li>If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes. In addition, reseed bare spots with shade tolerant grass seed mix and/or replant with plugs of slough sedge or other sedges.</li> </ul>
	Inlet/Outlet	<ul style="list-style-type: none"> <li>Inlet/outlet areas clogged with sediment and/or debris.</li> </ul>	<ul style="list-style-type: none"> <li>Remove material so that there is no clogging or blockage in the inlet and outlet area.</li> </ul>

## No. 134 – Basic Biofiltration Swales

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulated in the bio-swale.</li> </ul>	<ul style="list-style-type: none"> <li>Remove trash and debris from swale.</li> </ul>
	Erosion/Scouring	<ul style="list-style-type: none"> <li>Eroded or scoured swale bottom due to flow channelization, or higher flows.</li> </ul>	<ul style="list-style-type: none"> <li>For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.</li> </ul>

## 145. Wet Biofiltration Swales

### What Is a Wet Biofiltration Swale?

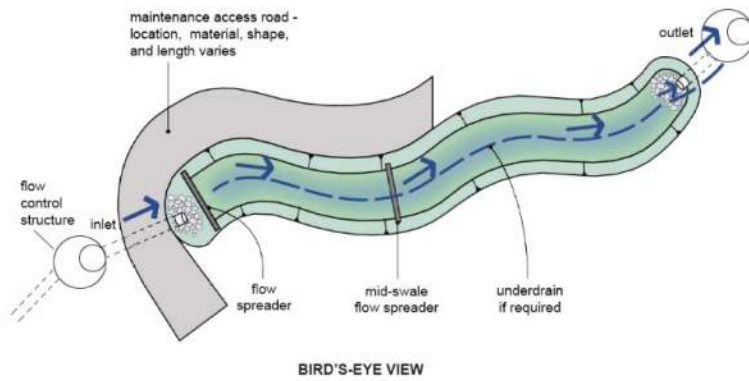
A wet biofiltration swale<sup>s</sup> is a variation of the basic biofiltration swale for use where the centerline slope is slight, groundwater tables are high, or a continuous low base flow is likely to result in wet soil conditions for long periods of time. Where continuously wet soil conditions exceed about 2 weeks, typical grasses die. Thus, vegetation specifically adapted to wet soil conditions is needed. Different vegetation, in turn, requires modification of several design and maintenance standards from the basic biofiltration swale. Wet biofiltration swales convey and treat stormwater. They are often used in series with other stormwater management facilities.

### How Does a Wet Biofiltration Swale Work?

Wet biofiltration swales use dense, water-tolerant vegetation in conjunction with slow and shallow depth flow to remove pollutants by the combined effects of sedimentation, filtration, infiltration, soil adsorption, and/or plant uptake. They remove low concentrations of pollutants.



## Wet Biofiltration Swale With Underdrain



### Common Maintenance Considerations

If cutting aquatic vegetation is necessary, consider scheduling the cutting for ~~sometimes~~some time in the fall season, after the green leaves above the water have wilted and the plant has become dormant. Avoid stepping in the bottom of a wet biofiltration swale or rolling equipment over it. This will compact the soil, suppressing plant growth and limiting the soil's ability to infiltrate the stormwater.

Common tools for maintenance of wet biofiltration swales are hand tools such as rakes to remove built up sediment and debris in the swale. Grass can be maintained with a trimmer by cutting it to a minimum height of 6-12".

Fertilizing a biofilter should be avoided, if possible. If use of a fertilizer cannot be avoided, it's best to use a slow-release fertilizer formulation in the least amount needed. It may be necessary to consult with a landscape professional that can test the soils to determine nutrient levels and fertilizer needs.

Suitable plants for vegetation maintenance are given below:

Recommended Plants for Wet Biofiltration Swale		
Common Name	Scientific Name	Spacing (on center)
Shortawn foxtail	<i>Alopecurus aequalis</i>	seed
Water foxtail	<i>Alopecurus geniculatus</i>	seed
Spike rush	<i>Eleocharis spp.</i>	4 inches
Slough sedge*	<i>Carex obnupta</i>	6 inches or seed
Sawbeak sedge	<i>Carex stipata</i>	6 inches
Sedge	<i>Carex spp.</i>	6 inches
Western mannagrass	<i>Glyceria occidentalis</i>	seed
Velvetgrass	<i>Holcus mollis</i>	seed
Slender rush	<i>Juncus tenuis</i>	6 inches
Watercress*	<i>Rorippa nasturtium-aquaticum</i>	12 inches
Water parsley*	<i>Oenanthe sarmentosa</i>	6 inches
Hardstem bulrush	<i>Scirpus acutus</i>	6 inches
Small-fruited bulrush	<i>Scirpus microcarpus</i>	12 inches
*Good choices for swales with significant periods of flow, such as those downstream of a detention facility.		
Note: Cattail ( <i>Typha latifolia</i> ) is not appropriate for most wet swales because of its very dense and clumping growth habit which prevents water from filtering through the clump		

Refer to the table below titled No. 14~~5~~ – Wet Biofiltration Swales for specific maintenance standards.

## Maintenance Standards

No. 1 <del>45</del> <sup>46</sup> – Wet Biofiltration Swales			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Sediment Accumulation	<ul style="list-style-type: none"> <li>Sediment depth exceeds 2 inches in 10% of the swale treatment area</li> </ul>	<ul style="list-style-type: none"> <li>Remove sediment deposits in treatment area</li> </ul>
	Water Depth	<ul style="list-style-type: none"> <li>Water not retained to a depth of about 4 inches during the wet season</li> </ul>	<ul style="list-style-type: none"> <li>Build up or repair outlet berm so that water is retained in the wet swale</li> </ul>
	Wetland Vegetation	<ul style="list-style-type: none"> <li>Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps</li> </ul>	<ul style="list-style-type: none"> <li>Determine cause of lack of vigor of vegetation and correct. Replant as needed with wetland plants. For excessive cattail growth cut cattail shoots back and compost offsite</li> <li>Normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters</li> </ul>
	Inlet/Outlet	<ul style="list-style-type: none"> <li>Inlet/outlet area clogged with sediment and/or debris.</li> </ul>	<ul style="list-style-type: none"> <li>Remove clogging or blockage in the inlet and outlet areas.</li> </ul>
	Erosion/Scouring	<ul style="list-style-type: none"> <li>Swale has eroded or scoured due to flow channelization, or higher flows.</li> </ul>	<ul style="list-style-type: none"> <li>Check design flows to assure swale is large enough to handle flows</li> <li>Bypass excess flows, or enlarge swale</li> <li>Replant eroded areas with fibrous-rooted plants such as Soft Rush; <i>Juncus effusus</i> or Slough Sedge; <i>Carex obnupta</i> in wet areas or Snowberry; <i>Symphoricarpos albus</i> in dryer areas</li> </ul>

## 156. Compost-Amended Vegetated Filter Strips (CAVFS)

### What is a CAVFS?

A compost-amended vegetated filter strip is a variation of the basic, vegetated filter strip that adds soil amendments to the roadside embankment. The soil amendments improve infiltration characteristics, increase surface roughness, improve plant sustainability and overall health, allow greater retention and infiltration capacity, improves removal of soluble pollutants, and reduces potential for invasive weeds.

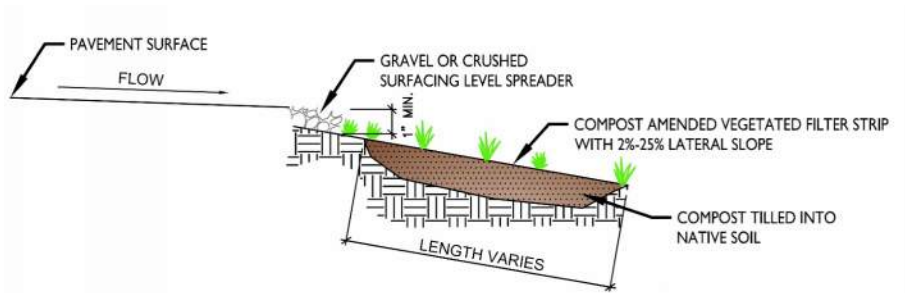
### How does a CAVFS work?

A CAVFS works by evenly distributing stormwater runoff in a manner where it flows slowly and at shallow depth over a vegetated, amended embankment removing pollutants through the combined effects of sedimentation, filtration through the vegetation, infiltration into the amended soil, settling, soil sorption, and plant uptake.

### Typical CAVFS design

Similar to filter strips, a CAVFS design includes a linear, vegetated slope below a flow spreader device or gravel-filled trench placed adjacent and parallel to paved areas such as parking lots, driveways, and roadways. The addition of compost-amended soil allows the CAVFS design to require less treatment area than the basic filter strip.

## Compost-Amended Vegetated Filter Strip (Typical Section)



### Common Maintenance Consideration

Removing sediment at the flow spreader and maintaining even sheetflow over the filter will reduce long-term maintenance.

Site activities should protect vegetation covering and avoid compaction of the underlying soil.

The most common tools for maintenance of filter strips are mowers and hand tools to remove built up debris at the edge of the filter strip and restore evenly distributed flow across the strip.

Refer to the table below titled No. 156 – Compost Amended Vegetated Filter Strips (CAVFS) for specific maintenance standards.

## Maintenance Requirements

No. 1 <del>36</del> – Compost Amended Vegetated Filter Strip (CAVFS)			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Sediment Accumulation on Grass	<ul style="list-style-type: none"> <li>Sediment depth exceeds 2 inches.</li> </ul>	<ul style="list-style-type: none"> <li>Remove sediment deposits on grass treatment area of the swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased. Reseed any bare spots as needed in loosened, fertile soil.</li> </ul>
	Poor Vegetation Coverage	<ul style="list-style-type: none"> <li>When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.</li> </ul>	<ul style="list-style-type: none"> <li>Determine why grass growth is poor and correct that condition. Replant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or reseed into loosened, fertile soil.</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.</li> </ul>	<ul style="list-style-type: none"> <li>Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.</li> </ul>
	Inlet/Outlet	<ul style="list-style-type: none"> <li>Inlet/outlet areas clogged with sediment and/or debris.</li> </ul>	<ul style="list-style-type: none"> <li>Remove material so that there is no clogging or blockage in the inlet and outlet area.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulated in the bio-swale.</li> </ul>	<ul style="list-style-type: none"> <li>Remove trash and debris from swale.</li> </ul>

No. 1~~36~~ – Compost Amended Vegetated Filter Strip (CAVFS)

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Erosion/Scouring	<ul style="list-style-type: none"> <li>Eroded or scoured swale bottom due to flow channelization, or higher flows.</li> </ul>	<ul style="list-style-type: none"> <li>For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.</li> </ul>

## 167. Media Filter Drain

### What is a media filter drain?

A media filter drain is a linear flow-through stormwater treatment device sited along highway side slopes, medians, or other linear depressions. A media filter drain can be constructed on shallow slopes adjacent to roads without curbs. It removes suspended solids, phosphorus, and metals from roadway runoff through physical, chemical, and biological processes. In some designs, particularly in poorly draining soils, an underdrain may be installed beneath the downhill side of the media filter mix bed.

