Stormwater Facility Descriptions and Maintenance Checklists

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Catch Basins, Manholes, and Grate Inlets

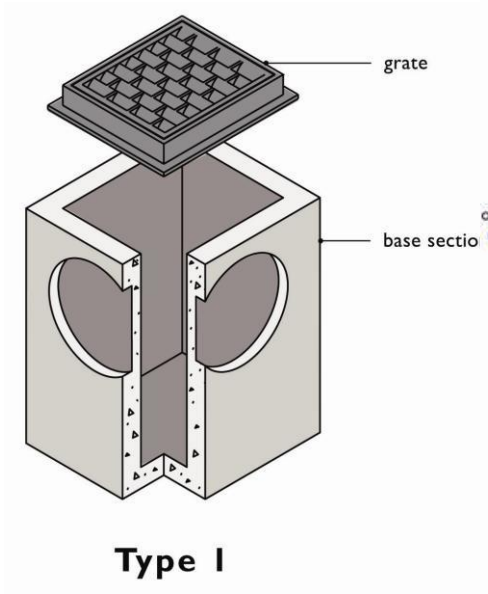
Catch basins are underground concrete structures typically provided with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two catch basin types.

A Type 1 catch basin is a rectangular box with approximate dimensions of 3‟x2‟x5‟. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the gate to the bottom of the pipe is less than 5 feet.

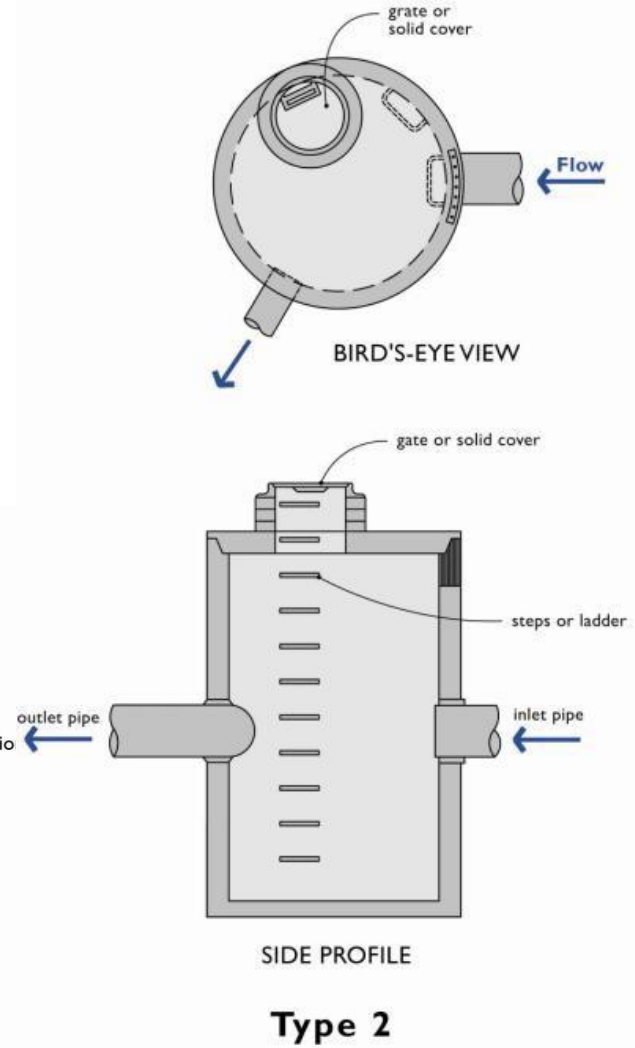
Type 2 catch basins, also commonly referred to as storm manholes, are round concrete structures ranging in diameter of 4 feet to 8 feet. Type 2 catch basins typically have manhole steps mounted on the side of the structure to allow for access. Type 2 catch basins or manholes can have either a solid access cover or a slotted grate inlet similar to a Type I catch basin.

Both catch basin types typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also provided with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils within the basin.

The most common cleaning method for catch basins is to utilize a truck with a tank and vacuum hose (vactor truck) to remove sediment and debris from the sump. Catch basins may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual with training and certification in working in hazardous confined spaces.



Type I



Type 2

Catch Basins, Manholes, and Grate Inlets

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Cleaning				
Standing water	As needed	Standing water present during maintenance activities.	Yes No	Remove/dispose with other material in accordance with state and federal regulations. Do not pump to downstream stormwater system.
Trash, debris, sediment, vegetation	A2	Accumulated material within 6 inches of the bottom of the lowest pipe entering or exiting the structure or filling greater than 60 percent of the sump depth.	Yes No	Remove/dispose in accordance with state and federal regulations.
	A	Sediment, debris, or vegetation blocking 1/3 the diameter of any pipe.	Yes No	Remove/dispose in accordance with state and federal regulations.
	B, W, E	Vegetation/debris blocking 10 percent or more of inlet grate capacity.	Yes No	Clean and dispose of material
	A	Dead animals or vegetation that could generate odors and cause complaints or dangerous gases (e.g., methane).	Yes No	Remove/dispose
Pollution	A2, E	Any visible accumulation of oil, gas, paint, or other contaminant (includes concrete debris or slurry).	Yes No	Remove/dispose in accordance with state and federal regulations. If possible, identify and control source
Structure				
Frame and/or top slab	A	Corner extends more than 0.75 inches past curb face or street surface (where applicable).	Yes No	Repair so frame even with curb
	A	Holes greater than 2 inches or cracks greater than 0.25 inches in top slab.	Yes No	Repair to water tight condition
	A	Frame not flush with top slab (separation >0.75 inches) or not securely attached.	Yes No	Repair

Catch Basins, Manholes, and Grate Inlets

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Catch Basin structure	A	Cracks wider than 0.5 inches and longer than 1 foot, missing bricks, evidence of water of soil entering, or judged to be structurally unsound by maintenance personnel.	Yes No	Repair; Grout where feasible; Catch basin may require replacement where found to be structurally unsound
	A	Cracks wider than 0.5 inches and longer than 1 foot at pipe inlet/outlet.	Yes No	Regrout and reseal pipe at basin wall
Cover/Grate Inlet	A	Cover/grate missing, damaged, or only partially in place.	Yes No	Repair/replace
	A	Grate openings are wider than 7/8 inch.	Yes No	Replace
	A	Cannot be opened by one person. Locking bolts missing, damaged, or have less than ½ inch of thread.	Yes No	Repair/replace
	A	Buried.	Yes No	Expose and restore to surface grade
Ladder	A	Ladder rungs damaged, missing, or misaligned.	Yes No	Repair/replace

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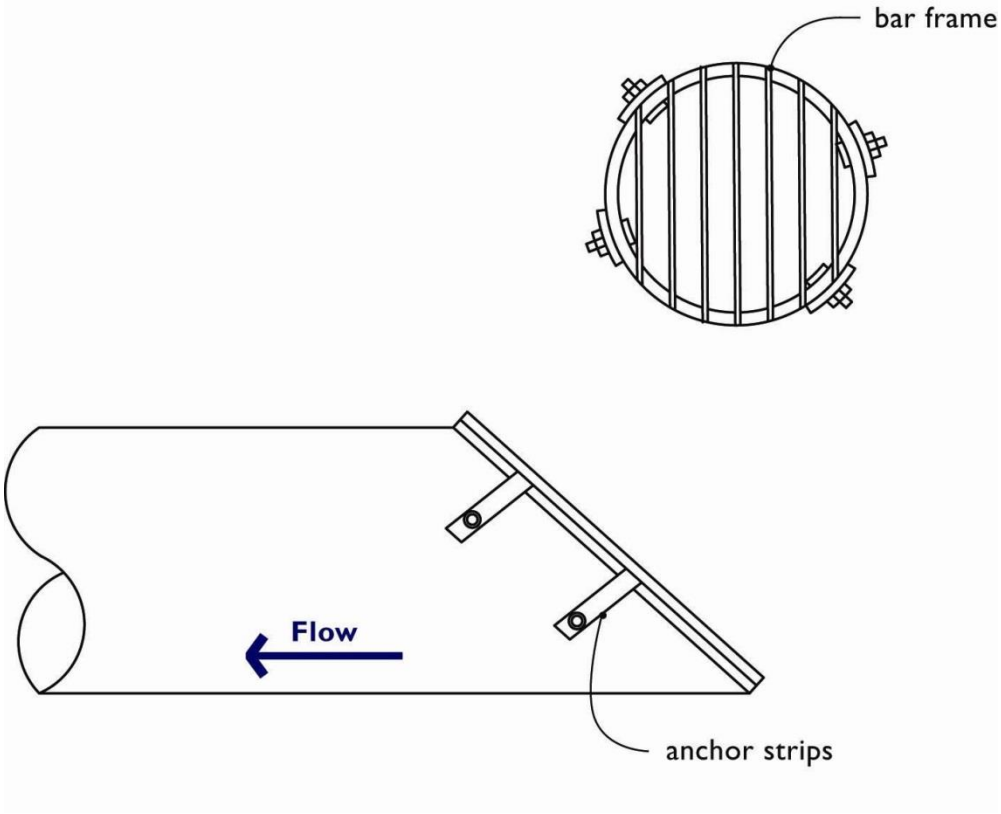
W = Recommend that at least one inspection occur during the wet season, preferably after trees have lost their leaves;
E = Recommend that additional inspections be performed as appropriate after major events (e.g., >1 inch of precipitation in 24 hours or environmental incident which causes contaminant release).

[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

Debris Barriers (e.g. Trash Racks)

Debris barriers consist of bar grates over the open end of a culvert or conveyance pipe. The intent of a debris barrier is to prevent large materials from entering a closed pipe system. Debris barriers are typically located on the outlet pipe from a detention pond to the control structure. If a debris barrier is not located on the outlet pipe, one should be provided to prevent plugging of the control structure and possible flooding.

Access barriers are similar to debris barriers but are included on all pipe ends that exceed 18 inches in diameter. Their function is to prevent debris and unauthorized access into the storm conveyance pipe. Removing debris and maintenance to the debris barrier when there is flow through the conveyance pipe should be performed by qualified personnel only. Ideally, inspection of debris barriers should occur during summer and autumn months when there are minimal or no flows through the pipe.



Debris Barriers (e.g. Trash Racks)

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Trash and Debris	B, W	Trash or debris that is plugging more than 20% of the openings in the barrier.	Yes No	Safely remove debris from rack inlet.
Metal	A2	Bars are bent out of shape more than 3 inches.	Yes No	Bar repair with no bends more than 3/4 inch.
	A	Bars are missing or entire barrier missing.	Yes No	Replace bars or supply replacement barrier.
	B, W, E	Bars are loose and rust is causing 50% deterioration to any part of barrier.	Yes No	Barrier replaced or repaired to design standards.
	A	Debris barrier missing or not attached to pipe	Yes No	Barrier firmly attached to pipe

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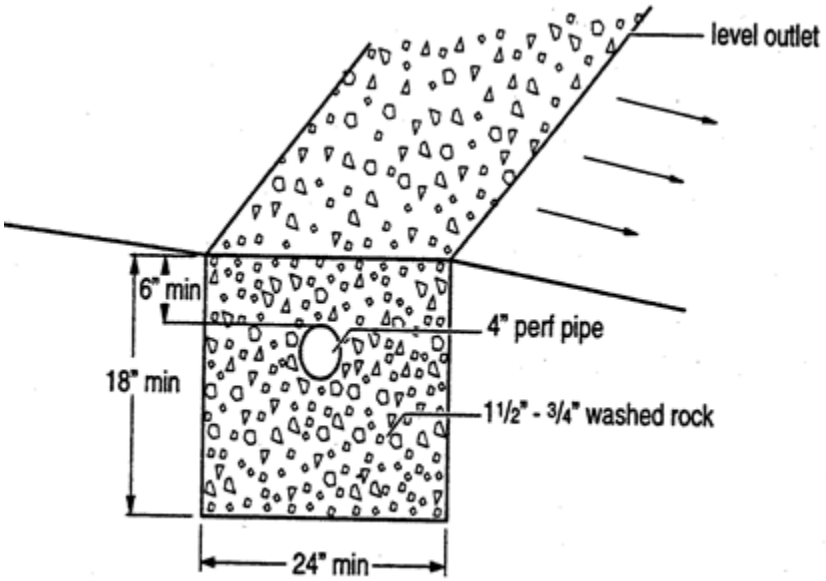
Energy Dissipaters

Energy dissipaters are provided on the inlet and outlet to a closed pipe system to prevent erosion at these locations. Design of an energy dissipater can vary significantly from highly engineered systems (concrete or rock gabion structures) to the more commonly used rock pad.

The rock pad is typically constructed of 4- to 12-inch diameter rocks a minimum of 12 inches thick and is often lined with filter fabric. The rock pad should extend above the top of the pipe a minimum of 1 foot. Rock pad type energy dissipaters typically extend at least 5 to 10 feet beyond the outfall of a pipe. The actual size of the rock pad depends on the amount and velocity of water leaving the pipe.

Dispersion trenches are a special type of dissipater that includes a trench filled with drain rock and sometimes a weir board. The goal of a dispersion trench is to spread flows over a wide area to eliminate erosion impacts or to more closely mimic natural stormwater flow conditions.

Gravel Flow Dispersion Trench



Energy Dissipaters

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
External:				
Rock Pad				
Missing or Moved Rock	A	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Yes No	Rock pad replaced to design standards.
Erosion	A, E	Soil erosion in or adjacent to rock pad.	Yes No	Rock pad replaced to design standards.
Dispersion Trench				
Pipe Plugged with Sediment	A	Accumulated sediment that exceeds 20% of the design depth.	Yes No	Pipe cleaned/flushed so that it matches design.
Not Discharging Water Properly	A, E	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.	Yes No	Trench redesigned or rebuilt to standards.
Perforations Plugged.	A	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Yes No	Perforated pipe cleaned or replaced.
Water Flows Out Top of "Distributor" Catch Basin.	A, E	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Yes No	Facility rebuilt or redesigned to standards.
Receiving Area Over-Saturated	A, E	Water in receiving area is causing or has potential of causing landslide problems.	Yes No	No danger of landslides.

Energy Dissipaters

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Internal:				
Manhole/Chamber				
Worn or Damaged Post, Baffles, Side of Chamber	A	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Yes No	Structure replaced to design standards.