### How does a media filter drain work?

Media filter drains work by dispersing concentrated runoff across a vegetated, soil amended embankment where the water is filtered through the media thereby removing pollutants.

### Typical media filter drain designs.

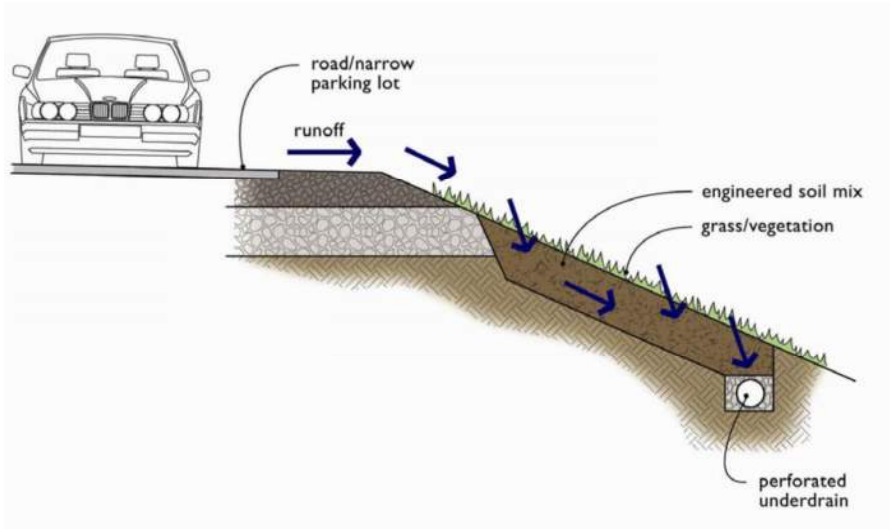
A media filter drain has four basic components: a gravel strip, a grass strip, a media filter mix, and a conveyance system. The gravel strip has no vegetation and is used to ensure the water flow is dispersed evenly. It also provides some treatment by trapping some pollutants. The grass strip, which may be amended with composted material, provides pretreatment to further enhance filtration and extend the life of the system. The runoff is then filtered through a porous, granular media bed. The underdrain, if present, then conveys the treated stormwater to a control facility, a stormwater outfall, or a desired location downstream.

Conventional designs are usually used alongside highway side slopes.

The dual media filter drains are usually used in the medians of highway.



## Media Filter Drain (Typical Section)



### Common Maintenance Considerations.

Maintenance will consist of routine roadside management. Herbicides should not be applied directly over the media filter drain. However, it may be necessary to use herbicides in areas around the media filter drain to control unwanted weeds and precautions should be taken. If the media filter drain is in a critical aquifer recharge area for drinking water supplies, the use of pesticides may be prohibited. The designer should check with the local water district or local health department.

Preventing vehicles or traffic from going on the MFD, helps minimize rutting and reduces the need for maintenance repairs.

Refer to the table below titled No. 167 – Media Filter Drain for specific maintenance standards.

## Maintenance Standards

No. 167 – Media Filter Drain			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
General	Sediment Accumulation on Grass	<ul style="list-style-type: none"> <li>Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheetflow.</li> </ul>	<ul style="list-style-type: none"> <li>Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.</li> </ul>
	Poor Vegetation Coverage	<ul style="list-style-type: none"> <li>Grass is sparse or bare or eroded patches are observed in more than 10% of the grass strip surface area.</li> </ul>	<ul style="list-style-type: none"> <li>Determine why grass growth is poor and correct that condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope:</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>Grass becomes excessively tall (greater than 10-inches); nuisance weeds and other vegetation starts to take over.</li> </ul>	<ul style="list-style-type: none"> <li>Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass should to a height of 3 to 4 inches. Remove grass clippings.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulated on embankment.</li> </ul>	<ul style="list-style-type: none"> <li>Remove trash and debris from embankment.</li> </ul>
	Erosion/Scouring	<ul style="list-style-type: none"> <li>Eroded or scoured embankment due to flow channelization, or higher flows.</li> </ul>	<ul style="list-style-type: none"> <li>For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.</li> </ul>



## 178. Filter Strips

### What Is a Filter Strip?

A filter strip, also known as vegetated filter strip, is a linear, vegetated slope below a flow spreader device or gravel-filled trench. Filter strips are typically placed adjacent and parallel to paved areas such as parking lots, driveways, and roadways. The filter strip functions similar to a biofiltration swale. Contaminated stormwater runoff is evenly distributed as sheetflow across the upper width of the strip where it slowly moves as sheetflow over the surface and through vegetation, usually grass.

### How Does a Filter Strip work?

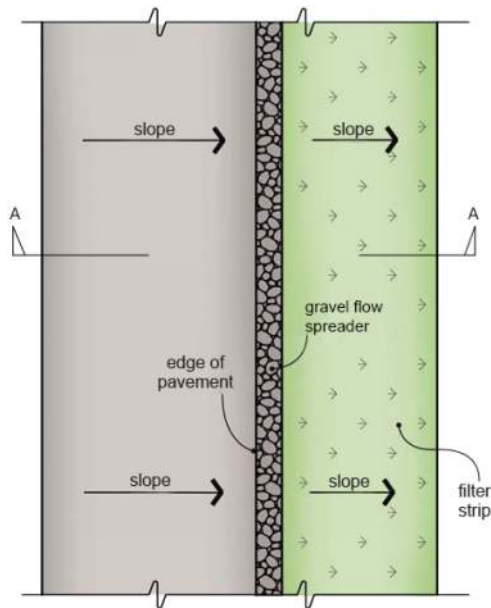
Filter strips work by evenly distributing stormwater runoff in a manner where it flows slowly and at shallow depth through vegetation removing pollutants through the combined effects of sedimentation, filtration, infiltration, settling, soil sorption, and/or plant uptake.

### Typical Filter Strip Design

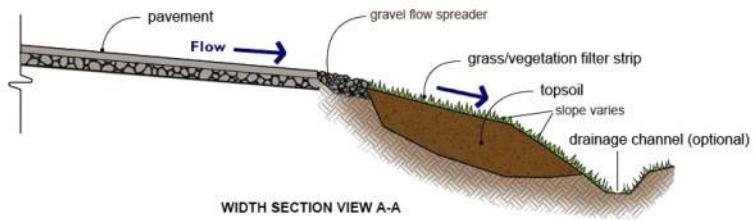
A typical filter strip consists of a flow spreader device at the top of a planted slope with a deep bed of topsoil. The topsoil supports growth and survival of the vegetation and promotes shallow infiltration. The strip is sloped in a manner that ensures the runoff is flowing as sheetflow and at a low rate.

Enhanced filter strips, otherwise known as compost-amended vegetated filter strips (CAVFS), have compost-amended soil and a level of maintenance that result in higher vegetation density which provides a level of treatment beyond a typical filter strip.

## Filter Strip



**BIRD'S-EYE VIEW**



**WIDTH SECTION VIEW A-A**

### Common Maintenance Considerations

Removing sediment at the flow spreader and maintaining even sheetflow over the filter will reduce long-term maintenance.

Site activities should protect vegetation covering and avoid compaction of the underlying soil.

The most common tools for maintenance of filter strips are mowers and hand tools to remove built up debris at the edge of the filter strip and restore evenly distributed flow across the strip.

Refer to the table below titled No. 178 – Filter Strips for specific maintenance standards.

### Maintenance Standards

No. 178 – Filter Strips			
Component	Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
General	Sediment Accumulation on Grass	<ul style="list-style-type: none"> <li>Sediment depth exceeds 2 inches</li> </ul>	<ul style="list-style-type: none"> <li>Remove sediment deposits, re-level so slope is even and flows pass evenly through strip</li> <li>Reseed any bare spots as needed in loosened, fertile soil</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>When the grass becomes excessively tall (greater than 10 inches)</li> <li>When nuisance weeds and/or other vegetation starts to take over</li> </ul>	<ul style="list-style-type: none"> <li>Mow grass, control nuisance vegetation, such that flow is not impeded</li> <li>Grass should be mowed to a height between 3-4 inches</li> </ul>
	Erosion/Scouring	<ul style="list-style-type: none"> <li>Eroded or scoured areas due to flow channelization, or higher flows</li> </ul>	<ul style="list-style-type: none"> <li>For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time.</li> <li>If bare areas are large, generally greater than 12 inches wide, the filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident</li> </ul>
	Flow spreader	<ul style="list-style-type: none"> <li>Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width</li> </ul>	<ul style="list-style-type: none"> <li>Level the spreader and clean so that flows are spread evenly over entire filter width</li> </ul>

## 1819. Sand Filters (above ground/open)

### What is a Sand Filter?

Sand filters filter stormwater through a constructed sand bed with an underdrain system. The above ground/open sand filter may consist of an open basin dug into the ground, similar to a pond with a sand bottom, or may consist of an open-topped concrete vault with a sand bottom.

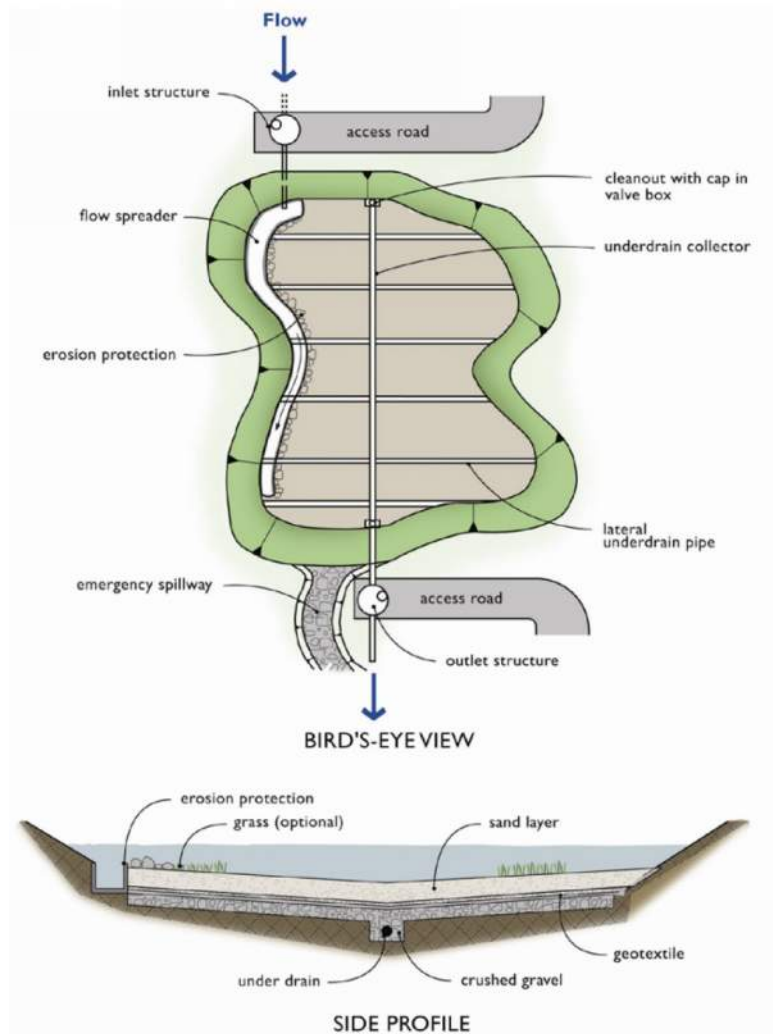
### How Do Sand Filters Work?

Stormwater runoff is filtered through the sand to remove suspended solids, phosphorus, and insoluble organics (including oils). The treated runoff is collected in the underdrain system and routed to a detention/retention facility or a downstream conveyance system.

### Typical Sand Filter Designs

A typical sand filtration system consists of a pretreatment system, flow spreader(s), sand bed, and underdrain piping. The sand filter bed includes a geotextile fabric between the sand bed and the bottom underdrain system. An impermeable liner may be constructed under the facility if the filtered runoff requires additional treatment to remove soluble ground water pollutants; or where additional ground water protection is mandated. The above ground sand filter is constructed at surface level and open to the elements. Sand filters often are required to have a pretreatment system to prevent the sand bed from becoming plugged and a level spreader to make sure the water is flowing evenly over the sand filter.

## Sand Filters (above ground/open)



### Common Maintenance Considerations

Inspections of sand filters and pretreatment systems should be conducted every 6 months and after storm events as needed during the first year of operation, and annually thereafter if the sand filter performs as designed.

Accumulated silt and debris on top of the sand filter should be scraped off during dry periods with steel rakes or other devices. Once sediment is removed, the sand medium's permeability can typically be restored. Finer sediments that have penetrated deeper into the sand medium can reduce the permeability, which may necessitate the replacement of some or all of the sand.

Water Infiltration drawdown tests could be conducted, as needed, during the wet season. These tests include allowing the sand filter to fill (or partially fill) during a storm event and then measuring the decline in water level over a 4-8 hour period. An inlet and an underdrain outlet valve is necessary to conduct such a test.

Avoid driving heavy equipment on the sand filter to prevent compaction and rut formation.

Refer to table below titled No. 18-19 – Sand Filters (above ground/open) for specific maintenance standards.

### Maintenance Standards

No. <u>18-19</u> - Sand Filters (above ground/open)			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Above Ground (open sand filter)	Sediment Accumulation on top layer	<ul style="list-style-type: none"> <li>Sediment depth exceeds 1/2 inch.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposit on top layer of sand filter that would impede permeability of the filter section.</li> </ul>
	Trash and Debris Accumulations	<ul style="list-style-type: none"> <li>Trash and debris accumulated on sand filter bed.</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris removed from sand filter bed.</li> </ul>
	Sediment/Debris in Clean-Outs	<ul style="list-style-type: none"> <li>When the clean-outs become fully or partially plugged with sediment and/or debris.</li> </ul>	<ul style="list-style-type: none"> <li>Sediment removed from clean-outs.</li> </ul>



## No. 18-19 - Sand Filters (above ground/open)

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Sand Filter Media	<ul style="list-style-type: none"> <li>Drawdown of water through the sand filter media takes longer than 24 hours, and/or flow through the overflow pipes occurs frequently.</li> </ul>	<ul style="list-style-type: none"> <li>Top several inches of sand are scraped. (mid-winter scraping suggested).</li> <li>Removal of thatch.</li> <li>Aerating the sand filter surface.</li> <li>Tilling the sand filter surface (late-summer rototilling suggested).</li> <li>Replace top 4 inches of sand medium.</li> <li>Inspect geotextiles for clogging.</li> <li>May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).</li> </ul>
	Prolonged Flows	<ul style="list-style-type: none"> <li>Rapid drawdown in the sand bed (greater than 12 inches per hour) indicating short-circuiting.</li> </ul>	<ul style="list-style-type: none"> <li>Inspect cleanouts on the underdrain pipes and along the base of the embankment for leakage.</li> </ul>
		<ul style="list-style-type: none"> <li>Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.</li> </ul>	<ul style="list-style-type: none"> <li>Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.</li> </ul>
	Short Circuiting	<ul style="list-style-type: none"> <li>When flows become concentrated over one section of the sand filter rather than dispersed.</li> </ul>	<ul style="list-style-type: none"> <li>Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.</li> </ul>
	Erosion Damage to Slopes	<ul style="list-style-type: none"> <li>Erosion over 2 inches deep where cause of damage is prevalent or potential for continued erosion is evident.</li> </ul>	<ul style="list-style-type: none"> <li>Slopes stabilized using proper erosion control measures.</li> </ul>

No. ~~18-19~~ - Sand Filters (above ground/open)

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Rock Pad Missing or Out of Place	<ul style="list-style-type: none"> <li>• Soil beneath the rock is visible.</li> </ul>	<ul style="list-style-type: none"> <li>• Rock pad replaced or rebuilt to design specifications.</li> </ul>
	Flow Spreader	<ul style="list-style-type: none"> <li>• Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.</li> </ul>	<ul style="list-style-type: none"> <li>• Spreader leveled and cleaned so that flows are spread evenly over sand filter.</li> </ul>
	Damaged Pipes	<ul style="list-style-type: none"> <li>• Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.</li> </ul>	<ul style="list-style-type: none"> <li>• Pipe repaired or replaced.</li> </ul>

## 1920. Sand Filters (below ground/enclosed)

### What is a Sand Filter?

Sand filters filter stormwater through a constructed sand bed with an underdrain system. The underground sand filter is enclosed in a vault buried beneath the ground.

### How Do Sand Filters Work?

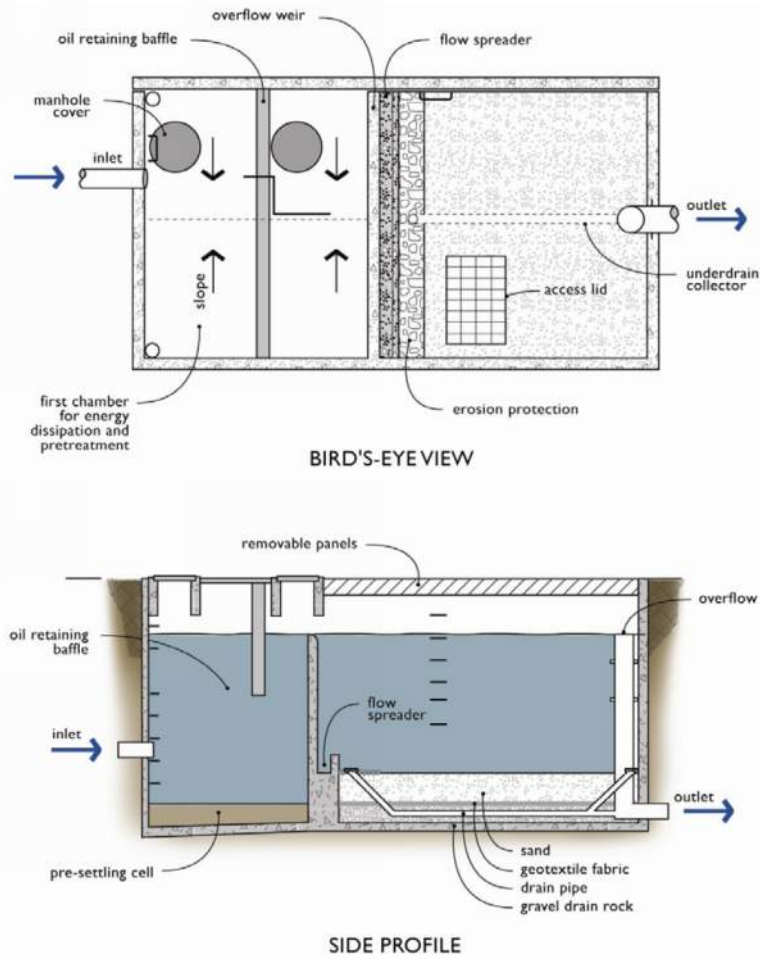
Stormwater runoff is filtered through the sand to remove suspended solids, phosphorus, and insoluble organics (including oils). The treated runoff is collected in the underdrain system and routed to a detention/retention facility or a downstream conveyance system.

### Typical Below Ground/Enclosed Sand Filter Designs

A below ground/enclosed sand filter has the components of a typical sand filtration system consisting of a pretreatment system, flow spreader(s), sand bed, and underdrain piping, but enclosed in a vault. The sand filter bed includes a geotextile fabric between the sand bed and the bottom underdrain system. An impermeable liner may be constructed under the facility if the filtered runoff requires additional treatment to remove soluble ground water pollutants; or where additional ground water protection is mandated. Below ground/enclosed sand filters are required to have a presettling cell to prevent the sand bed from becoming plugged and a level spreader to make sure the water is flowing evenly over the sand filter.

Inspections of sand filters and pretreatment systems should be conducted every 6 months and after storm events as needed during the first year of operation, and annually thereafter if the sand filter performs as designed. Repairs should be performed as necessary.

## Sand Filters (below ground/enclosed)



### Common Maintenance Considerations

Inspections of sand filters and pretreatment systems should be conducted every 6 months and after storm events as needed during the first year of operation, and annually thereafter if the sand filter performs as designed. Repairs should be performed as necessary.

Frequent overflow into the spillway or overflow structure or slow drawdown are indicators of plugging problems. A sand filter should empty in 24 hours following a storm event (24 hours for the pre-settling chamber), depending on pond depth. If the hydraulic conductivity drops to one (1) inch per hour corrective action is needed.

Water Infiltration drawdown tests could be conducted, as needed, during the wet season. These tests include allowing the sand filter to fill (or partially fill) during a storm event and then measuring the decline in water level over a 4-8 hour period. An inlet and an underdrain outlet valve is necessary to conduct such a test. Rapid drawdown in the sand bed (greater than 12 inches per hour) indicates short-circuiting of the sand filter. Inspect the cleanouts on the underdrain pipes and along the base of the embankment for leakage.

Formation of rills and gullies on the surface of the sand filter indicates improper function of the inlet flow spreader, or poor sand compaction. Check for accumulation of debris on or in the flow spreader and refill rills and gullies with sand medium. Sediments and standing water which are removed during maintenance operations must be disposed of in accordance with requirements of the Snohomish County Code and Washington State laws.