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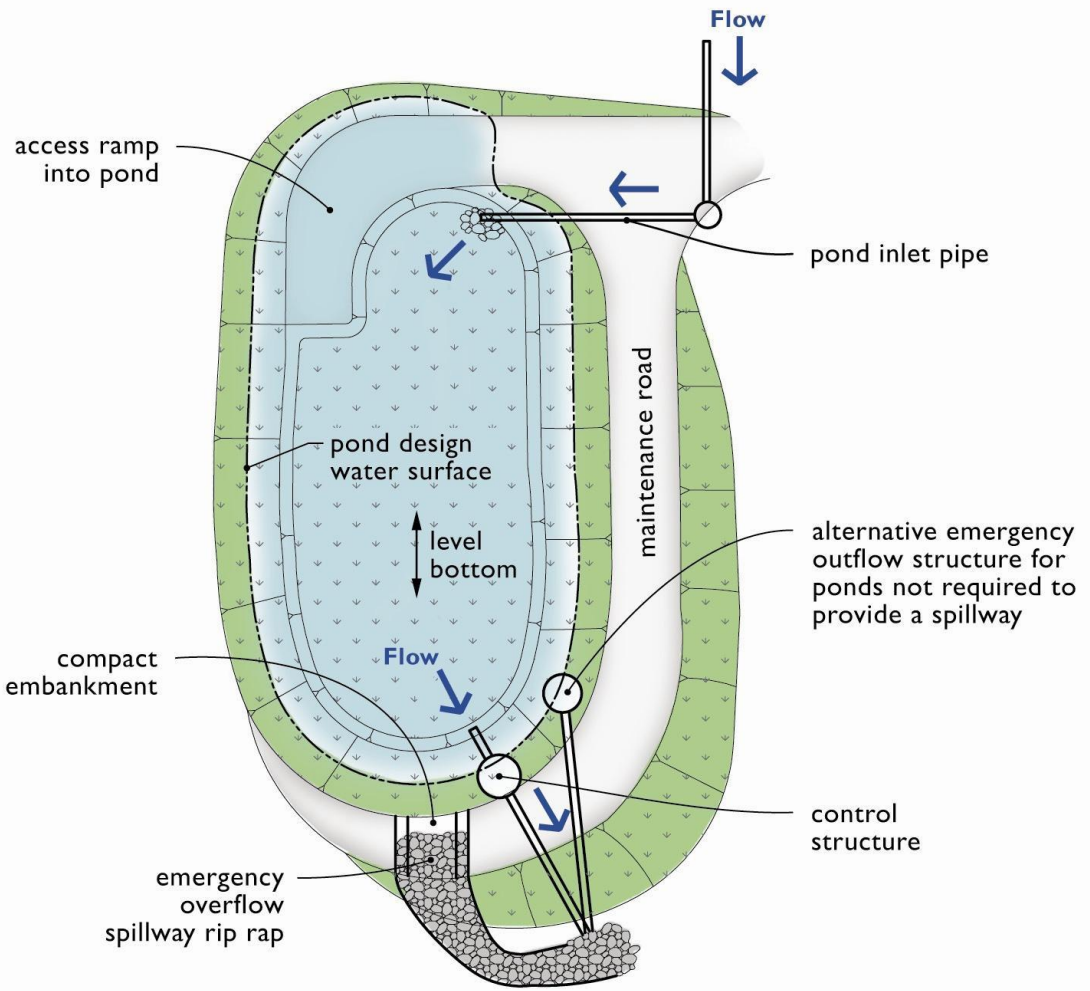
[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

Detention Ponds

Stormwater detention ponds are open basins built by excavating below existing ground or by constructing above-ground berms (embankments). The detention pond temporarily stores excess stormwater runoff during rain events and slowly releases it through an outlet (flow control structure). Detention ponds are typically designed to drain out completely within 24-48 hours after a storm event. Detention ponds are specially designed to hold a specific volume of water based on the land area draining to it. Changes or reductions to the volume or holding capacity of a pond can cause pond failure, flooding, and property damage.

Components that are typically associated with a detention pond include the following: inlet pipes, manhole or catch basin structures, a flow control structure/flow restrictor, debris barrier (e.g. trash rack), energy dissipaters, maintenance access road, and fence. These items are covered by separate checklists.

Management of vegetation is of special concern when inspecting and maintaining detention ponds. Some vegetation in your pond may provide aesthetic landscape and screening function, or have erosion control benefits. At a minimum, vegetation should be managed to ensure the flood control functionality of your detention pond remains intact.



Detention Ponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Trash & Debris	B, W, E	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Yes No	Trash and debris cleared from site.
Poisonous Vegetation and noxious weeds	A2	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	Yes No	Clear danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with City of Olympia Water Resources) Complete eradication of noxious weeds may not be possible. Compliance with State or City eradication policies required
Contaminants and Pollution	B, E	Any evidence of oil, gasoline, contaminants or other pollutants	Yes No	Clean up contaminants or pollutants. (Coordinate removal/cleanup with City of Olympia Water Resources).
Rodent Holes	B	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Yes No	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
Beaver Dams	B	Dam results in change or function of the facility.	Yes No	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies).
Insects	A	When insects such as wasps and hornets interfere with maintenance activities.	Yes No	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.

Detention Ponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Vegetation, Tree Growth, and Hazard Trees	A, D	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.	Yes No	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).
	A, D	If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements).	Yes No	Remove Hazard Trees in accordance with the City of Olympia Urban Forestry Manual.
	A, D	Significant amounts of dead or dying vegetation in pond area. Decomposing vegetation releases nutrient pollutants.	Yes No	Remove excess or dead vegetation.
Side Slopes of Pond and Storage Area				
Erosion	B, E	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Yes No	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
	B, E	Any erosion observed on a compacted berm embankment.	Yes No	If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Sediment	A[2], D	Accumulated sediment that exceeds 10% (typically 6" to 12") of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Yes No	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
Liner (If Applicable)	A, D	Liner in pond bottom is visible and has more than three 1/4-inch holes in it.	Yes No	Repair or replace liner; Completely cover liner with soil/vegetation per design.

Detention Ponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Pond Berms/Dikes				
Settlements	B, W, E	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Yes No	Dike is built back up to the design elevation.
Piping/Seepage	B, W, E	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Yes No	Piping or seepage eliminated. Erosion potential resolved. Resolution may require reconstruction of the berm at the direction of a geotechnical engineer.
Emergency Overflow Spillway or Outlet				
Vegetation or Tree Growth	A	Vegetation or tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Yes No	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. A licensed civil engineer should be consulted for proper berm/spillway restoration.
Spillway Surface	A	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 out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Yes No	Rocks and pad depth are restored to design standards.

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D = Inspection and Maintenance of facility should occur during dry weather (summer/early fall) prior to rainy season.

[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

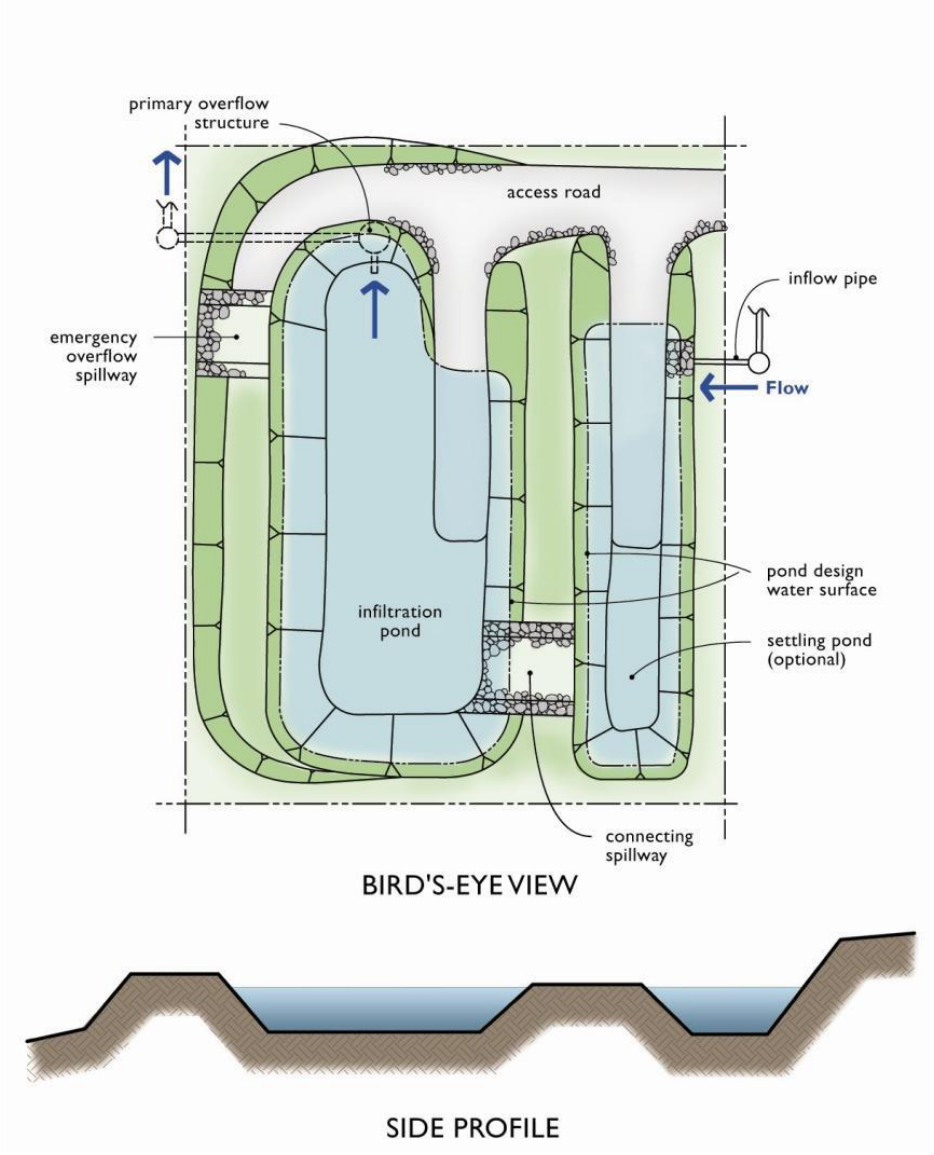
Infiltration Ponds

Stormwater infiltration ponds are open basins built by excavating below existing ground or by constructing above-ground berms (embankments). An infiltration pond temporarily stores excess stormwater runoff during rain events, but unlike the detention pond, the infiltration pond does not discharge to a downstream conveyance system or nearby surface water. Instead, the infiltration pond relies on the ability of the site soils to absorb and infiltrate the stormwater into the ground.

Components that are typically associated with an infiltration pond include the following: energy dissipaters, access road, and fence. In cases where a pond cannot infiltrate all stormwater onsite, a flow control structure may be provided to meter the release of stormwater offsite like a detention pond.

Infiltration ponds are typically designed to drain out completely within 24-48 hours after a storm event. Infiltration ponds are specially designed to hold a specific volume of water based on the land area draining to it and the rate at which the site soils are able to infiltrate water to the ground. Changes or reductions to the volume or holding capacity of a pond can cause pond failure, flooding, and property damage.

Management of vegetation is of special concern when inspecting and maintaining infiltration ponds. Some vegetation in your pond may provide aesthetic landscape and screening function, or have erosion control benefits. At a minimum, vegetation should be managed to ensure the flood control functionality of your infiltration pond remains intact. Because stormwater leaves an infiltration pond by infiltrating downward into the native soils, protection of the infiltrative surface soils at the pond bottom is critical. Too much sediment in the pond or soil consolidation can slow the rate at which stormwater can infiltrate and possibly cause failure of your storm pond.



Infiltration Ponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Trash & Debris	B, W, E	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Yes No	Trash and debris cleared from site.
Poisonous Vegetation and noxious weeds	A[2]	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	Yes No	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required. ***Use of herbicides and pesticides is prohibited in groundwater protection areas.***
Trees and other Vegetation	A, D	Trees or vegetation exists to a point that the infiltration pond does not drain out within 48 hours or that the storage volume of the pond has reduced by presence of vegetation.	Yes No	Remove vegetation as necessary to restore storage volume and function.
Contaminants and Pollution	B, E	Any evidence of oil, gasoline, contaminants or other pollutants	Yes No	No contaminants or pollutants present. (Coordinate removal/cleanup with local water quality response agency).
Rodent Holes	B	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Yes No	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
Insects	A	When insects such as wasps and hornets interfere with maintenance activities.	Yes No	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.

Infiltration Ponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Tree Growth and Hazard Trees	A, D	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.	Yes No	Remove trees where they do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).
	A, D	If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Yes No	Remove hazard Trees
Side Slopes of Pond and Storage Area				
Erosion	B, E	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Yes No	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
	B, E	Any erosion observed on a compacted berm embankment.	Yes No	If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Sediment	A[2], E, D	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Yes No	Sediment is removed and/or facility is cleaned so that infiltration system works according to design. Infiltration testing verification may be necessary after major reconstructive maintenance.
Pre-settling Ponds and Vaults	B, W, E	Facility or sump filled with sediment or debris. Removed at 6" depth, or the design depth of sediment trap.	Yes No	Remove sediment to design depth/bottom of facility.

Infiltration Ponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Pond Berms/Dikes				
Settlements	B, W, E	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Yes No	Dike is built back to the design elevation.
Piping and seepage	B, W, E	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair.	Yes No	Piping or seepage eliminated. Erosion potential resolved.
Emergency Overflow Spillway or Outlet				
Vegetation or Tree Growth	A	Vegetation or tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Yes No	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. A licensed civil engineer should be consulted for proper berm/spillway restoration.
Spillway Surface	A	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 out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Yes No	Rocks and pad depth are restored to design standards.

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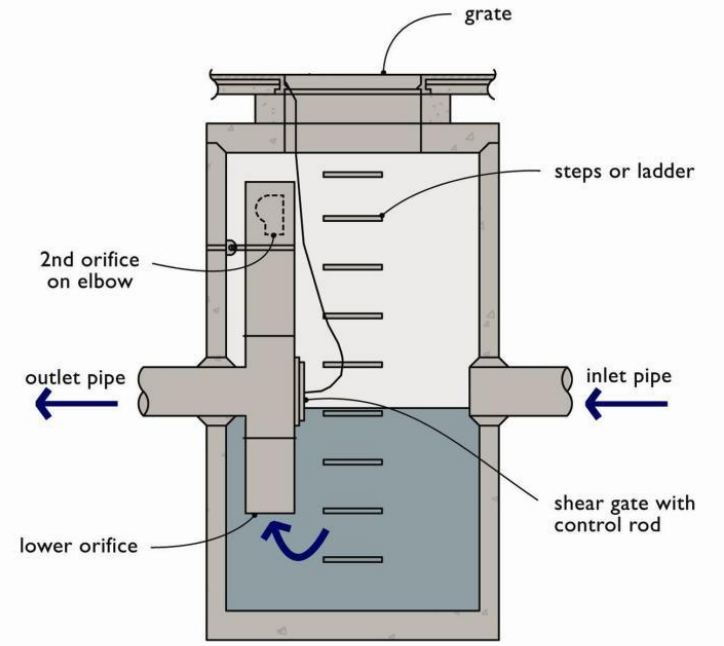
Flow Control Structures/Flow Restrictors

Flow control structures/flow restrictors are located on the outlet pipe of a detention system. The control structure is typically a Type 2 concrete catch basin with a riser (vertical pipe). The control structure reduces the discharge rate of stormwater from a detention facility to the rate at which water was leaving the site prior to development. The flow is regulated by a combination of orifices (holes in the riser pipe with specifically sized diameters) and weirs (rectangular or V-shaped notches in the riser pipe or a separate plate). Lack of maintenance of the control structure can result in the plugging of an orifice. This can result in a backup of stormwater in the detention facility, flooding of the stormwater system, and/or an increase in the rate of discharge from the site potentially damaging downstream property.

Flow control structures are an essential component to the function of a detention pond to limit downstream flooding, undue erosion and stream degradation, and function of the storm and surface water infrastructure maintained by the City of Olympia. While it may be unnerving to watch the water level in a pond fill up dramatically during a major storm event and water slowly trickle out, this is the designed intent of the detention pond and flow control device. Removing the flow restrictor to alleviate pond levels should never be attempted as this will cause downstream damage and flooding. Damage, plugging, or removal of flow control devices is the leading cause of failed detention facilities and flooding.



Flow Control Structures/Flow Restrictors

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Trash and Debris (Includes Sediment)	A	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Yes No	Control structure orifice is not blocked. All trash and debris removed.
Structural Damage	A	Structure is not securely attached to manhole wall.	Yes No	Structure securely attached to wall and outlet pipe.
	A	Structure is not in upright position (allow up to 10% from plumb).	Yes No	Structure in correct position.
	A	Connections to outlet pipe are not watertight and show signs of rust.	Yes No	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
	A	Any holes--other than designed holes--in the structure.	Yes No	Structure has no holes other than designed holes.
Cleanout Gate				
Damaged or Missing	A	Cleanout gate is not watertight or is missing.	Yes No	Gate is watertight and works as designed.
	A	Gate cannot be moved up and down by one maintenance person.	Yes No	Gate moves up and down easily and is watertight.
	A	Chain/rod leading to gate is missing or damaged.	Yes No	Chain is in place and works as designed.
	A	Gate is rusted over 50% of its surface area.	Yes No	Gate is repaired or replaced to meet design standards.
Orifice Plate				
Damaged or Missing	B, D	Control device is not working properly due to missing, out of place, or bent orifice plate.	Yes No	Plate is in place and works as designed.

Flow Control Structures/Flow Restrictors

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Obstructions	B, D	Any trash, debris, sediment, or vegetation blocking the plate.	Yes No	Plate is free of all obstructions and works as designed.
Overflow Pipe				
Obstructions	A	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Yes No	Pipe is free of all obstructions and works as designed.

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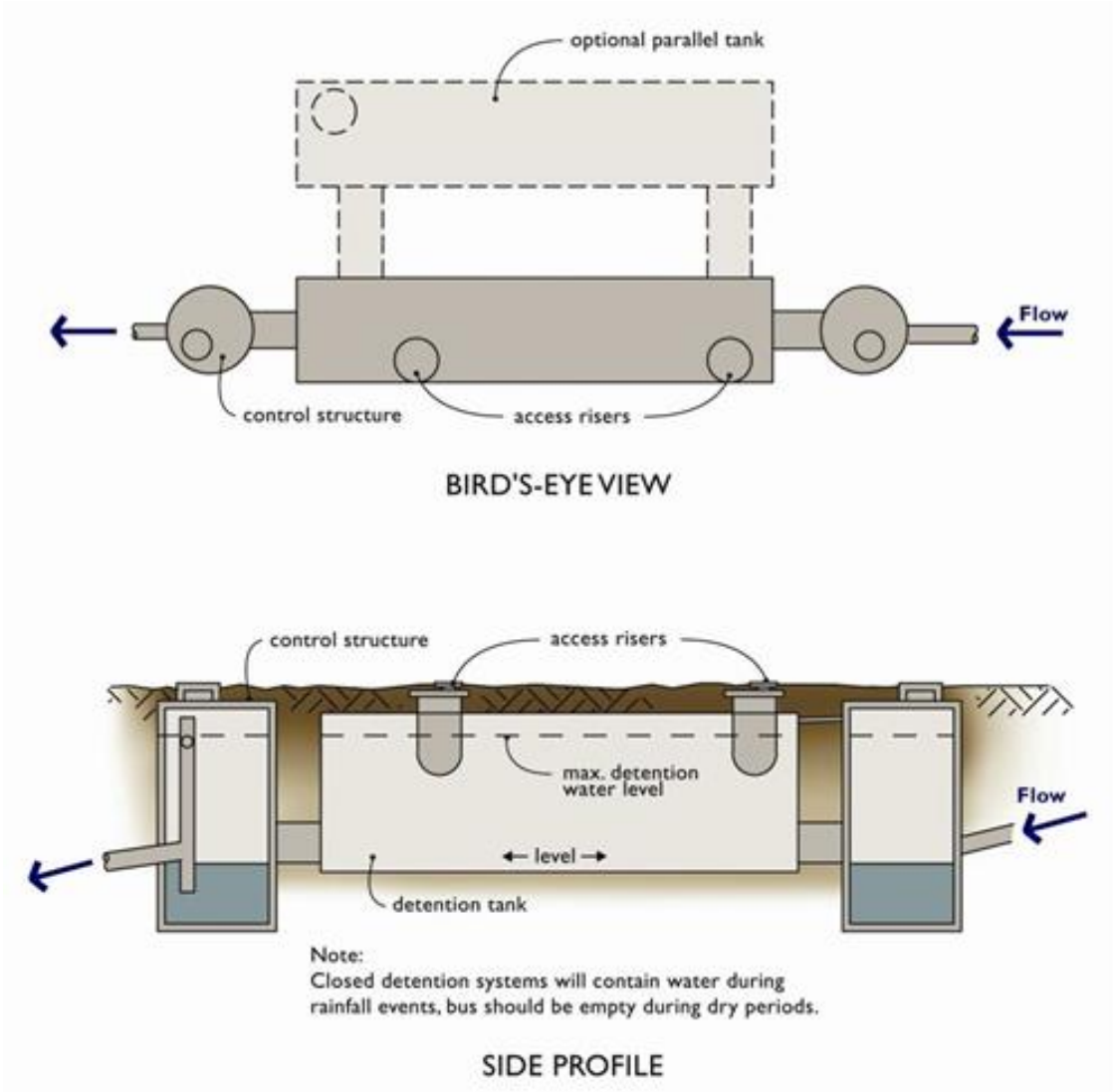
Closed Detention Systems (Tanks/Vaults)

Closed detention systems function similar to detention ponds with the temporary storage volume provided by an underground structure to regulate the storm discharge rate from the site. The structure is typically constructed of large diameter pipe (48” diameter or greater) or a concrete box (Vault). These systems are typically utilized for sites that do not have space available for an open, above-ground system and are more commonly associated with commercial sites.

Underground detention systems are an enclosed space where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual with training and certification in working in hazardous confined spaces.

Access to detention vaults and tanks can be made through access risers and inspection ports. Flow control devices may be located within a detention vault or in a separate downstream manhole.

Detention tanks/vaults are designed to drain out completely within 48 hours of a storm event. Facilities that continue to hold water well beyond a storm event should be inspected for damage or blockages at the outlet structure.



Closed Detention Systems (Tanks/Vaults)

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Storage Area				
Plugged Air Vents	A	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Yes No	Vents open and functioning.
Debris and Sediment	A[2]	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault 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.)	Yes No	All sediment and debris removed from storage area.
Joints Between Tank/Pipe Section	A	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	Yes No	All joint between tank/pipe sections are sealed.
Tank Pipe Bent Out of Shape	A	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Yes No	Tank/pipe repaired or replaced to design.
Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	A	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.	Yes No	Vault replaced or repaired to design specifications and is structurally sound.
	A	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.	Yes No	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole				
Cover Not in Place	B	Cover is missing or only partially in place. Any open manhole requires maintenance.	Yes No	Manhole is closed.
Locking Mechanism Not Working	A	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Yes No	Mechanism opens with proper tools.

Closed Detention Systems (Tanks/Vaults)

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Cover Difficult to Remove	A	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Yes No	Cover can be removed and reinstalled by one maintenance person.
Ladder Rungs Unsafe	A	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Yes No	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins or Manholes				
See "Catch Basins"	A	See "Catch Basins"	Yes No	See "Catch Basins"

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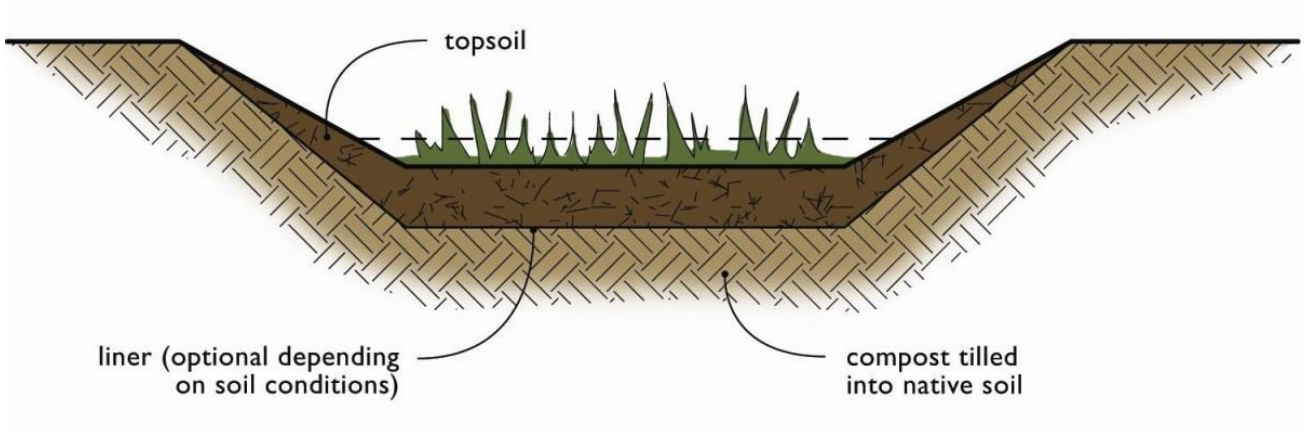
Basic Biofiltration Swale

Biofiltration swales are engineered grass-lined open channels with moderate centerline slope similar in appearance to typical ditches, except swales have a generally trapezoidal shape with a flat bottom and specific vegetation needs. Biofiltration facilities – or biofilters – are a form of permanent stormwater runoff treatment. Biofiltration swales are appropriate for low stormwater flows from sites with low pollution generating potential (e.g. residential sites).

Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As stormwater runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration, and settling. These effects are aided by the reduction of the velocity of stormwater as it passes through the vegetation in the biofilter. Typically, biofiltration swales are not constructed with a compost-amended soil lining unless native soils are incapable of supporting plant life.

Ponding or standing water within biofiltration swales is not acceptable; prolonged periods of inundation can cause grasses to die off rendering the treatment swale useless. Biofiltration swales need established vegetation to function as designed.

Biofiltration swales provide stormwater quality control (treatment), but do not provide stormwater quantity control (detention/retention).



Basic Biofiltration Swale

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Sediment Accumulation on Grass	A[2]	Sediment depth exceeds 2 inches.	Yes No	Remove sediment deposits on grass treatment area of the bio-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.
Standing Water	A, E	When water stands in the swale between storms and does not drain freely.	Yes No	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.
Flow spreader	A	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Yes No	Level the spreader and clean so that flows are spread evenly over entire swale width.
Constant Baseflow	A	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.	Yes No	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
Poor Vegetation Coverage	A	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Yes No	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
Vegetation	A	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Yes No	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.
Excessive Shading	A	Grass growth is poor because sunlight does not reach swale.	Yes No	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.

Basic Biofiltration Swale

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Inlet/Outlet	A, E	Inlet/outlet areas clogged with sediment and/or debris.	Yes No	Remove material so that there is no clogging or blockage in the inlet and outlet area.
Trash and Debris Accumulation	B	Trash and debris accumulated in the bio-swale.	Yes No	Remove trash and debris from bioswale.
Erosion/Scouring	B, E	Eroded or scoured swale bottom due to flow channelization, or higher flows.	Yes No	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 re-graded and re-seeded. 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.

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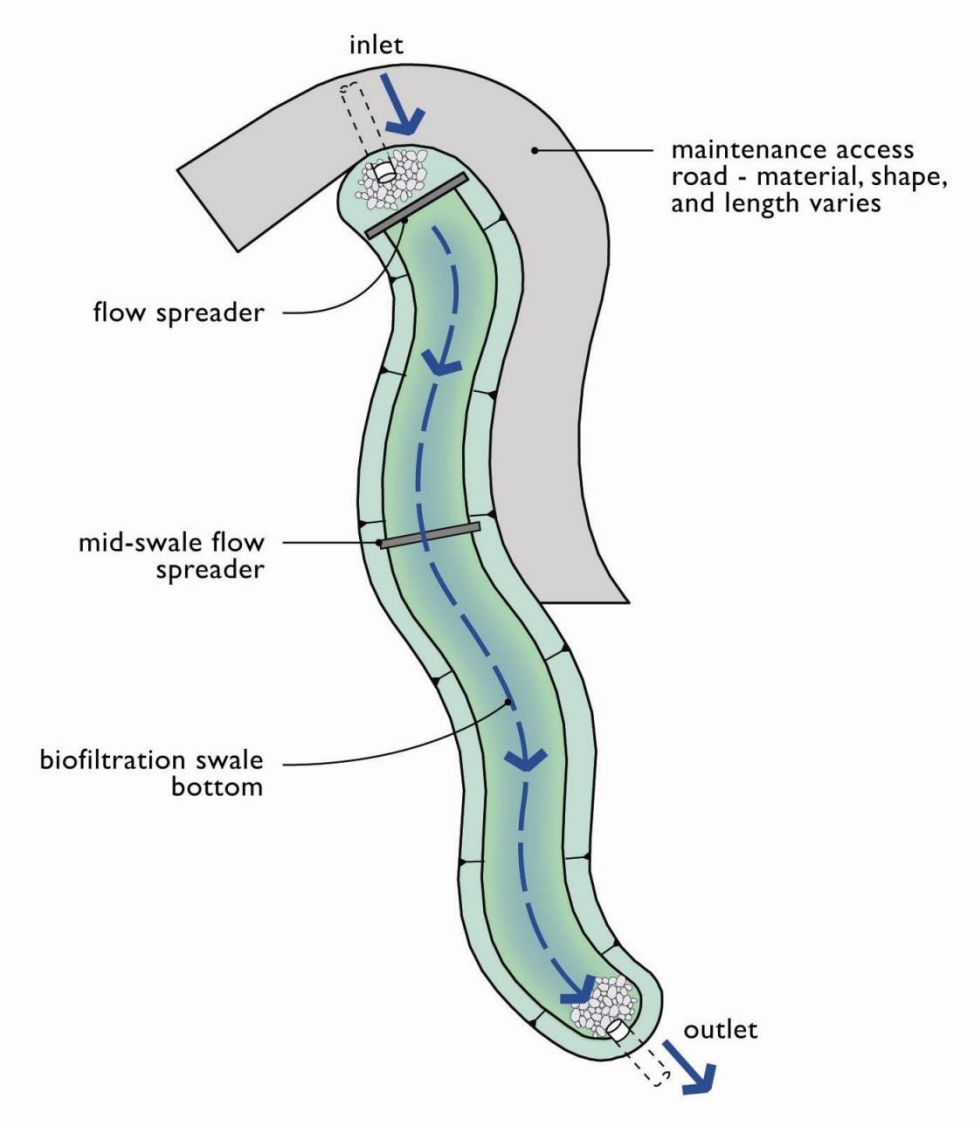
Wet Biofiltration Swale

Biofiltration swales are engineered grass-lined open channels with moderate centerline slope similar in appearance to typical ditches, except swales have a generally trapezoidal shape with a flat bottom and specific vegetation needs. Biofiltration facilities – or biofilters – are a form of permanent stormwater runoff treatment. Biofiltration swales are appropriate for low stormwater flows from sites with low pollution generating potential (e.g. residential sites). Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As stormwater runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration, and settling. These effects are aided by the reduction of the velocity of stormwater as it passes through the vegetation in the biofilter. Typically, biofiltration swales are not constructed with a compost-amended soil lining unless native soils are incapable of supporting plant life.

A wet biofiltration swale is a variation of a 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. Where continuously wet soil conditions exceeds about 2 weeks, typical grasses will die. Thus, swale vegetation specifically adapted to wet soil conditions is needed. Different vegetation in turn requires modification of several of the design and maintenance requirements from the basic biofiltration swale.