Refer to the table below titled No. [49-20](#) – Sand Filters (below ground/enclosed) for specific maintenance standards.

### Maintenance Standards

No. <a href="#">49-20</a> - Sand Filters (below ground/enclosed)			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Below Ground Vault.	Sediment Accumulation on Sand Media Section	<ul style="list-style-type: none"> <li>Sediment depth exceeds 1/2 inch.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposits on sand filter section that would impede permeability of the filter section.</li> </ul>
	Sediment Accumulation in Presettling Portion of Vault	<ul style="list-style-type: none"> <li>Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6 inches.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposits in first chamber of vault.</li> </ul>
	Trash/Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris removed from vault and inlet/outlet piping.</li> </ul>

## No. 19-20 - Sand Filters (below ground/enclosed)

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Sediment/Debris in Drain Pipes/Cleanouts	<ul style="list-style-type: none"> <li>Sediment, trash, and/or other debris material located in any inlet, outlet, or cleanout pipe is blocking more than 1/3 of its height.</li> </ul>	<ul style="list-style-type: none"> <li>Sediment and debris removed.</li> </ul>
	Short Circuiting	<ul style="list-style-type: none"> <li>When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.</li> </ul>	<ul style="list-style-type: none"> <li>Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.</li> </ul>
	Damaged Pipes	<ul style="list-style-type: none"> <li>Inlet or outlet piping damaged or broken and in need of repair.</li> </ul>	<ul style="list-style-type: none"> <li>Pipe repaired and/or replaced.</li> </ul>
	Access Hole Cover Damaged/Not Working	<ul style="list-style-type: none"> <li>One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools.</li> </ul>	<ul style="list-style-type: none"> <li>Cover can be removed and reinstalled by one maintenance person with proper hand tools.</li> </ul>
	Ventilation	<ul style="list-style-type: none"> <li>Ventilation area blocked or plugged</li> </ul>	<ul style="list-style-type: none"> <li>Blocking material removed or cleared from ventilation area. Specified % of the vault surface area provides ventilation to the vault interior (see design specifications).</li> </ul>
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or qualified maintenance or inspection personnel determine that the vault is not structurally sound.</li> </ul>	<ul style="list-style-type: none"> <li>Vault replaced or repairs made so that vault meets design specifications and is structurally sound.</li> </ul>

## No. 19-20 - Sand Filters (below ground/enclosed)

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
		<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.</li> </ul>
	Baffles/Internal walls	<ul style="list-style-type: none"> <li>Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by qualified maintenance or inspection personnel.</li> </ul>	<ul style="list-style-type: none"> <li>Baffles repaired or replaced to specifications.</li> </ul>
	Access Ladder Damaged	<ul style="list-style-type: none"> <li>Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, has cracked/broken rungs, and/or is misaligned.</li> </ul>	<ul style="list-style-type: none"> <li>Ladder replaced or repaired to specifications, and allows maintenance person safe access.</li> </ul>
	Flow Spreader	<ul style="list-style-type: none"> <li>Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.</li> </ul>	<ul style="list-style-type: none"> <li>Spreader leveled and cleaned so that flows are spread evenly over sand filter.</li> </ul>

**CAUTION:** A below ground sand filter is considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions

## 2021. Permeable Pavement

### What is Permeable Pavement?

Permeable pavement is a paving system which allows rainfall to percolate through the surface into the underlying soil or an aggregate bed, where stormwater is stored and infiltrated into the underlying soil or removed by an overflow drainage system. Common types are pervious concrete, porous asphalt, permeable interlocking concrete pavers, and aggregate pavers. Plastic or concrete grid systems are another form of permeable pavement system where the open space in the grid is filled with topsoil and grass or permeable aggregate.

Asphalt, concrete, and pavers can be used in a variety of applications including driveways, sidewalks, parking lots, walking and bike trails, and recreational areas.

### How Does Permeable Pavement Work?

Permeable pavement prevents stormwater runoff by allowing rainfall to flow through the pavement surface by means of open air-spaces. Stormwater can then infiltrate the native soil below thereby removing pollutants and reducing runoff volumes.

### Typical Permeable Pavement Design

Permeable pavement has open air-spaces either within the surface wear layer (e.g. pervious concrete and porous asphalt), in the joints between the wear layer segments (e.g. interlocking pavers and aggregate pavers), or spread throughout the surface by manufactured voids within the structural surfacing (e.g. grid systems)

Common design elements found in permeable pavement may include:

- Wearing course: the top layer used as a driving or walking surface
- Aggregate base/storage reservoir: open-graded aggregate layer beneath the wear layer intended to provide a stable surface for the wear layer and store runoff until it can be infiltrated
- Underdrain: used to direct excess water to a safe location and prevent the wear layer from being saturated

Categories of permeable paving systems include:

- Pervious concrete: a continuous, rigid surface similar to conventional concrete pavement.
- Permeable asphalt: a flexible, continuous surface similar to standard asphalt pavement.
- Permeable interlocking concrete pavers: precast, modular units in which the joints between units are filled with permeable aggregate.
- Aggregate pavers: similar to permeable interlocking concrete pavers except they are intended for pedestrian use only.
- Grid systems: grid system are made from plastic or concrete. Plastic grids tend to be manufactured in rolls or large panels whereas concrete grids are precast with large voids that usually resemble a lattice. After placement, the voids are filled with topsoil and seeded with grass or filled with permeable aggregate.



Permeable sidewalk



### Common Maintenance Considerations

The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment. Minimizing salt use or sand for de-icing and traction in the winter, keeping the landscaping areas well maintained and preventing soil from being washed onto the pavement helps increase its life. Deep cleaning is seldom needed if preventative maintenance is performed as well as some good housekeeping. A mobile sweeper should be used twice yearly, usually after the end of winter and after autumn leaf fall.

Preventative maintenance can also be done with low-cost, handheld power brooms or leaf blowers. Conditions such as tree proximity, type of pavement (pathway, parking or roadway), and traffic (foot, bicycle, vehicle) may indicate a need for more frequent or deeper cleaning, as appropriate.

Deeper cleaning may be needed if infiltration capacity is diminished. Porous asphalt and pervious concrete should then be cleaned with suction, sweeping with suction, or high-pressure washing and suction. Hand held pressure washers are suitable for smaller areas such as sidewalks. Larger areas require the use of vacuum surface cleaning machines.



Power broom (head)

The ASTM C1701 (infiltration rate) test can be performed when the facility is new and at times over the course of its lifespan. Tests performed at the same location across a period of time can be used to detect a reduction of infiltration for that permeable surface, which generally indicates there is a need for maintenance.

Avoid cutting permeable surfaces for utility installation. If necessary, small areas can be patched with conventional asphalt or concrete but this practice should be minimized as it reduces the effective infiltration area.

Refer to the table below titled No. ~~20-21~~ – Permeable Pavement for specific maintenance standards.

## Maintenance Standards

No. <del>20</del> 21 – Permeable Pavement			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>All pavement types:</b> <ul style="list-style-type: none"> <li>• Porous asphalt</li> <li>• Pervious concrete</li> <li>• Permeable pavers</li> <li>• Open-celled paving grid</li> </ul>	Unstable soil on adjacent area	<ul style="list-style-type: none"> <li>• Runoff from adjacent areas deposits soil, mulch, or sediment on permeable pavement</li> </ul>	<ul style="list-style-type: none"> <li>• Remove deposited material from pavement, and stabilize adjacent areas so that further deposition of material on pavement will not occur.</li> </ul>
	Adjacent vegetation is covering permeable pavement	<ul style="list-style-type: none"> <li>• Vegetation impedes infiltration in permeable pavement</li> </ul>	<ul style="list-style-type: none"> <li>• Trim or remove vegetation so that infiltration is not impeded</li> </ul>
	Unwanted vegetation or moss is growing in or on permeable pavement	<ul style="list-style-type: none"> <li>• Unwanted vegetation impedes infiltration in permeable pavement or displaced desired vegetation</li> </ul>	<ul style="list-style-type: none"> <li>• Remove unwanted vegetation, repair permeable pavement as needed, replace desired vegetation as needed</li> </ul>
	None (routine maintenance)	<ul style="list-style-type: none"> <li>• N/A</li> </ul>	<ul style="list-style-type: none"> <li>• Vacuum or sweep according to equipment manufacturer's specifications so that infiltration is not impeded</li> </ul>
	Debris or sediment on pavement	<ul style="list-style-type: none"> <li>• Sediment or debris deposits are visible on pavement</li> </ul>	<ul style="list-style-type: none"> <li>• Remove sediment or debris and vacuum or sweep according to equipment manufacturer's specifications so that infiltration is not impeded</li> </ul>
	Infiltration capacity is reduced	<ul style="list-style-type: none"> <li>• Water ponds on pavement or runs off pavement during rain events</li> </ul>	<ul style="list-style-type: none"> <li>• Vacuum or sweep according to equipment manufacturer's specifications so that infiltration is not impeded</li> </ul>
	Settlement	<ul style="list-style-type: none"> <li>• Settlement of pavement impedes infiltration</li> </ul>	<ul style="list-style-type: none"> <li>• Restore pavement to design grade</li> </ul>

No. ~~20-21~~ – Permeable Pavement

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Porous asphalt and pervious concrete</b>	Cracks in pavement	<ul style="list-style-type: none"> <li>Pavement spalls or ravels at crack edges</li> </ul>	<ul style="list-style-type: none"> <li>Patch or cut and replace the affected area with paving material similar to the original pavement. Replace in-kind where feasible. Porous asphalt may be replaced with conventional asphalt if it is a small percentage of the total permeable pavement area and does not impact the overall permeable pavement function.</li> </ul>
<b>Permeable pavers</b>	Paving block missing or damaged	<ul style="list-style-type: none"> <li>Paving block missing or damaged</li> </ul>	<ul style="list-style-type: none"> <li>Repair or replace missing or damaged pavers according to manufacturer's specifications</li> </ul>
<b>Open-celled paving grid</b>	Paving grid missing or damaged	<ul style="list-style-type: none"> <li>Three or more adjacent rings in paving grid missing or damaged</li> </ul>	<ul style="list-style-type: none"> <li>Repair or replace missing or damaged paving grid according to manufacturer's specifications</li> </ul>
	Loss of aggregate in paving grid	<ul style="list-style-type: none"> <li>Loss of aggregate in paving grid</li> </ul>	<ul style="list-style-type: none"> <li>Replenish aggregate material in grid to manufacturer's specifications</li> </ul>
	Poor / missing grass in vegetated paving grid	<ul style="list-style-type: none"> <li>Poor / missing grass in vegetated paving grid</li> </ul>	<ul style="list-style-type: none"> <li>Replace growing medium in grid, replant or reseed with grass</li> </ul>
<b>Pipe inlet/ outlet/ underdrain system</b>	Pipe system is blocked or damaged	<ul style="list-style-type: none"> <li>Flow does not pass as designed through pipe system</li> </ul>	<ul style="list-style-type: none"> <li>Clean or repair pipe system to restore design flow capacity</li> </ul>

## ~~21~~22. Vegetated Roofs

Note: This section was developed for “BMP T5.17: Vegetated Roofs,” which is in the 2016 Snohomish County Drainage Manual, Volume V, page 84.