Wet Biofiltration Swale

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Sediment Accumulation	A[2]	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Yes No	Remove sediment deposits in treatment area.
Water Depth	A	Water not retained to a depth of about 4 inches during the wet season.	Yes No	Build up or repair outlet berm so that water is retained in the wet swale.
Wetland Vegetation	A	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.	Yes No	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
Inlet/Outlet	A	Inlet/outlet area clogged with sediment and/or debris.	Yes No	Remove clogging or blockage in the inlet and outlet areas.
Trash and Debris Accumulation	B	Trash or debris impedes the function of the swale	Yes No	Remove trash and debris from wet swale.
Erosion/Scouring	A, E	Swale has eroded or scoured due to flow channelization, or higher flows.	Yes No	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

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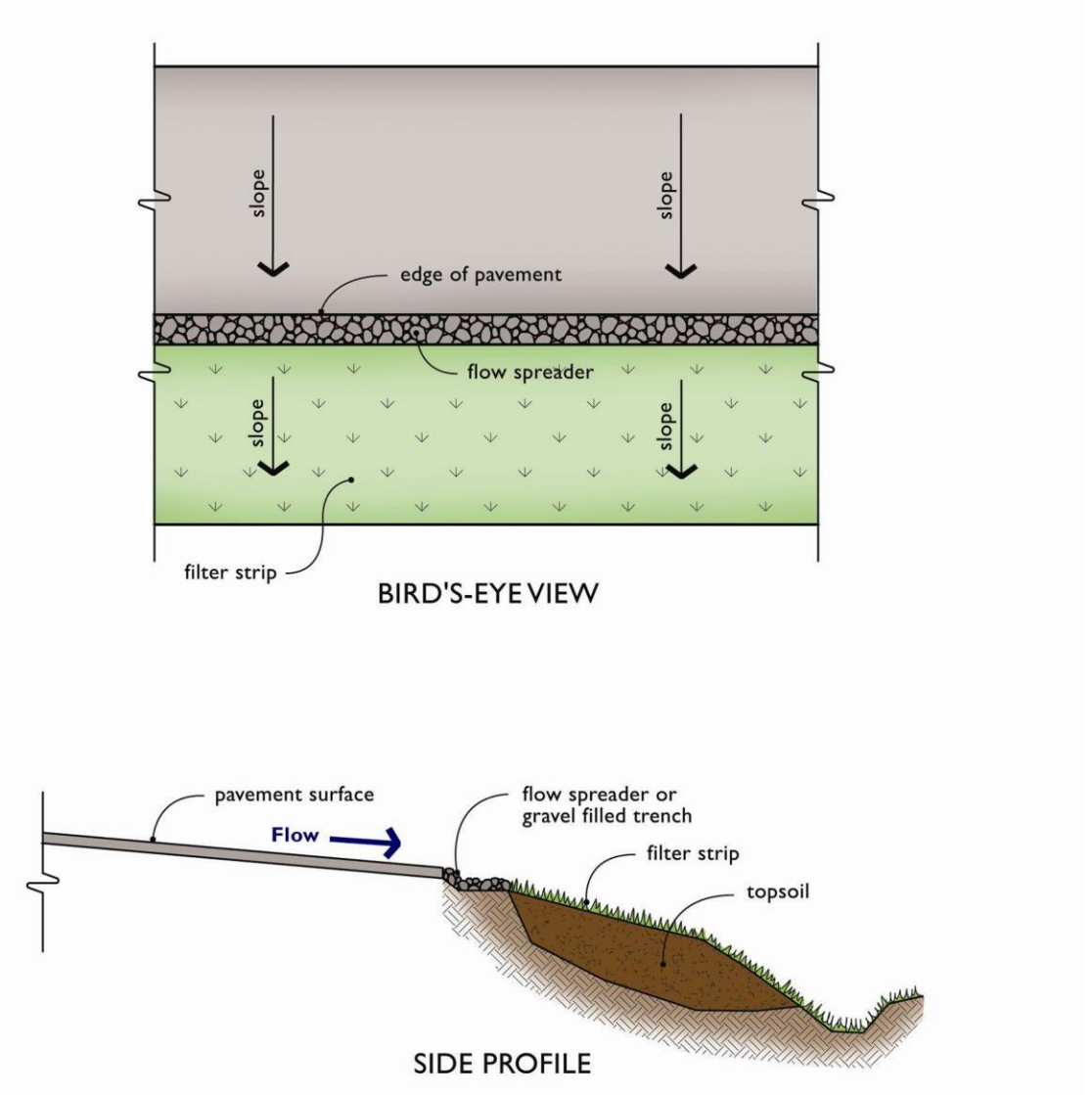
Filter Strips

A basic filter strip consists of a vegetated, grass slope area that provides the same treatment function as a biofiltration swale. Biofiltration facilities use vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As stormwater runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration, and settling. These effects are aided by the reduction of the velocity of stormwater as it passes through the vegetation in the biofilter.

Polluted stormwater runoff – typically from a parking area or street – is distributed as shallow flow across the top width of a biofilter strip through a flow spreader device or curb cuts at the edge of a paved area. The flow spreader device typically consists of a gravel filled trench and a board or concrete curb with a level top to evenly distribute the stormwater runoff across the entire length of the filter strip. Most filter strips have a collection ditch at the base to collect and route the treated runoff to a detention/retention facility or downstream conveyance system.

As with other biofiltration treatment facilities, maintenance of the grass treatment area is the highest priority for retaining the function of a filter strip. Typical maintenance functions are mowing and grass reestablishment.



Filter Strips

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Sediment Accumulation on Grass	A[2]	Sediment depth exceeds 2 inches.	Yes No	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
Vegetation	A	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Yes No	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
Trash and Debris Accumulation	B	Trash and debris accumulated on the filter strip.	Yes No	Remove trash and Debris from filter.
Erosion/Scouring	A, E	Eroded or scoured areas due to flow channelization, or higher flows.	Yes No	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. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
Flow spreader	A	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Yes No	Level the spreader and clean so that flows are spread evenly over entire filter width.

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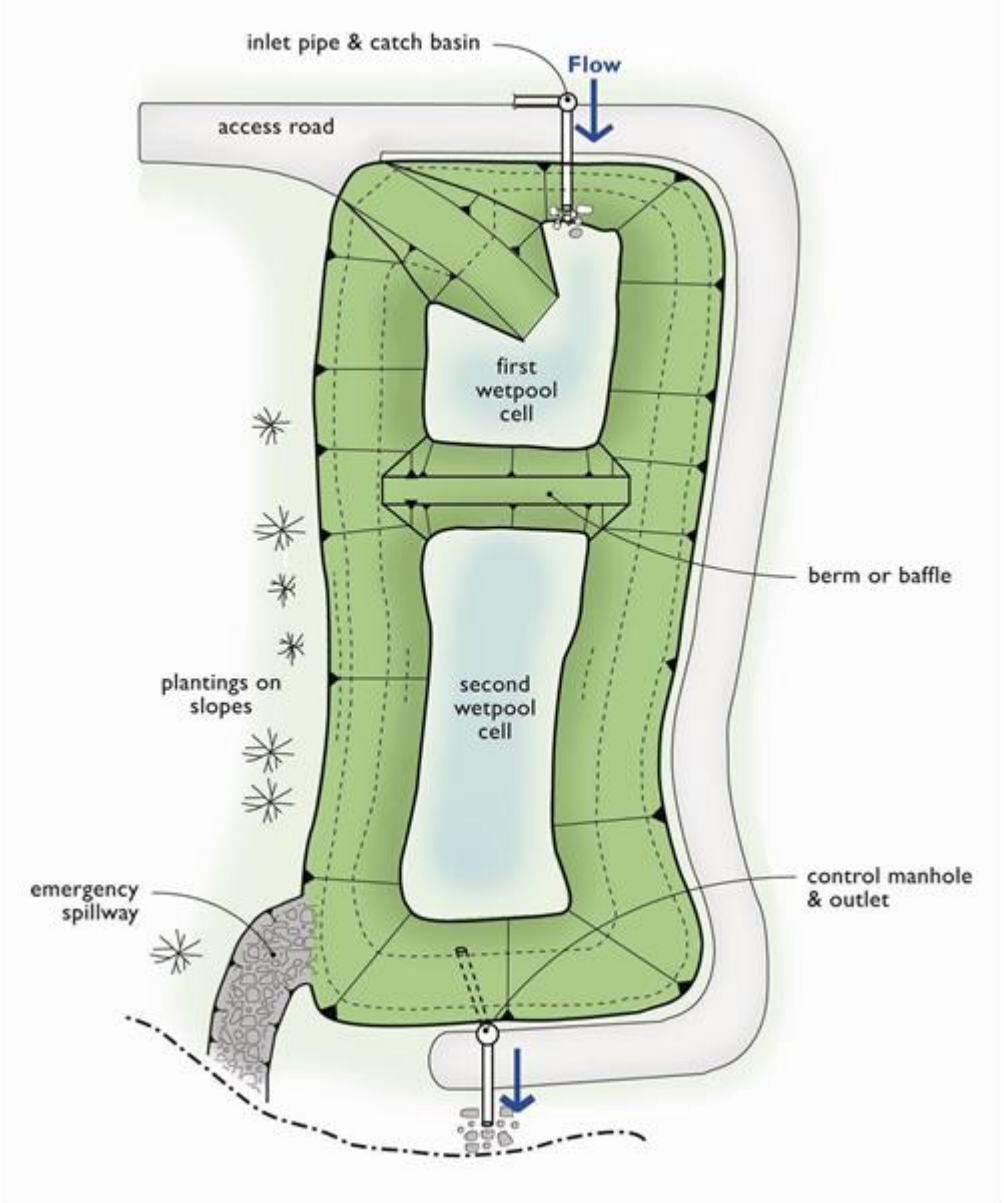
Wetponds

A wetpond is an open basin that retains a permanent pool of water (wetpool) year round or only during the wet season. The designed volume of water in the wetpool and the pond geometry allows sediment and other pollutants to settle out of the stormwater. Wetland vegetation is typically planted within the wetpond to provide aesthetic benefits and some additional treatment through nutrient (i.e. nitrogen) removal.

Detention and flow control can be provided with additional temporary storage volume above the permanent pool elevation – this type of facility is classified as a 'combined wetpond/detention pond'. Those facilities are subject to the maintenance standards for both wetponds and detention ponds.

The volume of the wetpond is critical to the facility functioning properly. Reduction of the pond volume can occur by sediment accumulation, invasive and uncontrolled plant growth, and dead or decaying plant matter accumulation in the pond. Emergent wetland vegetation in a wetpond should be kept from growing out of control to avoid pond volume reduction and leaching of nutrient pollutants (i.e. nitrogen, phosphorus, etc.) from dead or decaying plant matter.

Wetponds have an impermeable liner that helps retain the permanent pool of water in the pond. When mechanically removing sediment, care should be taken to not disturb or puncture the liner of the pond.



Wetponds

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Water level	A, W	First cell is empty, doesn't hold water.	Yes No	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
Trash and Debris	B	Accumulation that exceeds 1 CF per 1000-SF of pond area.	Yes No	Trash and debris removed from pond.
Inlet/Outlet Pipe	A, D	Inlet/Outlet pipe clogged with sediment and/or debris material.	Yes No	No clogging or blockage in the inlet and outlet piping.
Sediment Accumulation in Pond Bottom	A[2], D	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Yes No	Sediment removed from pond bottom.
Oil Sheen on Water	A, E	Prevalent and visible oil sheen.	Yes No	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
Erosion	A[2], E	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Yes No	Slopes stabilized using proper erosion control measures and repair methods.
Settlement of Pond Dike/Berm	A	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Yes No	Dike/berm is repaired to specifications.
Internal Berm	A	Berm dividing cells should be level.	Yes No	Berm surface is leveled so that water flows evenly over entire length of berm.
Overflow Spillway	A	Rock is missing and soil is exposed at top of spillway or outside slope.	Yes No	Rocks replaced to specifications.

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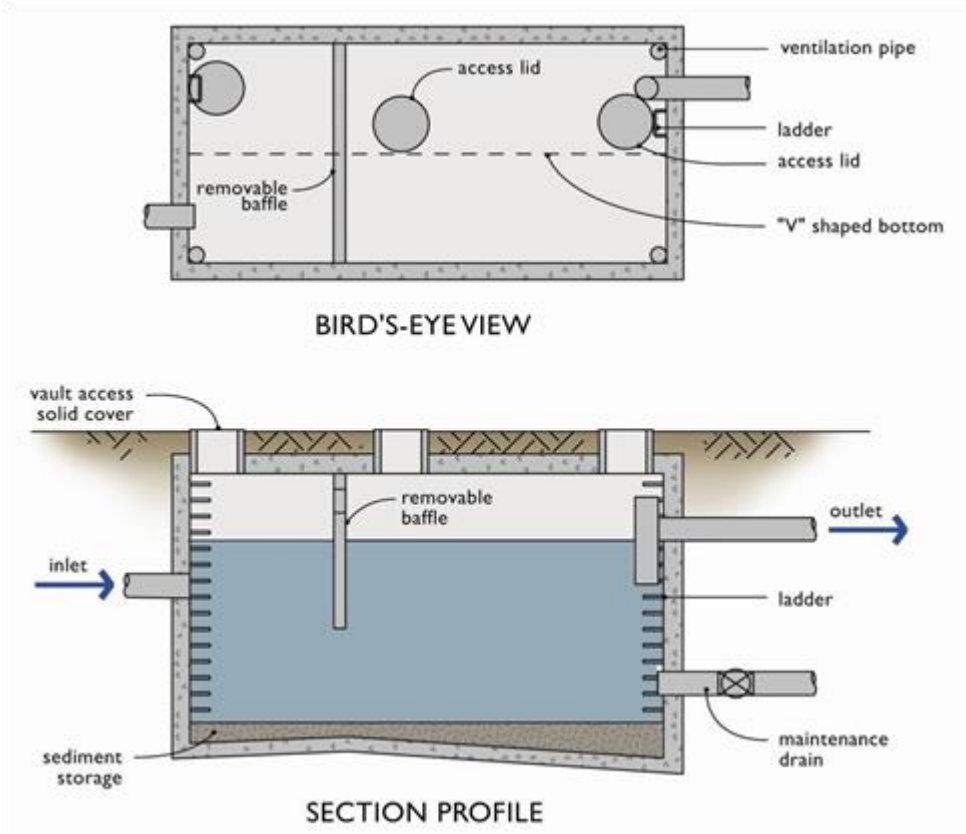
Wet Vaults

A wet vault is an underground structure that maintains a permanent pool of water (wetpool) which dissipates energy and improves the removal and settling of sediment and other pollutants. The designed volume of water in the wetpool and the vault geometry allows sediment and other pollutants to settle out of the stormwater. Some wet vault configurations will include a baffle design to trap floatable pollutants such as oil and hydrocarbons in the vault. Sediment levels and debris accumulation are highest concern for inspection and vault maintenance.

Wet vaults are typically serviced by a vactor or pump truck to remove sediment and debris. Access to vaults can be made through access risers. Wet vaults are a closed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual with training and certification in working in hazardous confined spaces.



Wetvaults

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Trash/Debris Accumulation	A	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Yes No	Remove trash and debris from vault.
Sediment Accumulation in Vault	A[2]	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Yes No	Remove sediment from vault.
Damaged Pipes	A	Inlet/outlet piping damaged or broken and in need of repair.	Yes No	Pipe repaired and/or replaced.
Access Cover Damaged/Not Working	B	Cover cannot be opened or removed, especially by one person.	Yes No	Pipe repaired or replaced to proper working specifications.
Ventilation	A	Ventilation area blocked or plugged.	Yes No	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	A	Maintenance/inspection personnel determine that the vault is not structurally sound.	Yes No	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
	A	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Yes No	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
Baffles	A	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Yes No	Baffles repaired or replaced to specifications.
Access Ladder Damage	A	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Yes No	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

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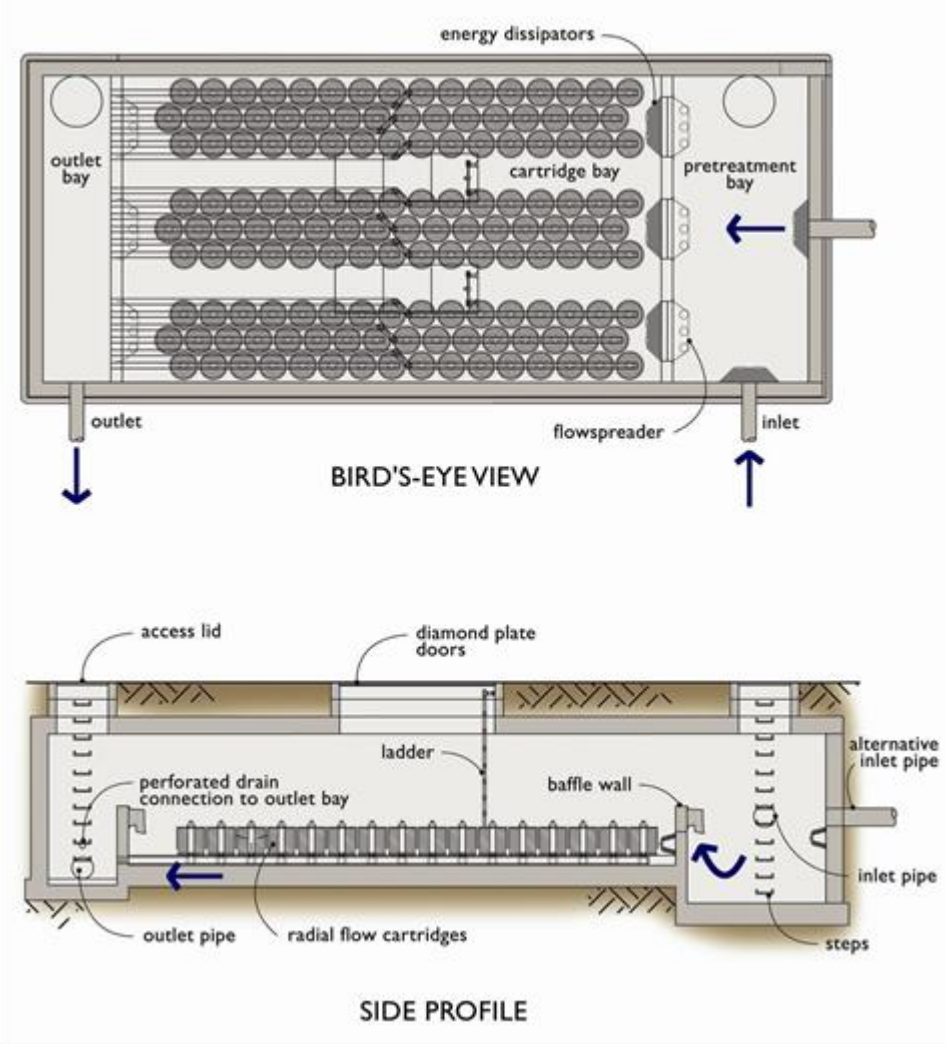
Manufactured Media Filters

A manufactured media filter is a special device or vault that achieves removal of pollutants from stormwater using a proprietary design and special media. The media that polluted stormwater passes through and subsequently removes pollutants – can come in many forms and installations. Media can be as layers in a concrete vault, contained in vertical media cartridges, or other configurations that direct stormwater to move through the media for treatment.

Media filters are continuously evolving and improving on past designs, and all emerging technologies for stormwater treatment must be evaluated and approved by the Washington State Department of Ecology to assure they meet minimum pollutant removal standards.

Manufactured media filter devices and vaults are sometimes preferred over conventional wetponds or swales because they save space on a development site. These technologies, however, often require more intensive maintenance schedule and have increased cost of maintenance depending on the product or configuration.

The following maintenance checklist applies to all types of manufactured media filters. Your *Stormwater Facility Maintenance Program* should include this checklist and a separate product specific checklist for the media filter(s) on your site. When replacing media or media contained in cartridges, it is important to replace them with the same media specified on the design plans/as-built drawings. Different media mixes target different pollutants for removal.



Example of a Contech StormFilter Vault

Manufactured Media Filters

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Below Ground Vault				
Sediment Accumulation on Media.	A[2], D	Sediment depth exceeds 0.25-inches.	Yes No	No sediment deposits which would impede permeability of the compost media.
Sediment Accumulation in Vault	A[2], D	Sediment depth exceeds 6-inches in first chamber.	Yes No	No sediment deposits in vault bottom of first chamber.
Trash/Debris Accumulation	A	Trash and debris accumulated on compost filter bed.	Yes No	Trash and debris removed from the compost filter bed.
Sediment in Drain Pipes/Clean-Outs		When drain pipes, clean-outs, become full with sediment and/or debris.	Yes No	Sediment and debris removed.
Damaged Pipes	A	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Yes No	Pipe repaired and/or replaced.
Access Cover Damaged/Not Working	B	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Yes No	Cover repaired to proper working specifications or replaced.
Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	A	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.	Yes No	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
	A	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Yes No	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.

Manufactured Media Filters

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Baffles	A	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Yes No	Baffles repaired or replaced to specifications.
Access Ladder Damaged	A	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Yes No	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type				
Media	A[2]	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Yes No	Media cartridges replaced.
Short Circuiting	E	Flows do not properly enter filter cartridges.	Yes No	Filter cartridges replaced.

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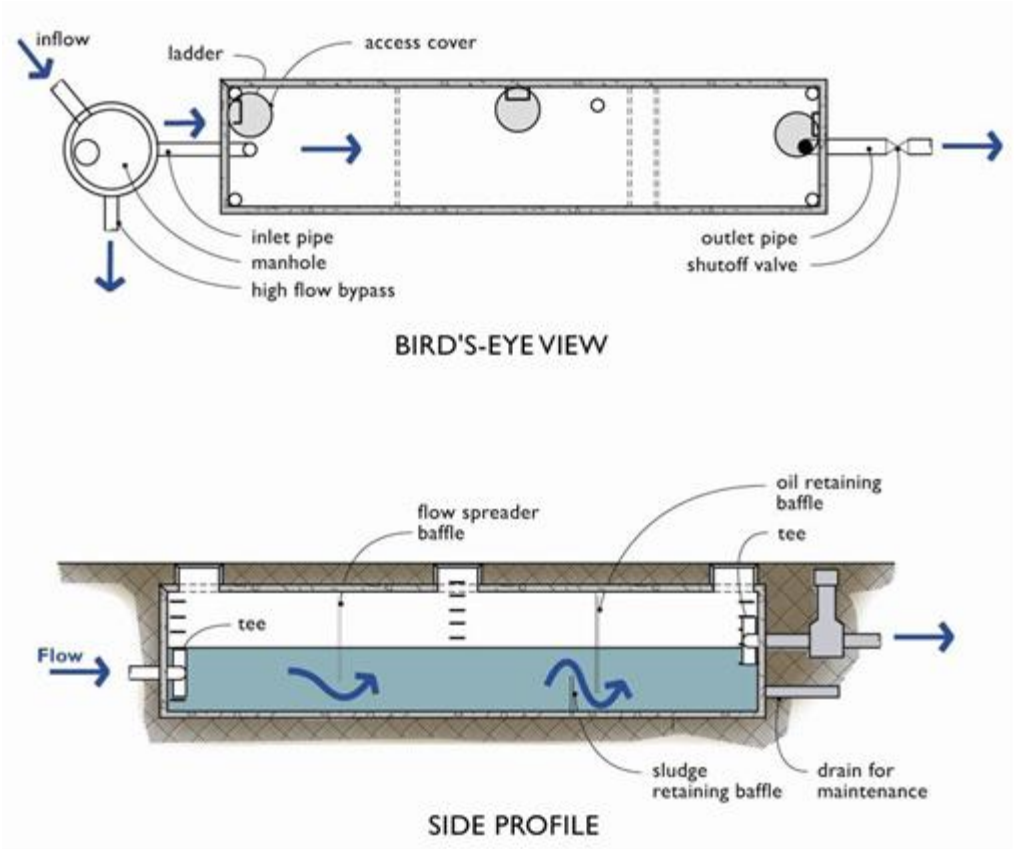
Baffle Oil/Water Separator (API Type)

American Petroleum Institute (API) oil/water separators consist of an underground vault separated into three bays by a series of partial divider walls (baffles). The three bays consist of a forebay, separator section, and the afterbay. Oil/water separators are typically utilized in locations where high oil concentrations in the stormwater runoff are anticipated (i.e. service and fuel stations). Oil/water separators are most commonly used as the first *pre-treatment* facility in a series of stormwater treatment facilities ("treatment train").



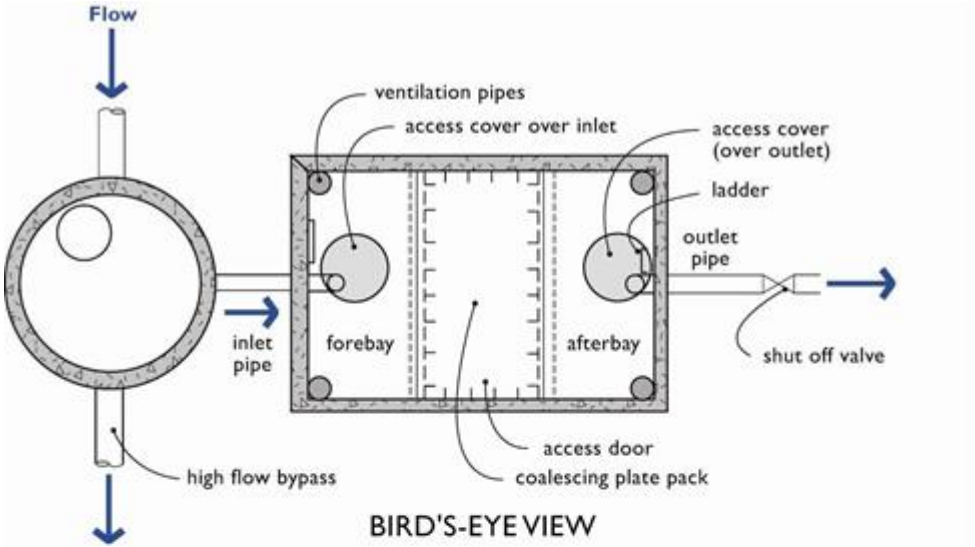
Baffle Oil/Water Separators (API Type)

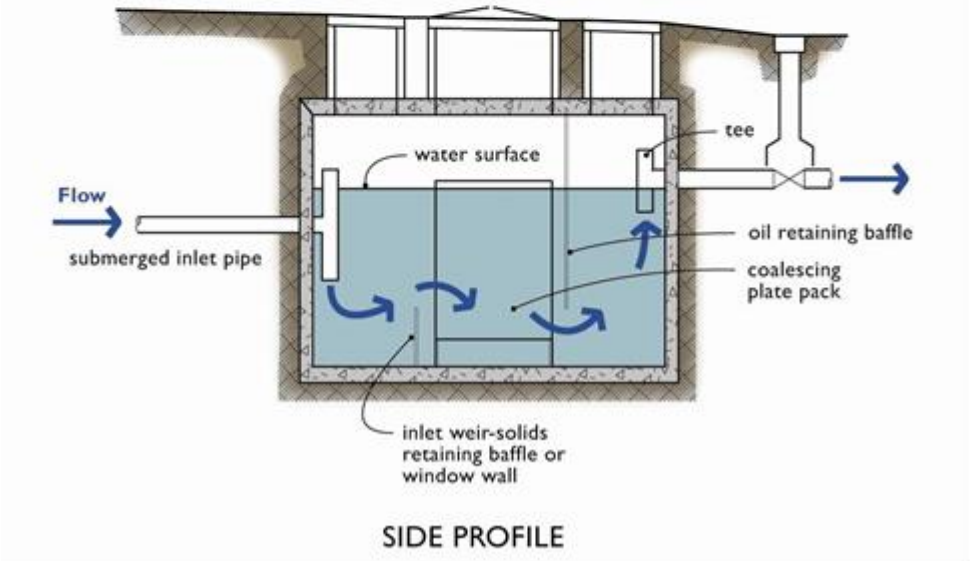
Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Monitoring	E	Inspection of discharge water for obvious signs of poor water quality.	Yes No	Effluent discharge from vault should be clear without thick visible sheen.
Sediment Accumulation	A[2]	Sediment depth in bottom of vault exceeds 6-inches in depth.	Yes No	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
Trash and Debris Accumulation	A[2]	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Yes No	Trash and debris removed from vault, and inlet/outlet piping.
Oil Accumulation	A[2]	Oil accumulations that exceed 1-inch, at the surface of the water.	Yes No	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
Damaged Pipes	A	Inlet or outlet piping damaged or broken and in need of repair.	Yes No	Pipe repaired or replaced.
Access Cover Damaged/Not Working	B	Cover cannot be opened, corrosion/deformation of cover.	Yes No	Cover repaired to proper working specifications or replaced.
Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	A	See “Catch Basins”	Yes No	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
	A	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Yes No	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
Baffles	A	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Yes No	Baffles repaired or replaced to specifications.

Coalescing Plate Oil/Water Separators

Oil/water separators consist of an underground vault typically utilized in locations where high oil concentrations in the stormwater runoff are anticipated (i.e. service and fuel stations). Oil/water separators are most commonly used as the first *pre-treatment* facility in a series of stormwater treatment facilities ("treatment train"). The oil/water separator is divided into three section: the forebay where stormwater enters, the plate pack, and the afterbay which precedes the discharge pipe from the structure.

Coalescing plate separators include a series of parallel plates in the separation bay (2nd bay) that increase the oil removal efficiency of the separator.





Coalescing Plate Oil/Water Separators

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Monitoring	E	Inspection of discharge water for obvious signs of poor water quality.	Yes No	Effluent discharge from vault should be clear with no thick visible sheen.
Sediment Accumulation	A[2]	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	Yes No	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
Trash and Debris Accumulation	A[2]	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Yes No	Trash and debris removed from vault, and inlet/outlet piping.
Oil Accumulation	A[2]	Oil accumulation that exceeds 1-inch at the water surface.	Yes No	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.
Damaged Coalescing Plates	A	Plate media broken, deformed, cracked and/or showing signs of failure.	Yes No	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
Damaged Pipes	A	Inlet or outlet piping damaged or broken and in need of repair.	Yes No	Pipe repaired and or replaced.
Baffles	A	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Yes No	Baffles repaired or replaced to specifications.
Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	A	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.	Yes No	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
	A	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Yes No	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
Access Ladder Damaged	A	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Yes No	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

[1] Inspection frequency:
A = Annually;
B = Biannually (twice per year);
W = Recommend that at least one inspection occur during the wet season, preferably after trees have lost their leaves;
E = Recommend that additional inspections be performed as appropriate after major events (e.g., >1 inch of precipitation in 24 hours or environmental incident which causes contaminant release).