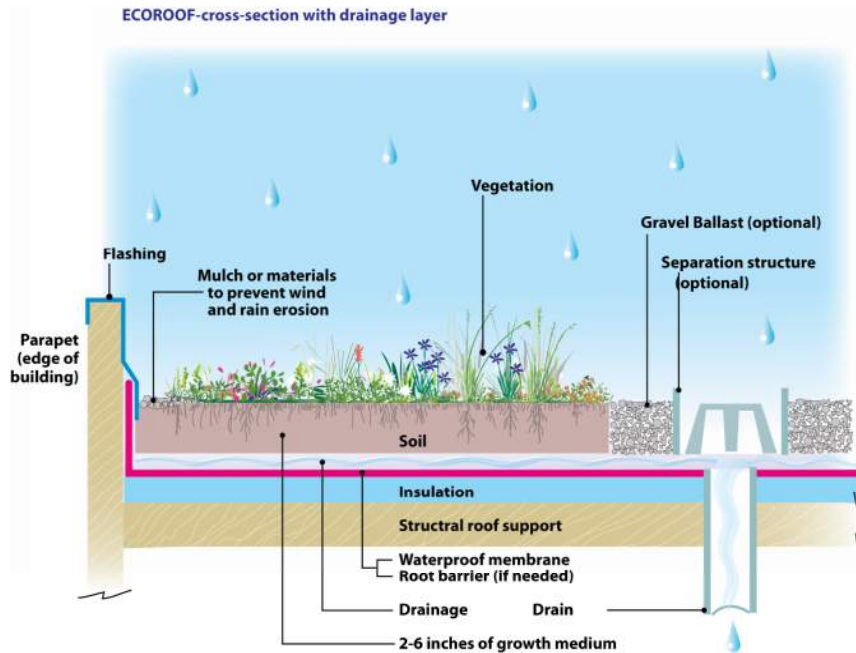
### What is a Vegetated Roof?

Vegetated roofs, also known as green roofs, are thin layers of engineered soil and vegetation constructed on top of conventional flat or sloped roofs. Vegetated roofs can provide stormwater flow control. All vegetated roofs consist of four basic components: a waterproof membrane, a drainage layer, a light-weight growth medium, and vegetation.

### How Does a Vegetated Roof work?

Vegetated roofs help provide stormwater detention through the soil media and vegetation, which also may provide some water quality benefit.

## Vegetated Roof Schematic (Ecoroof, example with drainage layer)



Source: City of Portland, Ecoroof Handbook (2009). Copyright © City of Portland, courtesy Bureau of Environmental Services. Used by permission. Note: another example of vegetated roofs, not shown here, is the Ecoroof with channels, from the same source.

## Common Maintenance Considerations

Proper maintenance and operation are essential to ensure that designed performance and benefits continue over the full life cycle of the installation.

Refer to the table below titled No. ~~21-22~~ – Vegetated Roofs for specific maintenance standards. In addition, each vegetated roof installation will have specific design, operation and maintenance guidelines provided by the manufacturer and installer.

## Maintenance Standards

No. <del>21-22</del> – Vegetated Roofs			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Structural and Drainage</b>	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Inlet pipe clogged or blocked.</li> </ul>	<ul style="list-style-type: none"> <li>Clear inlet pipes; remove soil substrate, vegetation or other debris. Free drainage of inlet pipes.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Fire ventilation blockage</li> </ul>	<ul style="list-style-type: none"> <li>Clear blockage. Fire and safety.</li> </ul>
	Trash and Debris Accumulation or disrepair	<ul style="list-style-type: none"> <li>Ingress or egress blockage.</li> </ul>	<ul style="list-style-type: none"> <li>Clear routes. Maintained to design standards.</li> </ul>
	Poorly draining pipe	<ul style="list-style-type: none"> <li>Pipe cracked or other visible defect, settlement, misalignment.</li> </ul>	<ul style="list-style-type: none"> <li>Properly align pipes, correct and recompact soils or fill surrounding pipe if needed. Free drainage of inlet pipes.</li> </ul>
	Insect management	<ul style="list-style-type: none"> <li>Ponded water which promotes insect larvae development.</li> </ul>	<ul style="list-style-type: none"> <li>Restore drainage rates with preceding drainage measures (chemical sprays should not be used). No ponded water for extended period of time.</li> </ul>
	Contaminant release	<ul style="list-style-type: none"> <li>Pet waste, chemical release or leaching.</li> </ul>	<ul style="list-style-type: none"> <li>Remove pollutants and control sources to protect water quality.</li> </ul>
<b>Vegetation and Growth Medium</b>	Invasive or nuisance plants	<ul style="list-style-type: none"> <li>Invasive or nuisance plant growth</li> </ul>	<ul style="list-style-type: none"> <li>Hand remove invasive or nuisance plants. Promote selected plant growth and survival; maintain aesthetics.</li> </ul>

No. ~~21-22~~ – Vegetated Roofs

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Dead material	<ul style="list-style-type: none"> <li>Accumulation of dead material</li> </ul>	<ul style="list-style-type: none"> <li>Recycle, remove and replace as warranted. Properly managed vegetation.</li> </ul>
	Poor vegetative health	<ul style="list-style-type: none"> <li>Poor plant growth or survival due to lack of nutrients</li> </ul>	<ul style="list-style-type: none"> <li>Fertilize as needed; apply an encapsulated, slow release fertilizer by hand. Vegetation health.</li> </ul>
	Improper use of mulch	<ul style="list-style-type: none"> <li>Over application of mulch, visible water retention and weeds.</li> </ul>	<ul style="list-style-type: none"> <li>Follow roof garden provider guidelines. Soil media maintained per design.</li> </ul>
	Over irrigation	<ul style="list-style-type: none"> <li>Weed establishment.</li> </ul>	<ul style="list-style-type: none"> <li>Irrigate only when needed for plant survival, using subsurface irrigation preferably, with drip irrigation next preferred. Vegetation health.</li> </ul>

## 2223. Media Cartridge Filters

### What are Media Cartridge Filters?

Media cartridge filters are a refillable stormwater treatment device that traps particulates and adsorbs pollutants found in stormwater runoff. The filter media can be customized to target site specific pollutants such as dissolved metals, hydrocarbons, nutrients, phosphorus, and other common pollutants found in stormwater runoff. The structures or vaults that house the cartridges can be configured in a variety of ways to accommodate a wide range of applications and water flow. Media cartridge filters are commercially available proprietary devices. Manufacturer's publications for maintenance should be followed.

### How do Media Cartridge Filters work?

Stormwater enters the filter vault through the inlet pipe. The polluted water is then drawn evenly through the filter medium efficiently and effectively treating the stormwater and removing pollutants. Once filtered through the media, the treated stormwater exits the structure to an adjacent stormwater conveyance system or natural water body.

### Typical Media Cartridge Filter designs.

Cartridges may be located inside of catch basins, manholes, or vaults. A typical design has a pretreatment bay that relies on passive mechanisms that take advantage of gravity separation as well as floating debris, rises to the surface and becomes trapped by baffles suspended in the pretreatment bay while heavy settleable solids drop to the bottom. Then the water would flow over a flowspreader into the actual media/cartridge bay. The treated water would then exit the cartridge bay through a manifold system to the outlet bay where treated water would flow out of the system.

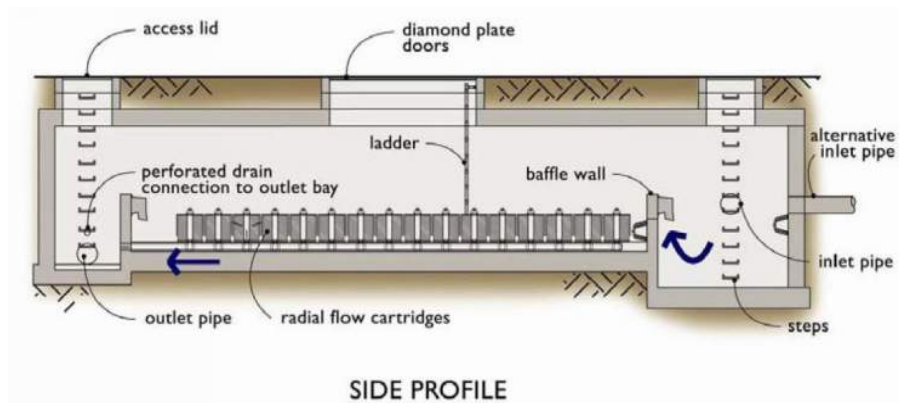
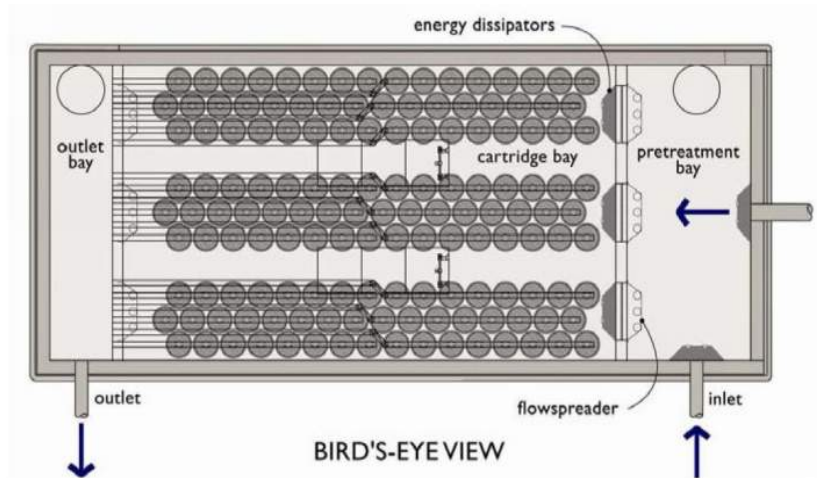


Media Cartridge Filter Vault with Accumulated Sediment

The number and size of cartridges used in media cartridge filter systems are designed to treat a specific flow rate or volume. Catch basins and manholes generally contain one to several cartridges, where vaults may contain several hundred. The media component of the cartridge is selected to remove site specific pollutants. Therefore, replacement cartridges should be of the same size, type, number, and contain the same media as those removed. Media bays and cartridge designs may vary widely by manufacturer.