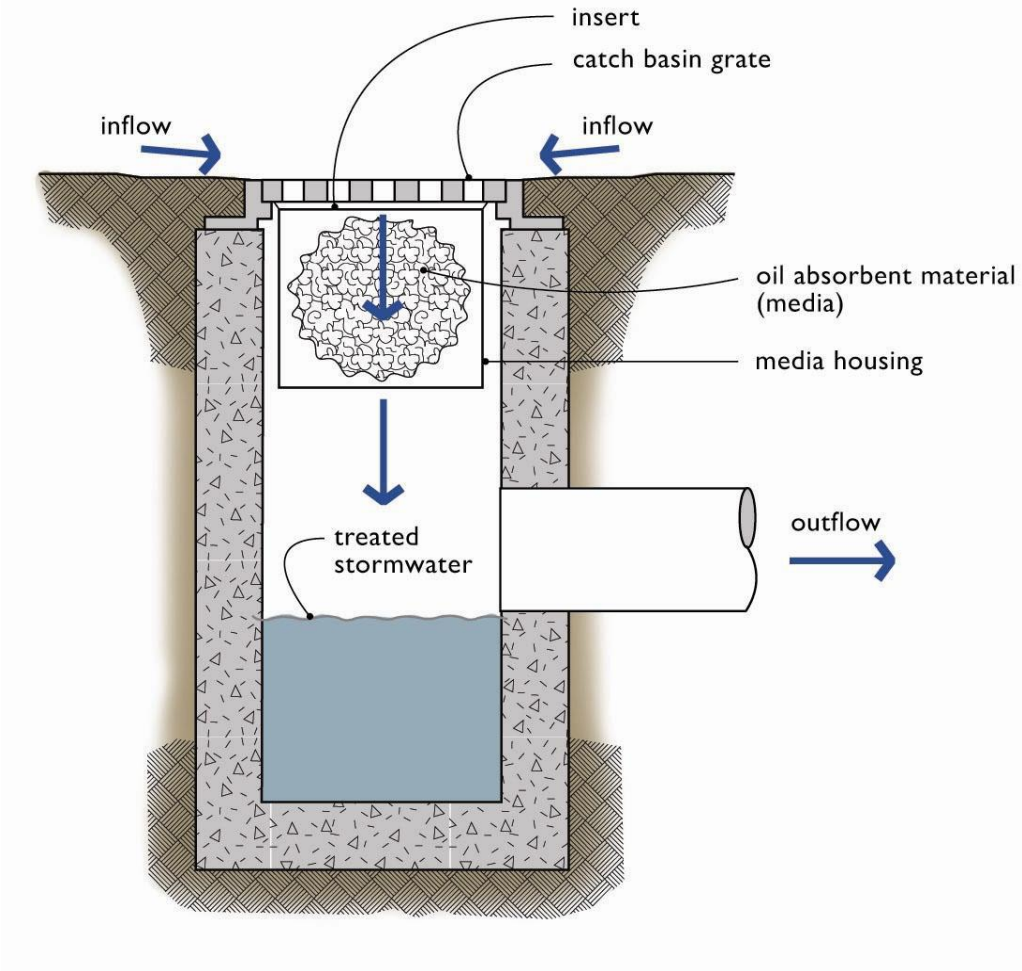
[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

Catch Basin Inserts

Catch basin inserts have been under development for many years in the Puget Sound Basin. Inserts are placed directly in a standard catch basin beneath the grate, and they are intended to serve as a pre-treatment device (i.e. a method for limiting the pollutant load on other downstream drainage systems or facilities). Catch basin inserts are generally maintenance intensive and require replacement of the treatment media or entire insert annually. Inspection, maintenance, and replacement intervals will vary from site to site and depend on the actual loading of pollutants entering the catch basin.

Catch basin inserts typically consist of the following components:

- A structure (screened box, brackets, etc.) which contains a pollutant removal medium
- A means of suspending the structure in a catch basin
- A filter medium such as sand, carbon, fabric, etc.
- A primary inlet and outlet for the stormwater
- A secondary outlet for bypassing flows that exceed design flow



Catch Basin Inserts

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Sediment Accumulation	B[2], W	When sediment forms a cap over the insert media of the insert and/or unit.	Yes No	No sediment cap on the insert media and its unit.
Trash and Debris Accumulation	B[2]	Trash and debris accumulates on insert unit creating a blockage/restriction.	Yes No	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
Media Insert Not Removing Oil	B[2], E	Effluent water from media insert has a visible sheen.	Yes No	Effluent water from media insert is free of oils and has no visible sheen.
Media Insert Water Saturated	B[2]	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Yes No	Remove and replace media insert
Media Insert-Oil Saturated	B[2]	Media oil saturated due to petroleum spill that drains into catch basin.	Yes No	Remove and replace media insert.
Media Insert Use Beyond Normal Product Life	B[2]	Media has been used beyond the typical average life of media insert product.	Yes No	Remove and replace media at regular intervals, depending on insert product.

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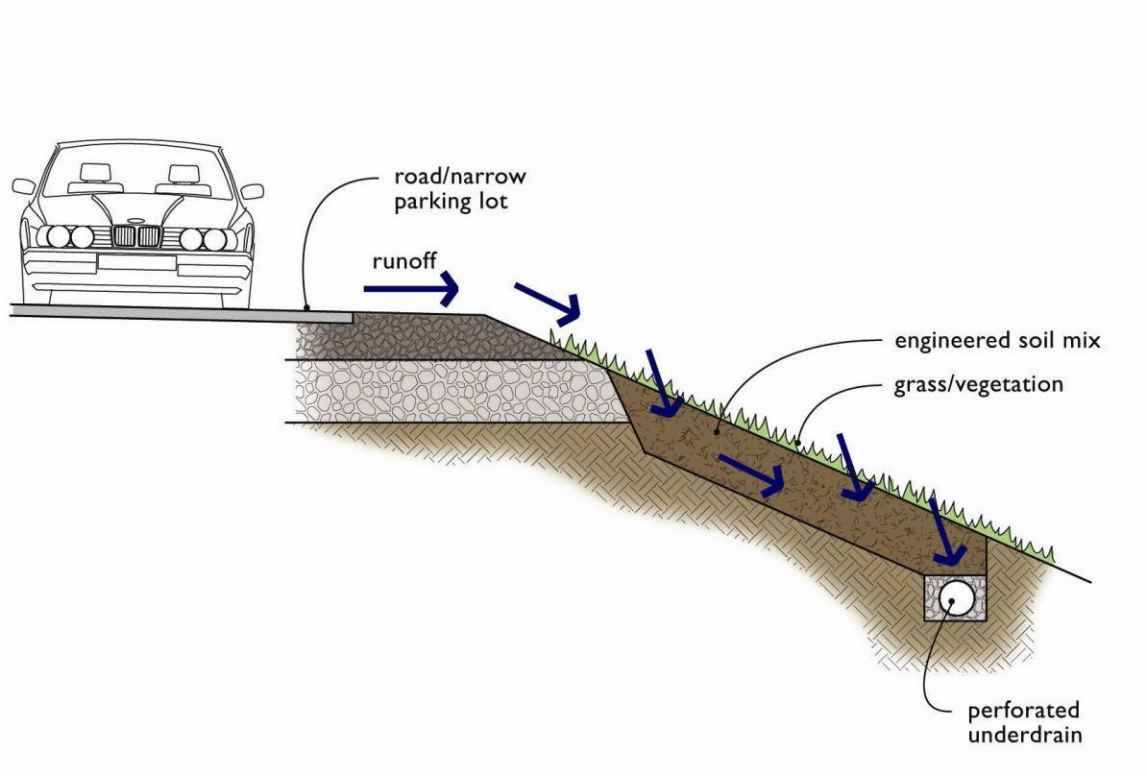
W = Recommend that at least one inspection occur during the wet season, preferably after trees have lost their leaves;
E = Recommend that additional inspections be performed as appropriate after major events (e.g., >1 inch of precipitation in 24 hours or environmental incident which causes contaminant release).

[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

Media Filter Drain (MFD)

A Media Filter Drain – also sometimes referred to as an Ecology Embankment – is an engineering soil and vegetated filter designed for water quality treatment of impervious areas with flow paths of 30 feet or less that can drain along their widest dimension to grassy areas. Typical applications of Media Filter Drains are for roads with limited right-of-way widths or for narrow parking strips.



Media Filter Drain (MFD)

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Sediment accumulation on grass filter strip	A[2], D	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Yes No	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.
No-vegetation zone/flow spreader	A	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Yes No	Level the spreader and clean to spread flows evenly over entire embankment width.
Poor vegetation coverage	A	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Yes No	Determine why grass growth is poor and correct the offending condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope.
Vegetation	B	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Yes No	Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass to a height of 6 inches.
Media filter drain mix replacement	A	Water is seen on the surface of the media filter drain mix long after the storms have ceased. Typically, the 6-month, 24-hour precipitation event should drain within 48 hours. More common storms should drain within 24 hours. Maintenance also needed on a 10-year cycle and during a preservation project.	Yes No	Excavate and replace all of the media filter drain mix contained within the media filter drain.
Excessive shading	A	Grass growth is poor because sunlight does not reach embankment.	Yes No	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
Trash and debris	B	Trash and debris have accumulated on embankment.	Yes No	Remove trash and debris from embankment.
Flooding of Media filter drain	B, E	When media filter drain is inundated by flood water	Yes No	Evaluate media filter drain material for acceptable infiltration rate and replace if media filter drain does not meet long-term infiltration rate standards.

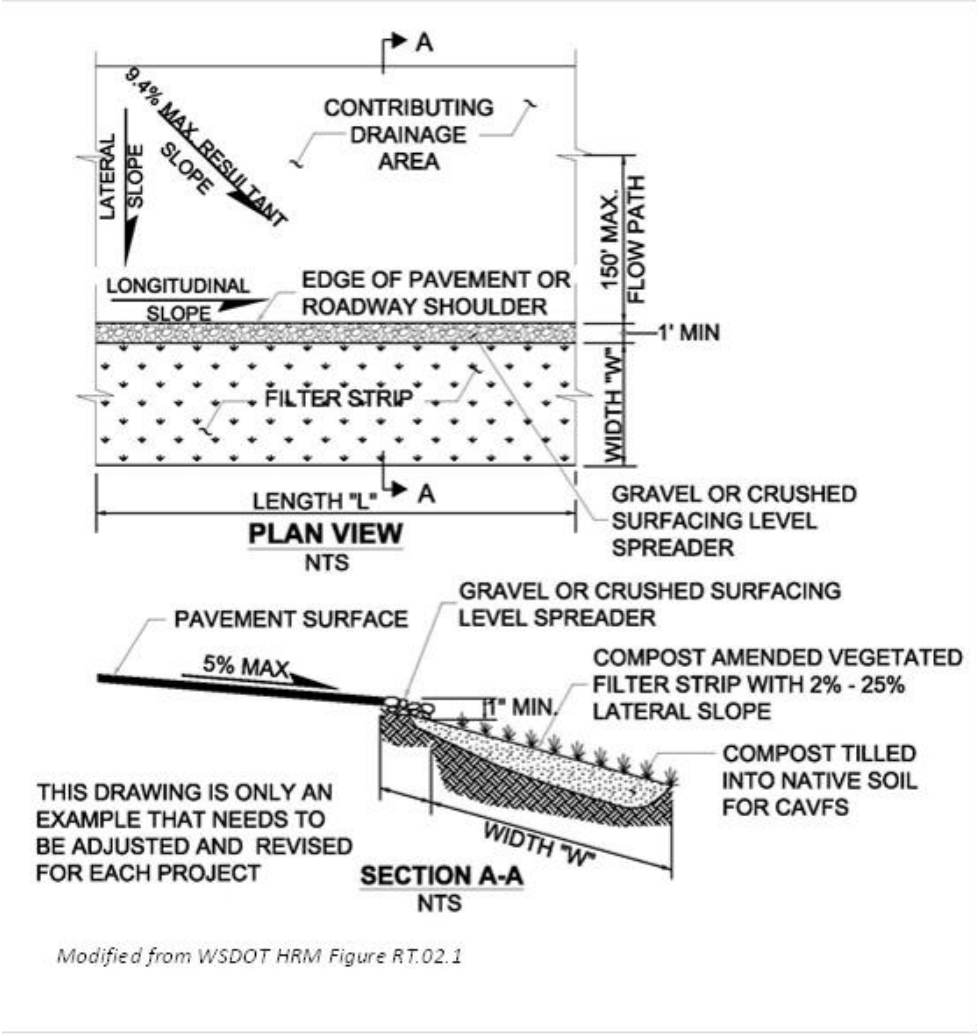
[1] Inspection frequency:
A = Annually;
B = Biannually (twice per year);
W = Recommend that at least one inspection occur during the wet season, preferably after trees have lost their leaves;
E = Recommend that additional inspections be performed as appropriate after major events (e.g., >1 inch of precipitation in 24 hours or environmental incident which causes contaminant release).

[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

Compost Amended Vegetated Filter Strips (CAVFS)

A compost amended vegetated filter strip (CAVFS) is a variation of the basic vegetated filter strip that adds soil amendments to a roadside or parking lot embankment. The soil amendments improve infiltration characteristics, increase surface roughness (which minimized erosion), and improve plant sustainability. CAVFS installations that are properly maintained can provide high levels of pollutant removal including removal of sediments, petroleum and oils, metals, and nutrients.

Compost-amended systems have somewhat higher construction costs due to more expensive materials, but require less land area for runoff treatment, which can reduce overall costs. Once plant establishment is complete, CAVFS systems require typical plant maintenance and occasional removal of sediment or replacement of compost amended soils.



Modified from WSDOT HRM Figure RT.02.1

Compost Amended Vegetated Filter Strip (CAVFS)

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Sediment accumulation on grass	A[2]	Sediment depth exceeds 2 inches.	Yes No	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
Vegetation	B	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Yes No	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
Trash and debris	B	Trash and debris have accumulated on the vegetated filter strip.	Yes No	Remove trash and debris from filter.
Erosion/scouring	B, E	Areas have eroded or scoured due to flow channelization or high flows.	Yes No	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with a 50/50 mixture of crushed gravel and compost. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
Flow spreader	A	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Yes No	Level the spreader and clean so that flows are spread evenly over entire filter width .

[1] Inspection frequency:
A = Annually;
B = Biannually (twice per year);
W = Recommend that at least one inspection occur during the wet season, preferably after trees have lost their leaves;
E = Recommend that additional inspections be performed as appropriate after major events (e.g., >1 inch of precipitation in 24 hours or environmental incident which causes contaminant release).

[2] Minimum requirement is for annual inspections. More frequent inspections and maintenance may be required depending on site conditions.

Vegetated Roofs

Vegetated roofs (also known as ecoroofs or green roofs) are thin layers of engineered soil and vegetation constructed on top of a conventional roof. Vegetated roofs consist of four basic components: a waterproof membrane, drainage layer, lightweight growth medium, and vegetation. Deeper installations – referred to as "intensive" roofs – are comprised of at least 6 inches of growth media and are planted with groundcovers, grasses, shrubs and sometimes trees. These intensive systems require regular landscape maintenance. Shallower installations – referred to as "extensive" roofs – are comprised of less than 6 inches of growth media and use a planting palette of drought-tolerant, low maintenance groundcovers. Your Stormwater Facility Maintenance Program should explain the type of system you have and the requirements for vegetation, growth media, and other design features.

Key Maintenance Considerations

The main components of vegetated roof facilities are listed below with descriptions of their function and key maintenance considerations. Components are listed in the order of installation from the roof deck upwards.

- ***Waterproof membrane****:* Waterproof membranes are installed on the roof deck below the vegetated roof system. Systems also include a protection layer and root barrier to preserve the integrity of the waterproof membrane.
- ***Drainage layer***: All vegetated roofs have a drainage component that routes excess water to the roof drain system. Usually this takes the form of a manufactured drain mat or granular drainage media.
- ***Growth media***: Vegetated roofs use a light-weight growth medium with adequate fertility and drainage capacity to support plant growth and allow infiltration and storage of water.
- ***Vegetation***: The plants on vegetated roofs are typically succulents, grass, herbs, and/or wildflowers adapted to the harsh conditions (minimal soils, seasonal drought, high winds, and strong sun exposure) prevalent on rooftops.
- ***Structural drainage elements***: The roof drainage system routes water from the vegetated roof drainage layer to a nearby drainage system.
- ***Border zone:*** This zone forms an area, composed of gravel and devoid of vegetation, around the perimeter of the vegetated roof, typically used as a fire prevention method and to prevent water damage.
- ***Gravel stops:*** These are sheet metal edges, typically installed outside of the border zone, along the perimeter of the roof to prevent growth medium from blowing or washing off the roof.

Vegetated Roofs

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Growth Medium Area				
Growth Medium	A b	Water does not permeate growth media (runs off soil surface) or crusting is observed.	Yes No	Aerate (e.g., rake) or replace medium taking care not to damage the waterproof membrane.
	A	Growth medium thickness is less than design thickness (due to erosion and plant uptake).	Yes No	Supplement growth medium to design thickness.
	B, W	Fallen leaves or debris are present.	Yes No	Remove/dispose.
	A, W, S	Growth media erosion/scour is visible (e.g., gullies).	Yes No	Take steps to repair or prevent erosion. Fill, hand tamp, or lightly compact, and stabilize with additional soil substrate/growth medium (similar in nature to the original material) and additional plants.
Erosion control measures	B c	Mat or other erosion control is damaged or depleted during plant establishment period.	Yes No	Repair/replace erosion control measures until 90% vegetation coverage attained. Avoid application of mulch on extensive vegetated roofs.
System Drainage and Structural Components				
Roof Drain	B, S	Sediment, vegetation, or debris reducing capacity of inlet structure.	Yes No	Clear blockage. Identify and correct any problems that led to blockage.
	A	Pipe is clogged.	Yes No	Remove roots or debris.
	A	Inlet pipe is in poor condition.	Yes No	Repair/replace.
Border zone	A	Vegetation is encroaching into border zone aggregate.	Yes No	Remove and dispose of weeds and transplant desirable vegetation to growth medium area
Flashing, gravel stops, utilities, or other structures on roof.	A	Flashing, utilities or other structures on roof are deteriorating (can serve as source of metal pollution in vegetated roof runoff).	Yes No	Repair (e.g., recoat) or replace to eliminate potential pollutant source. Note that any work done around flashings and drains should be done with care to protect the waterproof membrane.

Vegetated Roofs

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Access and safety	B	Insufficient egress/ingress routes and fall Protection.	Yes No	Maintain egress and ingress routes to design standards and fire codes. Ensure appropriate fall protection.
Vegetation				
Plant coverage	B	Vegetative coverage falls below 90% (unless design specifications stipulate less than 90% coverage).	Yes No	• Plant bare areas with vegetation. • If necessary, install erosion control measures until percent coverage goal is attained.
Sedums	A	Extensive roof with low-density sedum population.	Yes No	• Mulch mow sedums- creating cuttings from existing plants to encourage colonization.
Dead Plants	Fall and Spring	Dead vegetation is present.	Yes No	Normally dead plant material can be recycled on the roof; however, specific plants or aesthetic considerations may warrant removing and replacing dead material (see manufacturer's recommendations).
Trees and Shrubs – intensive vegetated roof.		Pruning as needed.	Yes No	All pruning of mature trees should be performed under the direct guidance of an ISA certified arborist.
Fertilization– extensive vegetated roof	A	Poor plant establishment and possible nutrient deficiency in growth medium.	Yes No	• Allow organic debris to replenish and maintain long-term nutrient balance and growth medium structure. • Conduct annual soil test 2-3 weeks prior to the spring growth flush to assess need for fertilizer. Utilize test results to adjust fertilizer type and quantity appropriately. • Apply minimum amount slow-release fertilizer necessary to achieve successful plant establishment. • Apply fertilizer only after acquiring required approval from facility owner and operator. Note that extensive vegetated roofs are designed to require zero to minimal fertilization after establishment (excess fertilization can contribute to nutrient export).
Fertilization– intensive vegetated roof	A	Fertilization may be necessary during establishment period or for plant health and survivability after establishment.	Yes No	• Conduct annual soil test 2-3 weeks prior to the spring growth flush to assess need for fertilizer. Utilize test results to adjust fertilizer type and quantity appropriately.

Vegetated Roofs

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Fertilization– intensive vegetated roof				• Apply minimum amount slow-release fertilizer necessary to achieve successful plant establishment. • Apply fertilizer only after acquiring required approval from facility owner and operator. • Intensive vegetated roofs may require more fertilization than extensive vegetated roofs.
Weeds	As needed	Weeds are present.	Yes No	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate. • Follow IPM protocols for weed management (see "Additional Maintenance Resources" for more information on IPM protocols).
Noxious weeds	As needed	Listed noxious vegetation is present (refer to current county noxious weed list).	Yes No	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately. • Reasonable attempts must be made to remove and dispose of class C noxious weeds. • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions.
Irrigation System (or Watering)				
Irrigation System (if any)	As needed	Irrigation System Present.	Yes No	Follow manufacturer's instructions for operation and maintenance.
Summer watering – extensive vegetated roof.		Once every 1-2 weeks as needed during prolonged dry periods.	Yes No	Water weekly during periods of no rain to ensure plant establishment (30 to 50 gallons per 100 square feet).
		As needed.	Yes No	Water during drought conditions or more often if necessary to maintain plant cover (30 to 50 gallons per 100 square feet).

Vegetated Roofs

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Summer watering – intensive vegetated roof.		Once every 1-2 weeks as needed during prolonged dry periods.	Yes No	• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist. • Use soaker hoses or spot water with a shower type wand when irrigation system not present.
		As needed.	Yes No	Water during drought conditions or more often if necessary to maintain plant cover.
Pest Control				
Mosquitoes	B, S	Standing water remains for more than 3 days after the end of a storm.	Yes No	• Identify the cause of the standing water and take appropriate actions to address the problem (e.g., aerate or replace medium, unplug drainage). • Manually remove standing water and direct to storm drainage system. • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti).
Nuisance animals	As needed	Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces.	Yes No	• Reduce site conditions that attract nuisance species. • Place predator decoys. • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" in Bioretention Facilities section for more information on IPM protocols).

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

[b] Inspection should occur during storm event.

[c] Inspection should occur during plant establishment period (typically first 2 years).

IPM – Integrated Pest Management, ISA – International Society of Arboriculture

Downspout Full Infiltration Systems

Downspout full infiltration systems include infiltration trenches or drywells intended only for use in infiltrating runoff from roof downspout drains. Infiltration trenches and drywells are backfilled with washed drain rock, allowing for temporary storage of stormwater runoff in the voids of the drain rock material. Stored runoff gradually infiltrates into the surrounding soil.

Key Maintenance Considerations

The main components of downspout full infiltration systems are listed below with descriptions of their function and key maintenance considerations.

- ***Rock trench/well****:* Trenches and drywells are excavated depressions filled with uniformly graded washed drain rock. Non-woven geotextile fabric may be used along the walls, bottom, and top of the drain rock. The surface of the trench can be covered with grating, pavement, and/or consist of stone, gabion, sand, or a grassed covered area with a surface inlet. To allow inspection of the drain rock trench/well, some facilities have an observation port (typically installed during construction) that allows monitoring of the water levels in the drain rock bed to determine if the facility is dewatering properly.
- ***Inlet:*** Stormwater runoff is typically routed to a trench/well with a solid-wall pipe and then distributed into the drain rock bed using a perforated or slotted subsurface pipe. Some trenches are designed to receive sheet flow that enters the facility by infiltrating through a top course of drain rock or sand. Maintenance must be performed to ensure inlets (e.g., pipes) are unobstructed and that surface sheet flow first passes through a grass buffer strip to remove larger sediment particles.
- ***Storage sump:*** Trenches and drywells designed to receive concentrated flows (e.g., piped flow) typically include a storage sump to settle particulates from inflow. Concentrated flows must be distributed into the aggregate using a perforated or slotted subsurface pipe. The sump must be maintained to remove accumulated sediment.

Downspout Full Infiltration Systems

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Rock Trench/Well				
Surface of trench/well (i.e., water enters through exposed aggregate)	Fall and Spring	Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow into facility	Yes No	Remove/dispose in accordance with local solid waste requirements.
	A	Vegetation/moss present on drain rock surface impedes sheet flow into facility	Yes No	Maintain open, freely draining drain rock surface.
Drain Rock	Fall and Spring	• If water enters the facility from the surface, inspect to see if water is ponding at the surface during storm events • If buried drain rock, observe drawdown through observation port or cleanout	Yes No	• Clear piping through facility when ponding occurs. • Replace rock/sand reservoirs as necessary. • Tilling of subgrade below reservoir may be necessary (for trenches) prior to backfill.
Inlet/Outlet Pipe Conveyance				
Pipes)	A, W	Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc.	Yes No	Remove/ dispose.
	A, W	Pipe from sump to trench or drywell has accumulated sediment or is plugged.	Yes No	Clear sediment from inlet/outlet pipe screen and inlet/outlet pipe.
	A, W	Cracked, collapsed, broken, or misaligned drain pipes.	Yes No	• Repair/seal cracks. • Replace when repair is insufficient.
Roof downspout	B, W	Splash pad missing or damaged.	Yes No	Repair/ replace.
	A, W	Leaves or other debris plugging downspout.	Yes No	Remove/ dispose.
Storage/Sump				
Sump	A	Sediment in the sump	Yes No	Remove/ dispose in accordance with local solid waste requirements
Access Lid	A	Cannot be easily opened	Yes No	Repair/ replace

Downspout Full Infiltration Systems

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
	A	Buried	Yes No	Refer to record drawings for design intent. If the access lid was designed to be exposed, expose and restore to surface grade
	A	Cover missing	Yes No	Replace

[1] Frequency: A= Annually; B= Biannually (twice per year); W= At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves).

Downspout, Sheet Flow, and Concentrated Dispersion Systems

Dispersion of stormwater reduces peak flows by slowing the runoff entering into the conveyance system, allowing some infiltration, and providing some water quality benefits. The following three types of dispersion systems are covered in this section:

Downspout dispersion systems: Splash blocks or gravel-filled trenches, which serve to spread roof runoff over vegetated pervious areas.

Sheet flow dispersion systems: Sheet flow dispersion is the simplest method of runoff control. This method can be used for any impervious or pervious surface that is graded to avoid concentrating flows. Because flows are already dispersed as they leave the surface, they need only traverse a narrow band of adjacent vegetation for effective flow reduction and treatment.

Concentrated dispersion systems: Dispersion of concentrated flows from driveways or other pavement through a vegetated pervious area.

Key Maintenance Considerations

The main components of dispersion systems are listed below with descriptions of their function and key maintenance considerations. For dispersion practices to be effective, the dispersion area must remain covered with dense, well-established vegetation. Site uses should protect vegetation and avoid compaction of soils.

- ***Splash block (downspout dispersion):*** Splash blocks are used to spread stormwater runoff from a downspout drain over vegetated pervious area. A downspout extension may be included if the ground is fairly level, if the structure includes a basement, or if foundation drains are proposed.
- ***Dispersion trench (downspout dispersion):*** Gravel-filled trenches are also used to spread stormwater runoff from a downspout drain over a vegetated pervious area. Downspout drains are routed to a trench via a perforated or slotted pipe. The trench typically includes a notched grade board or other device to distribute flow equally along the length of the trench. This board must be maintained at a level grade to prevent concentrated flow. Downspout drains are directed to the trench via a storage sump that must be maintained to remove accumulated sediment.
- ***Transition zone (sheet flow dispersion):*** A 2-foot-wide transition zone is typically included to discourage channeling between the edge of the impervious surface (or building eaves) and the downslope vegetation. This transition zone may consist of an extension of subgrade material (crushed rock), modular pavement, drain rock, or other material.
- ***Rock pad at discharge point (concentrated flow dispersion):*** A rock pad must be maintained at any point that a concentrated flow enters a dispersion area.
- ***Dispersal area:*** Stormwater is dispersed to an area vegetated with well-established lawn or pasture, landscaping with well-established groundcover, or native vegetation with natural groundcover. The required vegetated flow path is 50 feet for splash blocks and concentrated dispersion, 25 feet when using a dispersion trench, and varies for sheet flow dispersion. The groundcover for the extent of the flow must be maintained to be dense enough to help disperse and infiltrate flows and to prevent erosion.

Downspout, Sheet Flow, and Concentrated Dispersion Systems

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Splash Block (Downspout Dispersion)				
Splash Block	B	Water is being directed towards building structure.	Yes No	Reconfigure/ repair blocks to direct water away from building structure.
	B	Water disrupts soil media.	Yes No	Reconfigure/ repair blocks.
Transition Zone (Sheet Flow Dispersion)				
Transition Zone	A	Adjacent soil erosion; uneven surface creating concentrated flow discharge; or less than 2 foot of width.	Yes No	Repair/replace transition zone to meet design criteria and eliminate concentrated flows.
Dispersion Trench (Downspout Dispersion)				
Dispersion trench	A	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" from edge of trench; intent is to prevent erosion damage).	Yes No	• Remove debris from trench surface, if necessary. • Realign notched grade board or other distributor type, if possible. • Rebuild trench to standards, if necessary.
Surface of trench	Fall and Spring	Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow from facility.	Yes No	• Remove/dispose in accordance with local solid waste requirements.
	A, W	Vegetation/moss present on drain rock surface impedes sheet flow from facility.	Yes No	• Maintain open, freely draining drain rock surface.
Pipe(s) to trench	A, W	Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc.	Yes No	• Remove/ dispose.
	A, W	Pipe from sump to trench or drywell has accumulated sediment or is plugged.	Yes No	• Clear sediment from inlet/outlet pipe screen and inlet/outlet pipe.
	A, W	Cracked, collapsed, broken, or misaligned drain pipes.	Yes No	• Repair/seal cracks. • Replace when repair is insufficient.

Downspout, Sheet Flow, and Concentrated Dispersion Systems

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Sump	A	Sediment in the sump.	Yes No	• Remove/ dispose in accordance with local solid waste requirements. • Clear sediment from inlet/outlet pipe screen and/or inlet/outlet pipe.
Access Lid	A	Cannot be easily opened.	Yes No	• Repair/ replace.
	A	Buried.	Yes No	• Refer to record drawings for design intent. If the access lid was designed to be exposed, expose and restore to surface grade.
	A	Cover missing.	Yes No	• Replace.
Rock Pad (Concentrated Flow Dispersion)				
Rock Pad	A	Only one layer of rock exists above native soil in area 6 square feet or larger, or any exposure of native soil.	Yes No	• Replace/ repair rock pad to meet design standards. • Enlarge pad size or add additional courses of rock, if necessary.
	A	Soil erosion in or adjacent to rock pad.	Yes No	Repair/replace rock pad to meet design standards.
Dispersal Area				
Dispersal Area	B, S	Erosion (gullies/ rills) greater than 2 inches deep in dispersal area.	Yes No	Eliminate cause of erosion and stabilize damaged area (regrade, rock, revegetate).
	B, S	Accumulated sediment or debris to extent that blocks or channelizes flow path.	Yes No	• Remove excess sediment or debris • Identify and control the sediment source (if feasible).
Ponded Water	B, S	Standing surface water in dispersion area remains for more than 3 days after the end of a storm event.	Yes No	• Identify the cause of the standing water (e.g., grade depressions, compacted soil) and take appropriate actions to address the problem (e.g., regrade to eliminate depressions or aerate/ amend soils).