## Media Cartridge Filter



### Common Maintenance Considerations

The most common tool for cleaning media cartridge filters is a vac truck (truck with a tank and vacuum hose) to remove sediment and debris from the vault.

It is recommended to check the manufacturer's operation and maintenance manual for complete maintenance instructions.

Refer to the table below titled No. ~~22~~, 23 – Media Cartridge Filters for specific maintenance standards.

### Maintenance Standards

No. <del>22</del> , <u>23</u> – Media Cartridge Filters			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>Below Ground Vault</b>	Sediment Accumulation on Top of Media Cartridge Filters	<ul style="list-style-type: none"> <li>Sediment depth exceeds 1/4 inch.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposits which would impede permeability of the media.</li> </ul>
	Sediment Accumulation in Vault	<ul style="list-style-type: none"> <li>Sediment depth exceeds 6 inches in first chamber.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposits in vault bottom of first chamber.</li> </ul>
	Trash/Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulated in vault</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris removed from the vault.</li> </ul>
	Sediment/Debris in Drain Pipes/Cleanouts	<ul style="list-style-type: none"> <li>Sediment, trash, and/or other debris material located in any inlet, outlet, or cleanout pipe is blocking more than 1/3 of its height.</li> </ul>	<ul style="list-style-type: none"> <li>Sediment and debris removed.</li> </ul>
	Damaged Pipes	<ul style="list-style-type: none"> <li>Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.</li> </ul>	<ul style="list-style-type: none"> <li>Pipe repaired and/or replaced.</li> </ul>
	Access Hole Cover Damaged/Not Working	<ul style="list-style-type: none"> <li>One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools.</li> </ul>	<ul style="list-style-type: none"> <li>Cover can be removed and reinstalled by one maintenance person with proper hand tools.</li> </ul>
	Vault Structure Includes Cracks in Wall, Bottom,	<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch or evidence of soil particles entering the structure</li> </ul>	<ul style="list-style-type: none"> <li>Vault replaced or repairs made so that vault meets design</li> </ul>

No. ~~22-23~~ – Media Cartridge Filters

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Damage to Frame and/or Top Slab	through the cracks, or qualified maintenance or inspection personnel determine that the vault is not structurally sound.	specifications and is structurally sound.
		• Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	• Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.
	Baffles	• Baffles corroding, cracking warping, and/or showing signs of failure as determined by qualified maintenance or inspection personnel.	• Baffles repaired or replaced to specifications.
	Access Ladder Damaged	• Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, has cracked/broken rungs, and/or is misaligned.	• Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Media clogged	• Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	• Media cartridges replaced.
	Flow short Circuited	• Flows do not properly enter filter cartridges.	• Filter cartridges replaced.
	<u>Media past life expectancy</u>	• <u>Filter cartridge media installed for a time period in excess of manufacturer's operation and maintenance standards</u>	• <u>Replace filter cartridges and/or media</u>

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**CAUTION:** Most filter vaults are considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.



## 2324. Hydrodynamic Separators

### What are Hydrodynamic Separators?

Hydrodynamic separators are special proprietary catch basin or vaults that use special components such as baffles, weirs, and screens to direct the flow path, attenuate water velocity, and enhance the settling of particulates and the capture of oil and other floatables.

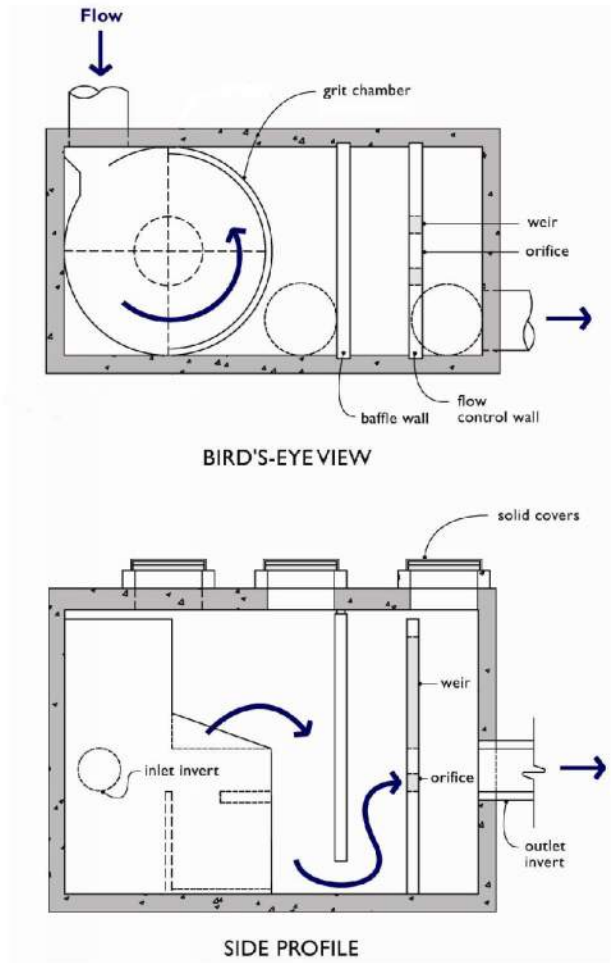
### How Hydrodynamic Separators Work?

Certain designs by certain manufacturers have received Ecology GULD approval for pretreatment. The core swirling or vortex mechanism helps concentrate and settle out sediments. Other design features may be used for other pollutant removal or stormwater benefit.

### Typical Hydrodynamic Separator Designs

The structures or vaults that house these inlets can be configured in a variety of ways to accommodate a wide range of applications and water flow. Certain designs may incorporate baffles, discharge controls, media cartridges, etc. for oil/water separation, floatables separation, flow control, etc. Manufacturer's publications for maintenance should be followed.

## Hydrodynamic Separators



### Common Maintenance Considerations

- Yearly inspection
- Vacuum removal of captured pollutants in the vault.
- Check manufacturer's operation and maintenance manual for complete maintenance instructions

Refer to the table below titled No. 23-24 – Hydrodynamic Separators for specific maintenance standards.

### Maintenance Standards

No. <u>23-24</u> – Hydrodynamic Separators			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
General	Sediment Accumulation	<ul style="list-style-type: none"> <li>• Sediment depth is within 12 through 18 inches of dry weather water surface elevation.</li> </ul>	<ul style="list-style-type: none"> <li>• Accumulated sediment should be removed.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>• Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.</li> </ul>	<ul style="list-style-type: none"> <li>• Trash and debris removed from vault, and inlet/outlet piping.</li> </ul>
	Oil Accumulation	<ul style="list-style-type: none"> <li>• Oil accumulation that exceeds 1- inch at the water surface.</li> </ul>	<ul style="list-style-type: none"> <li>• Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.</li> </ul>
Structure	Baffles	<ul style="list-style-type: none"> <li>• Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.</li> </ul>	<ul style="list-style-type: none"> <li>• Baffles repaired or replaced to specifications</li> </ul>
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	<ul style="list-style-type: none"> <li>• Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.</li> </ul>	<ul style="list-style-type: none"> <li>• Vault replaced or repairs made so that vault meets design specifications and is structurally sound.</li> </ul>

No. ~~23-24~~ – Hydrodynamic Separators

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	<ul style="list-style-type: none"> <li>Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.</li> </ul>



## 2425. API Baffle Oil/Water Separators

### What is an Oil/Water Separator?

This type of oil/water separator is a design from the American Petroleum Institute (API). An oil /water separator is an underground vault that treats stormwater by separating oil and other water-insoluble hydrocarbons from water. Oil/water separators are typically utilized in locations where high oil concentrations in stormwater runoff are anticipated (e.g. service and fuel stations). Oil/water separators are most commonly used as a pretreatment device in a series of stormwater management facilities.

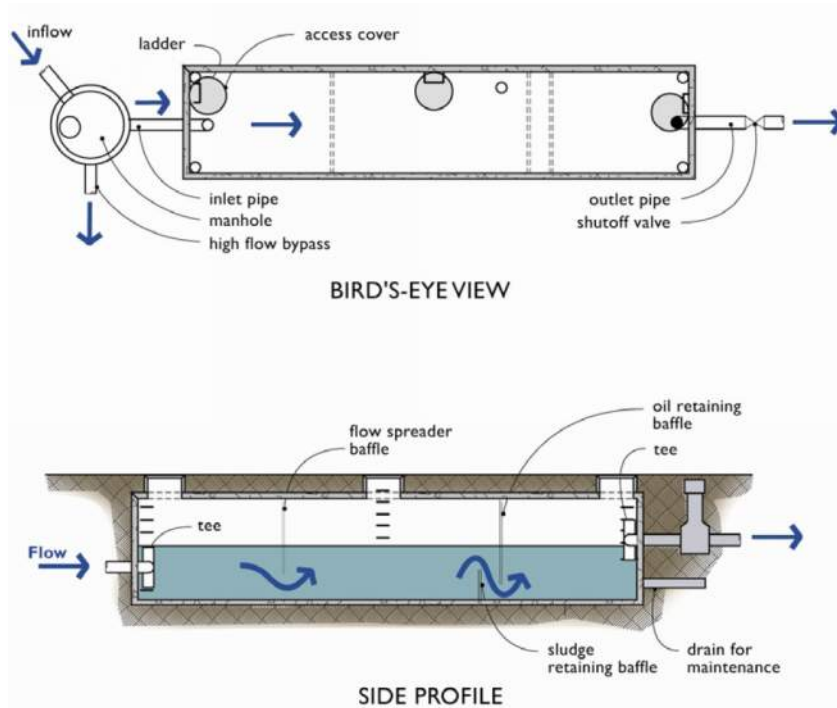
Oil-/water separators have the added benefit of separating some floatable debris and settleable solids as well.

### How does an API Oil/Water Separator work?

American Petroleum Institute (also called baffle type) oil/water separator relies on passive mechanisms that take advantage of gravity separation and the fact that oil is lighter than water. Oil, as well as floating debris, rises to the surface and becomes trapped by baffles suspended in the pool of water while heavy settleable solids drop to the bottom. The pollutants can then be periodically removed from the vault. Oil/water separators are designed to remove gross amounts of free oil and are not generally effective in separating oil that has become chemically or mechanically emulsified and dissolved in water.

As with coalescing plate separators, API separators typically have three bays: forebay, separator section, and the afterbay.

## API Oil-Water Separator (Typical)



## Common Maintenance Considerations

None.

Refer to the table below titled No. ~~24-25~~ – API Baffle Oil/Water Separators for specific maintenance standards.

## Maintenance Standards

No. <del>24-25</del> – API Baffle Oil/Water Separators			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Discharged Water Not Clean	<ul style="list-style-type: none"> <li>Water discharged from facility has obvious signs of poor water quality.</li> </ul>	<ul style="list-style-type: none"> <li>Treated stormwater discharged from vault should be clear without thick visible sheen.</li> </ul>
	Sediment Accumulation	<ul style="list-style-type: none"> <li>Sediment depth in bottom of vault exceeds 6 inches in depth.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris removed from vault, and inlet/outlet piping.</li> </ul>
	Oil Accumulation	<ul style="list-style-type: none"> <li>Oil accumulations that exceed 1 inch, at the surface of the water.</li> </ul>	<ul style="list-style-type: none"> <li>Extract oil from vault by vactoring. Disposal in accordance with state and local regulations.</li> </ul>
	Damaged Pipes	<ul style="list-style-type: none"> <li>Inlet or outlet pipes damaged or broken and in need of repair.</li> </ul>	<ul style="list-style-type: none"> <li>Pipes repaired or replaced.</li> </ul>
	Access Hole Cover Damaged/Not Working	<ul style="list-style-type: none"> <li>One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools.</li> </ul>	<ul style="list-style-type: none"> <li>Cover can be removed and reinstalled by one maintenance person with proper hand tools.</li> </ul>

No. ~~24-25~~ – API Baffle Oil/Water Separators

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or qualified maintenance or inspection personnel determine that the vault is not structurally sound.</li> </ul>	<ul style="list-style-type: none"> <li>Vault replaced or repairs made so that vault meets design specifications and is structurally sound.</li> </ul>
		<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.</li> </ul>
	Baffles	<ul style="list-style-type: none"> <li>Baffles corroding, cracking, warping and/or showing signs of failure as determined by qualified maintenance or inspection personnel.</li> </ul>	<ul style="list-style-type: none"> <li>Baffles repaired or replaced to specifications.</li> </ul>
	Access Ladder Damaged	<ul style="list-style-type: none"> <li>Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, has cracked/broken rungs, and/or is misaligned.</li> </ul>	<ul style="list-style-type: none"> <li>Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.</li> </ul>

**CAUTION:** Oil-water separators are considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.

## 2526. Coalescing Plate Oil/Water Separators

### What is an Oil/Water Separator?

An oil /water separator is an underground vault that treats stormwater by separating oil and other water-insoluble hydrocarbons from water. Oil/water separators are typically utilized in locations where high oil concentrations in stormwater runoff are anticipated (e.g. service and fuel stations). Oil/water separators are most commonly used as a pretreatment device in a series of stormwater management facilities.

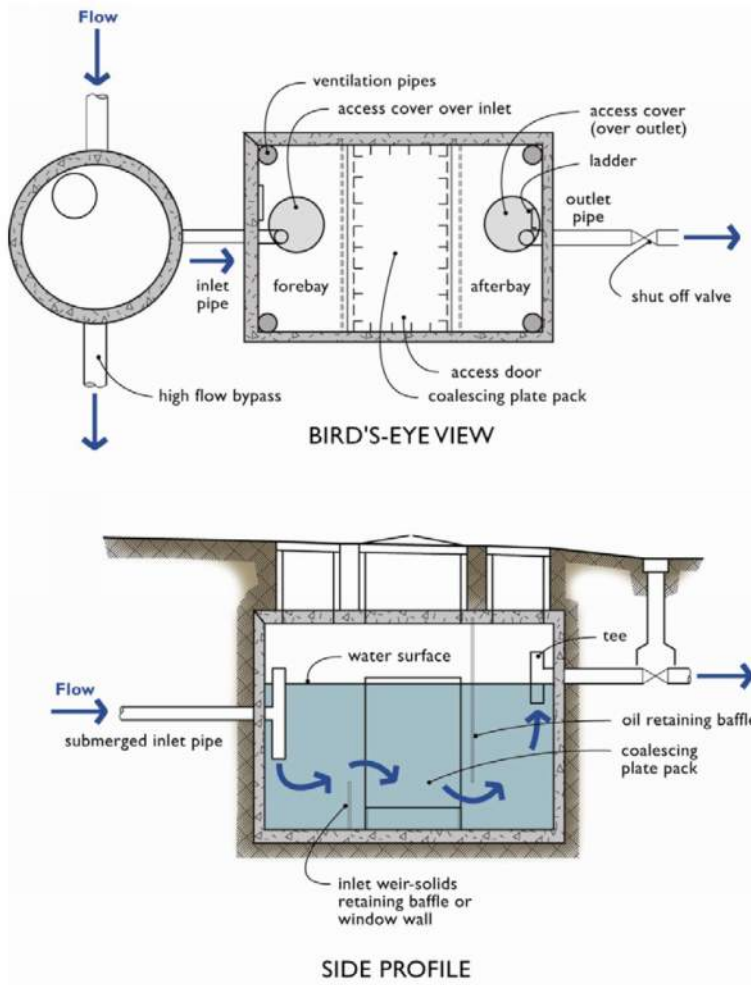
Oil / water separators have the added benefit of separating some floatable debris and settleable solids as well.

### How does an Oil/Water Separator work?

Oil/water separator relies on passive mechanisms that take advantage of gravity separation and the fact that oil is lighter than water. Oil, as well as floating debris, rises to the surface and becomes trapped by baffles suspended in the pool of water while heavy settleable solids drop to the bottom. The pollutants can then be periodically removed from the vault. Oil/water separators are designed to remove gross amounts of free oil and are not generally effective in separating oil that has become chemically or mechanically emulsified and dissolved in water.

As with API oil / water ~~seperators~~separators, the coalescing plate type separators typically have three bays: forebay, separator section, and the afterbay. However, coalescing plate separators need considerably less space for separation of the floating oil due to the shorter travel distances between the series of parallel plates.

## Coalescing Plate Oil-Water Separator (Typical)



## Common Maintenance Considerations

None.

Refer to the table below titled No. ~~25-26~~ – Coalescing Plate Oil/Water Separators for specific maintenance standards.

## Maintenance Standards

No. <del>25-26</del> – Coalescing Plate Oil/Water Separators			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Discharged Water Not Clean	<ul style="list-style-type: none"> <li>Water discharged from facility has obvious signs of poor water quality.</li> </ul>	<ul style="list-style-type: none"> <li>Treated stormwater discharged from vault should be clear with no thick visible sheen.</li> </ul>
	Sediment Accumulation	<ul style="list-style-type: none"> <li>Sediment depth in bottom of vault exceeds 6 inches in depth and/or visible signs of sediment on plates.</li> </ul>	<ul style="list-style-type: none"> <li>No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.</li> </ul>	<ul style="list-style-type: none"> <li>Trash and debris removed from vault, and inlet/outlet piping.</li> </ul>
	Oil Accumulation	<ul style="list-style-type: none"> <li>Oil accumulation that exceeds 1 inch at the water surface.</li> </ul>	<ul style="list-style-type: none"> <li>Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.</li> </ul>
	Damaged Coalescing Plates	<ul style="list-style-type: none"> <li>Plate media broken, deformed, cracked and/or showing signs of failure.</li> </ul>	<ul style="list-style-type: none"> <li>A portion of the media pack or the entire plate pack is replaced depending on severity of failure.</li> </ul>
	Damaged Pipes	<ul style="list-style-type: none"> <li>Inlet or outlet pipes damaged or broken and in need of repair.</li> </ul>	<ul style="list-style-type: none"> <li>Pipes repaired and or replaced.</li> </ul>

## No. 25-26 – Coalescing Plate Oil/Water Separators

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
	Baffles	<ul style="list-style-type: none"> <li>Baffles corroding, cracking, warping and/or showing signs of failure as determined by qualified maintenance or inspection person.</li> </ul>	<ul style="list-style-type: none"> <li>Baffles repaired or replaced to specifications.</li> </ul>
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks, or qualified maintenance or inspection personnel determine that the vault is not structurally sound.</li> </ul>	<ul style="list-style-type: none"> <li>Vault replaced or repairs made so that vault meets design specifications and is structurally sound.</li> </ul>
		<ul style="list-style-type: none"> <li>Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.</li> </ul>	<ul style="list-style-type: none"> <li>Vault repaired so that no cracks exist wider than 1/4 inch at the joint of the inlet/outlet pipe.</li> </ul>
	Access Hole Cover Damaged/Not Working	<ul style="list-style-type: none"> <li>One maintenance person cannot remove lid after applying normal lifting pressure with proper hand tools.</li> </ul>	<ul style="list-style-type: none"> <li>Cover can be removed and reinstalled by one maintenance person with proper hand tools.</li> </ul>
	Access Ladder Damaged	<ul style="list-style-type: none"> <li>Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, has cracked/broken rungs, and/or is misaligned.</li> </ul>	<ul style="list-style-type: none"> <li>Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.</li> </ul>

**CAUTION:** Oil-water separators are considered an enclosed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by individuals trained and certified to work in confined spaces under hazardous conditions.



## 2627. Catch Basin Inserts

### What is a Catch Basin Insert?

Catch basin inserts are most widely used in commercial parking areas and private residential roadway and parking areas to trap sediment and oil entering the catch basins.

### How Does a Catch Basin Insert Work?

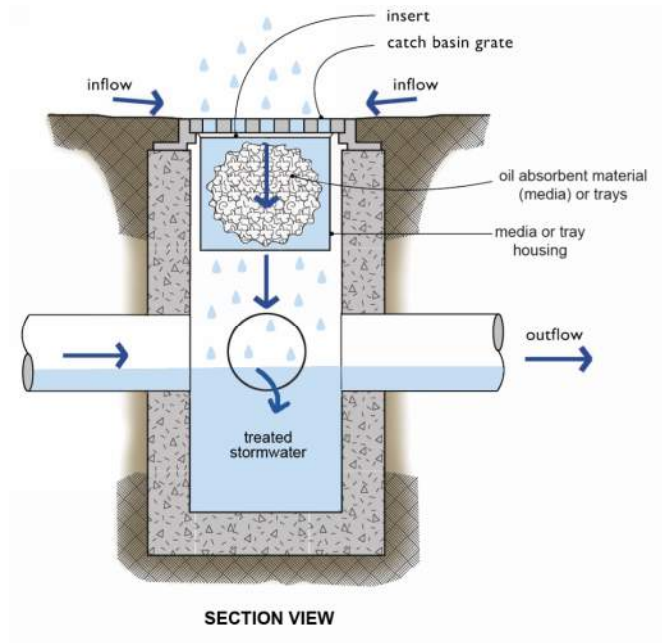
Most involve some type of filter media and oil-absorbent pads that are either attached to the basin or laid in trays/pans or some other container suspended within the basin. Some are just dropped in and float in the sump. There are a variety of metal or fiberglass pans (some with two or three levels) that function as a graduated sieve to catch different sizes of debris and sediment. These kinds of filters overflow their containers when they become clogged or when there are high storm flows.

### Typical Catch Basin Insert Designs

Most are variations on a theme of:

- Fabric bags
- Plastic or metal trays
- Plastic basins

## Catch Basin Insert



## Catch Basin Insert



Tray Catch Basin Insert



Top Tray



Bottom Tray

### Common Maintenance Considerations

- Replace fabric bags.
- Clean metal trays and replace if damaged.
- Clean plastic basins and replace if damaged.

Refer to the table below titled No. ~~26-27~~ – Catch Basin Inserts for specific maintenance standards.

### Maintenance Standards

No. <del>26-27</del> – Catch Basin Inserts			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Sediment Accumulation	<ul style="list-style-type: none"> <li>• When sediment forms a cap over the insert media of the insert and/or unit.</li> </ul>	<ul style="list-style-type: none"> <li>• No sediment cap on the insert media and its unit.</li> </ul>
	Trash and Debris Accumulation	<ul style="list-style-type: none"> <li>• Trash and debris accumulates on insert unit creating a blockage/restriction.</li> </ul>	<ul style="list-style-type: none"> <li>• Trash and debris removed from insert unit. Runoff freely flows into catch basin.</li> </ul>
	Media Insert Not Removing Oil	<ul style="list-style-type: none"> <li>• Stormwater discharge from media insert has a visible sheen.</li> </ul>	<ul style="list-style-type: none"> <li>• Stormwater discharge from media insert is free of oils and has no visible sheen.</li> </ul>
	Media Insert Water Saturated	<ul style="list-style-type: none"> <li>• Catch basin insert is saturated with water and no longer has the capacity to absorb.</li> </ul>	<ul style="list-style-type: none"> <li>• Remove and replace media insert</li> </ul>
	Media Insert-Oil Saturated	<ul style="list-style-type: none"> <li>• Media oil saturated due to petroleum spill that drains into catch basin.</li> </ul>	<ul style="list-style-type: none"> <li>• Remove and replace media insert.</li> </ul>
	Media Insert Use Beyond Normal Product Life	<ul style="list-style-type: none"> <li>• Media has been used beyond the typical average life of media insert product.</li> </ul>	<ul style="list-style-type: none"> <li>• Remove and replace media at regular intervals, depending on insert product.</li> </ul>

## 2728. Access Gates and Fencing

### Stormwater Facility Secure Gate Access

Six-foot-high galvanized chain-link security fencing and maintenance access gates are frequently required by Snohomish County Code.

- For reasons of:
  - safety to prevent injury, and
  - security to prevent malicious damage that may impair the function of a facility.
- To enclose stormwater facilities that are either:
  - a steep sloped open stormwater detention/retention pond/swale, or
  - a concrete vault with tall exposed walls from the top of the vault lid (creating a ledge) to ground level.

## Access Gates and Fencing



6' high black vinyl coated chain-link fence along perimeter of a detention pond



6' high black vinyl coated chain-link fence attached to inside face of concrete wall of water quality pond



6' high galvanized chain-link fence with posts set in top of water quality pond perimeter wall



6' high galvanized chain-link fence with posts set in top of water quality pond access road wall



6' high x 8' wide galvanized chain-link double hung gate



6' high x 8' wide galvanized chain-link double hung gate

### Common Maintenance Considerations

Access is necessary for operation and maintenance of a properly functioning stormwater facility. However, a stormwater facility is considered an “attractive nuisance,” and should be properly secured to limited any unauthorized users. Over time, trees can fall on fences and gates, soil can erode away from post holes, vandals may cut the wires, or tree limbs or roots may compromise or cause breaks in fencing. These types of issues should be identified and addressed promptly.

Refer to the table below titled No. 27-28 – Access Gates and Fencing for specific maintenance standards.

### Maintenance Standards

No. 27-28 – Access Gates and Fencing			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Gates	Damaged or missing components	• Gate and/or locking mechanism condition is such that access is impeded.	• Gate and locking mechanism are fully functional for access purposes.
		• Broken or missing hinges such that gate cannot be easily opened and closed by a maintenance person.	• Hinges intact and lubed. Gate is working freely.
		• Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	• Gate is aligned and vertical (plumb).
		• Missing stretcher bands, and ties.	• Stretcher bar, bands, and ties in place.
Fences	Erosion	• Erosion has resulted in an opening under a fence that allows entry to people or pets.	• Replace soil under fence so that no opening exceeds 4 inches in height.
	Damaged parts	• Posts out of plumb more than 6 inches.	• Post plumb to within 1-1/2 inches of plumb.
		• Top rails bent more than 6 inches.	• Top rail free of bends greater than 1 inch.

No. ~~27-28~~ – Access Gates and Fencing

Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
		<ul style="list-style-type: none"> <li>Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.</li> </ul>	<ul style="list-style-type: none"> <li>Fence is aligned and meets design standards.</li> </ul>
		<ul style="list-style-type: none"> <li>Missing or loose tension wire.</li> </ul>	<ul style="list-style-type: none"> <li>Tension wire in place and holding fabric.</li> </ul>
		<ul style="list-style-type: none"> <li>Missing or loose barbed wire that is sagging more than 2-1/2 inches between posts.</li> </ul>	<ul style="list-style-type: none"> <li>Barbed wire in place with less than ¾ inch sag between posts.</li> </ul>
		<ul style="list-style-type: none"> <li>Extension arm missing, broken, or bent out of shape more than 1-1/2 inches.</li> </ul>	<ul style="list-style-type: none"> <li>Extension arm in place with no bends larger than 3/4 inch.</li> </ul>



## 2829. Access Roads

### Stormwater Facility Access Roads

Many stormwater facilities have access roads to and into the facility. The roads need to be maintained so that maintenance vehicles and heavy equipment have an unobstructed path to any area needing maintenance or repair.

Most pond-type facilities have roads (more like driveways) extending from the street to the top rim of the pond. In addition many have roads that continue on top of a pond berm along the entire perimeter or only so far as the location of the flow control structure. Some ponds have roads that go down into the pond itself so that heavy excavation equipment and dump trucks can have easier access in and out of deep ponds. Most of the access roads in urban areas are asphalt and most in rural areas are gravel. They should be maintained for ease of inspection and ease of maintenance equipment access.

### Common Maintenance Considerations

Access is necessary for operation and maintenance of a properly functioning stormwater facility. Consider the follow actions:

- Remove leaves and debris from asphalt access roads.
- Repair asphalt as needed to keep access open.
- Remove all vegetation within the gravel access roads that limits access to the facility.
- Replace rock and repair any erosion or damage to gravel access road.

Refer to the table below titled No. ~~28-29~~ – Access Roads for specific maintenance standards.

## Maintenance Standards

No. <del>28-29</del> – Access Roads			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
<b>General</b>	Road Surface	<ul style="list-style-type: none"> <li>Condition of road surface may lead to erosion of the facility or limit access.</li> </ul>	<ul style="list-style-type: none"> <li>Road repaired.</li> </ul>
	Erosion of Ground Surface	<ul style="list-style-type: none"> <li>Noticeable rills are seen in landscaped areas.</li> </ul>	<ul style="list-style-type: none"> <li>Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded. If needed, regrade affected areas.</li> </ul>
	Vegetation	<ul style="list-style-type: none"> <li>Function of road is impaired by vegetation.</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation is removed or managed to restore proper function of facility.</li> <li>Use of herbicides shall be in accordance with applicable regulations.</li> </ul>
	Tree Growth	<ul style="list-style-type: none"> <li>Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove.</li> </ul>	<ul style="list-style-type: none"> <li>Trees do not hinder maintenance activities.</li> </ul>
		<ul style="list-style-type: none"> <li>Trees or shrubs that have fallen over road.</li> </ul>	<ul style="list-style-type: none"> <li>Fallen trees or shrubs removed from road.</li> </ul>

## 30. Light Rail Elevated Guideway Runoff Dispersion Systems

### Light Rail Elevated Guideways

Specific structural BMPs are required along Light Rail guideways in order to disperse runoff in areas with underlying permeable surfaces. Dispersal devices are mounted to the elevated guideway to intercept and disperse the runoff, preventing concentrated discharge points. Dispersion areas are vegetated areas below the guideway that allow runoff to infiltrate into the surrounding soil. See BMP T5.31 in Volume V of this manual for more information.

### Common Maintenance Considerations

The dispersal device should be checked to ensure that it is securely mounted and free of debris. Dispersion areas should be checked for signs of erosion or invasive plant species. If the dispersion area is to be planted, plantings should be monitored for viability during the first 2-3 years to ensure they establish.

Refer to the table below titled No. 30 – Light Rail Elevated Guideway BMPs for specific maintenance standards.

## Maintenance Standards

No. 30 – Light Rail Elevated Guideway Runoff Dispersion Systems			
Component	Potential Defect	Condition When Maintenance is Needed	Maintenance Action and Expected Results
Dispersal device	Broken or loose	<ul style="list-style-type: none"> <li>Any section of the dispersal rail is missing, damaged, or attached loosely</li> </ul>	<ul style="list-style-type: none"> <li>Damaged sections should be replaced and/or mounted securely to ensure proper dispersal function.</li> </ul>
	Debris	<ul style="list-style-type: none"> <li>Any debris in the dispersal device that reduces the dispersion function</li> </ul>	<ul style="list-style-type: none"> <li>Remove debris to ensure full function.</li> </ul>
Dispersion Area	Soil Erosion	<ul style="list-style-type: none"> <li>Visible disturbance of soil due to concentrated runoff from guideway</li> </ul>	<ul style="list-style-type: none"> <li>Check the dispersal device for damage, debris, or other failure that creates a concentrated discharge. Repair as necessary.</li> <li>Assess the vegetation to determine if insufficient canopy is contributing to erosion. If necessary, additional plantings shall be added to create a dense leaf canopy.</li> </ul>
	Dead/dying plants	<ul style="list-style-type: none"> <li>Vegetation failing to establish dense leaf canopy</li> </ul>	<ul style="list-style-type: none"> <li>Newly planted vegetation may require a temporary watering system in order to fully establish.</li> <li>If established plantings do not adequately protect the soil from the direct path of water from the dispersal device, additional plantings shall be added to create a dense leaf canopy.</li> </ul>
	Invasive or nuisance plants	<ul style="list-style-type: none"> <li>Invasive or nuisance plants inhibiting growth of the native or planted vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Remove undesired plants regularly until native or prescribed plants sufficiently establish a leaf canopy that inhibits new weed growth.</li> </ul>

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## ~~Appendix A~~

### ~~Snohomish County Drainage Manual Volume V, Chapter 4.6, “Maintenance Requirements for Stormwater”~~

~~For convenient reference, Appendix A will provide a verbatim copy of Chapter 4.6 of the Snohomish County Drainage Manual, Volume V, when revisions and updates to the Drainage Manual are adopted, anticipated by July 2021.~~