Downspout, Sheet Flow, and Concentrated Dispersion Systems

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Plant establishment	B	Dispersal area vegetation in establishment period (1-2 years, or additional 3rd year during extreme dry weather).	Yes No	Water weekly during periods of no rain to ensure plant establishment.
Vegetation	As Needed	Poor vegetation cover such that erosion is occurring.	Yes No	• Ensure proper care (e.g., watering). • Assess for nutrient deficiencies. • Replant as needed with appropriate plant species for the soil and moisture conditions. • Consider amending soils to promote plant health.
	B, S	Vegetation inhibits dispersed flow along flow path.	Yes No	Trim, weed or replant to restore dispersed flow path.
Storage Sump				
Sump	A	Accumulated sediment in the sump	Yes No	• Remove/ dispose in accordance with local solid waste requirements. • Clear sediment from inlet/outlet pipe screen and/or inlet/outlet pipe.
Access lid	A	Cannot be easily opened	Yes No	Repair/ replace.
	A	Buried	Yes No	Expose and restore to surface grade.
	A	Cover missing	Yes No	Replace.
Pest Control				
General Pests	As Needed	Signs of pest infestations (IPM protocol threshold(s) are exceeded).	Yes No	• Follow IPM protocols for weed and pest management (see "Additional Maintenance Resources" in Bioretention Facilities section for more information on IPM protocols).

Downspout, Sheet Flow, and Concentrated Dispersion Systems

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Mosquitoes	B, S	Standing surface water in dispersion area remains for more than 3 days after the end of a storm.	Yes No	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water"). • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti).
Rodents	As Needed	Rodent holes or mounds disturb dispersion flow paths	Yes No	Fill and compact soil around the holes and vegetate to restore flow path.

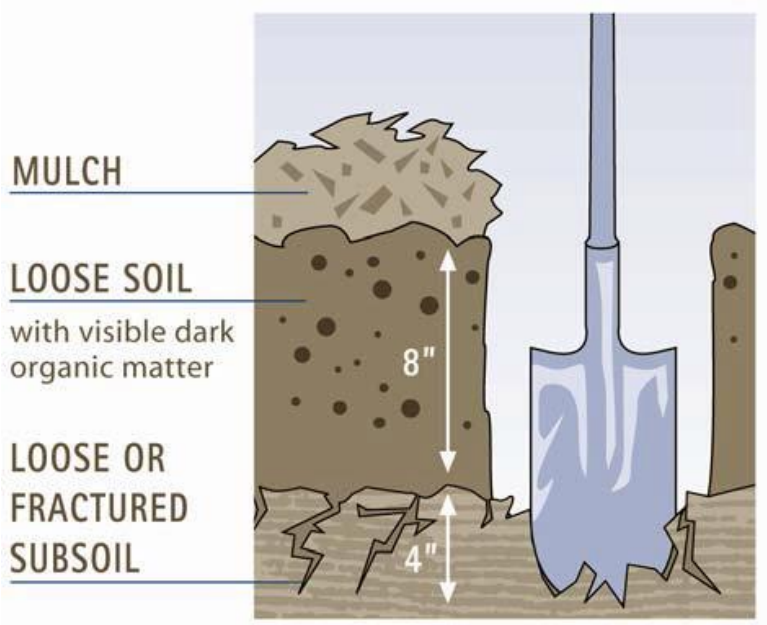
[a] Frequency: A= Annually; B= Biannually (twice per year); W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

[b] Inspection should occur during plant establishment period (1-2 years, or additional 3rd year during extreme dry weather).

Compost-Amended Soils

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. Compaction from construction can reduce the soils natural ability to provide these functions. Establishing a minimum soil quality and depth in the post-development landscape can regain some of these stormwater functions including increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals. Sufficient organic content is a key to soil quality. Soil organic matter can be attained through numerous amendments such as compost, composted woody material, biosolids, and forest product residuals.

City of Olympia development standards require that all disturbed pervious areas be conditioned with compost-amended soils to demonstrate an 8-inch minimum depth of loose soil with visible dark organic matter, covered by 4-inches of organic mulch.



Key Maintenance Considerations

Key maintenance considerations for compost-amended soils include the replenishment of soil media as needed (as a result of erosion) and addressing compacted, poorly draining soils. The full benefits of compost-amended soils are realized when desired soil media depths are maintained and soil compaction is minimized. Care should be taken to prevent compaction of soils via vehicular loads and/or excessive foot traffic, especially during wet conditions.

Compost-Amended Soils

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
General				
Soil media (maintain high organic soil content).	A	Vegetation not fully covering ground surface or vegetation health is poor.	Yes No	• Maintain 2 to 3 inches of mulch over bare areas in landscape beds. • Add plants if sufficient space. • Re-seed bare turf areas until the vegetation fully covers ground surface.
		None (routine maintenance)	Yes No	Return leaf fall and shredded woody materials from the landscape to the site when possible in order to replenish soil nutrients and structure.
		None (routine maintenance)	Yes No	On turf areas, "grasscycle" (mulch-mow or leave the clippings) to build turf health.
		None (routine maintenance)	Yes No	Avoiding use of pesticides (bug and weed killers), like "weed & feed", which damage the soil.
		None (routine maintenance)	Yes No	• Where fertilization is needed (mainly turf and annual flower beds), a moderate fertilization program should be used which relies on compost, natural fertilizers or slow-release synthetic balanced fertilizers. • Follow IPM protocols for fertilization procedures (see "Additional Maintenance Resources" in Bioretention Facilities section for more information on IPM protocols).
Soil media (maintain infiltration)	Ab	Soils become waterlogged, do not appear to be infiltrating.	Yes No	• To remediate compaction, aerate soil, till to at least 8-inch depth, or further amend soil with compost and re-till. • If areas are turf, aerate compacted areas and topdress them with 1/4 to 1/2 inch of compost to renovate them. • If drainage is still slow, consider investigating alternative causes (e.g., high wet season groundwater levels, low permeability soils). • Also consider site use and protection from compacting activities.

Compost-Amended Soils

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Erosion/ Scouring	A, W, S	Areas of potential erosion are visible.	Yes No	• Identify and address cause of erosion (e.g., concentrate flow entering area, channelization of runoff) and stabilize damaged area (regrade, rock, vegetation, erosion control matting). • For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made.
Grass/ Vegetation		Less than 75% of planted vegetation is healthy with a generally good appearance.	Yes No	• Take appropriate maintenance actions (e.g., remove/ replace plants). • If problem persists, evaluate if vegetation is appropriate for the location (e.g., exposure, soil, soil moisture).
Noxious weeds	B	Listed noxious vegetation is present (refer to current county noxious weed list).	Yes No	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately. • Reasonable attempts must be made to remove and dispose of class C noxious weeds. • Watch for and respond to new occurrences of especially aggressive weeds such as Himalayan blackberry, Japanese knotweed, morning glory, English ivy, and reed canary grass to avoid invasions. • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions.
Weeds	B	Weeds are present.	Yes No	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate. • Follow IPM protocols for weed management(see "Additional Maintenance Resources" in Bioretention Facilities section for more information on IPM protocols).

[a] Frequency: A= Annually; B= Biannually (twice per year); M = monthly; S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).; W = At least one inspection/maintenance visit should occur during the wet season (for debris/clog related maintenance, this maintenance visit should occur in the early fall, after deciduous trees have lost their leaves).

[b] Inspection should occur during storm event

IPM – Integrated Pest Management

Rain Gardens

Rain gardens are non-engineered, shallow, landscaped depressions with compost-amended soils and adapted plants. The depression temporarily stores stormwater runoff from adjacent areas. Some or all of the influent stormwater passes through the amended soil profile and into the underlying native soil. Stormwater that exceeds the storage capacity is designed to overflow to an adjacent drainage system.

Key Maintenance Considerations

The main components of rain gardens (and the associated maintenance considerations) are very similar to those listed for bioretention facilities. However, rain gardens do not require an engineered soil mix (native soils may be amended) and usually do not have underdrains or other control structures. Fertilizer use should be avoided in rain gardens, particularly those located in watersheds draining to phosphorous limited water bodies.

- ***Inlet**:* Stormwater can flow into a rain garden in a number of ways including: dispersed flow across vegetated areas, sheet flow across impervious areas, or piped from a roof downspout. Inlets must be maintained to be unobstructed to ensure that stormwater enters the garden as designed. Erosion control measures must also be maintained in areas of concentrated flows (e.g., piped inlets).
- ***Facility footprint**:* The facility footprint is typically an earthen depression or another type of basin (e.g., concrete planter box) that provides surface storage for stormwater before it infiltrates into the underlying soil. If the facility is located on a slope, low permeability check dams may be included (oriented perpendicular to the slope) to encourage ponding.
- Rain gardens are designed to infiltrate all ponded water within a 24-to 48-hour drawdown time after the end of a storm. This allows the soil to dry out periodically in order to restore the capacity of the system and prevent conditions supportive of mosquito breeding. Slower drawdown times may indicate that the underdrain (if present) is plugged or the amended soil is overly compacted or clogged.
- ***Mulch**:* The amended soil is covered by a layer of mulch, comprised of arborist wood chips, compost, and/or rocks. Mulch reduces weed establishment. Organic mulches regulate soil temperatures and moisture, and add organic matter to soil. The mulch layer must be supplemented regularly.
- ***Vegetation**:* Bioretention systems rely on vegetation (i.e., grasses, shrubs, and sometimes trees) to intercept, uptake, and evapotranspire stormwater. In addition, plant roots improve soil structure and increase infiltration capacity. Regular maintenance activities associated with vegetation include weeding and pruning. Plants also require irrigation during the first 2 to 3 years of establishment and during extended dry periods.
- ***Overflow**:* Flows exceeding the capacity of the facility are discharged via an overflow structure (e.g., pipe, curb cut, earthen channel). It is important to maintain clear outlet pipes and overflow structures to ensure that stormwater can be safely conveyed to a designated discharge point (e.g., storm drain system).

Rain gardens must be protected from foot traffic, vehicles and other loads, particularly during wet conditions, to prevent compaction of the amended soil and preserve infiltration capacity. Signage can also be used to identify the vegetated area as a stormwater management area and inform maintenance crews and the general public about protecting the rain garden's function (e.g., no walking in the garden).

Rain Gardens

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Rain Garden Footprint				
Earthen side slopes	B (during the wet season)	Persistent soil erosion on slopes.	Yes No	If erosion persists, water may be flowing into the garden too rapidly. In this case, the slope of the pipe or swale directing water to the garden, or the amount of water may need to be reduced (see "Erosion control at inlet").
Rockery sidewalls	A	Rockery side walls are insecure.	Yes No	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height).
Rain garden footprint		Trash and debris present.	Yes No	Clean out trash and debris.
Rain garden bottom area	A	Visible sediment deposition in the rain garden that reduces drawdown time of water in the rain garden.	Yes No	Remove sediment accumulation. If sediment is deposited from water entering the rain garden, determine the source and stabilize the area.
		Accumulated leaves in rain garden (may reduce infiltration capacity of rain garden or clog overflow).	Yes No	Remove leaves.
Ponded water	B, S	Excessive ponding water: Ponded water remains in the basin more than 3 days after the end of a storm.	Yes No	Confirm leaf, debris or sediment buildup in the bottom of the rain garden is not impeding infiltration. If necessary, remove leaf litter/debris/sediment. If this does not solve the problem, consultation with a professional with rain garden expertise is recommended to evaluate the following: • Check for other water inputs (e.g., groundwater, illicit connections). • Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. • Determine if the soil is clogged by sediment accumulation at the surface or if the soil has become overly compacted.

Rain Gardens

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Inlets/Outlets/Pipes				
Splash block inlet	A	Water is not being directed properly to the rain garden and away from the building.	Yes No	Reconfigure/ repair blocks to direct water to the rain garden and away from building.
Pipe inlet/ outlet	A	Pipe capacity is reduced by sediment or debris (can cause backups and flooding).	Yes No	Clear pipes of sediment and debris.
Pipe inlet/outlet (cont'd)	A	Damaged/cracked drain pipes.	Yes No	• Repair/seal cracks. • Replace when repair is insufficient.
Erosion control at inlet	A	Rock or cobble is removed or missing and concentrated flows are contacting soil.	Yes No	Maintain a cover of rock or cobbles to protect the ground where concentrated water flows into the rain garden from a pipe or swale.
Vegetation				
Vegetation		Dying, dead, or unhealthy plants.	Yes No	• Maintain a healthy cover of plants. • Remove any diseased plants or plant parts and dispose of in commercial landfill to avoid risk of spreading the disease to other plants. • Disinfect gardening tools after pruning to prevent the spread of disease. • Re-stake trees if they need more support, but plan to remove stakes and ties after the first year. • Cars can damage roots – protect root areas of trees and plants from vehicle traffic.
		Vegetation inhibits sight distances and sidewalks.	Yes No	Keep sidewalks and sight distances on roadways clear.
		Broken, dead, or sucker vegetation is present.	Yes No	Remove broken or dead branches and suckers.
		Vegetation is crowding inlets and outlets.	Yes No	Keep water inlets and outlets in the rain garden clear of vegetation.
		Broken, dead, or sucker vegetation is present.	Yes No	Remove broken or dead branches and suckers.
		Vegetation is crowding inlets and outlets.	Yes No	Keep water inlets and outlets in the rain garden clear of vegetation.

Rain Gardens

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Vegetation	One time March through June	• Yellowing: possible Nitrogen (N) deficiency • Poor growth: possible Phosphorous (P) deficiency. • Poor flowering, spotting or curled leaves, or weak roots or stems: possible Potassium (K) deficiency.	Yes No	• Test soil to identify specific nutrient deficiencies. • Consult with a professional knowledgeable in the area of natural amendments or refer to Natural Lawn and Garden Care resources and avoid synthetic fertilizers. • Consider selecting different plants for soil conditions.
Weeds		Problem weeds are present.	Yes No	• Remove weeds by hand, especially in spring when the soil is moist and the weeds are small. • Dig or pull weeds out by the roots before they go to seed. • Apply mulch after weeding (see "Mulch").
Mulch				
Mulch		Bare spots (without mulch cover) are present or mulch depth less than 2 inches.	Yes No	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Use coarse compost in the bottom of the rain garden and arborist wood chips on side slopes and rim (above typical water levels) • Keep all mulch from being in contact with woody stems.
Watering				
Summer watering (first year)		Tree, shrubs and groundcovers in first year of establishment period	Yes No	• 10 to 15 gallons per tree to 5 gallons per shrub • gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present • Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present

Rain Gardens

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Summer watering (second and third years)		Tree, shrubs and groundcovers in second or third year of establishment period	Yes No	• 10 to 15 gallons per tree • to 5 gallons per shrub • gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present
Summer watering (after establishment)		Established vegetation (after 3 years)	Yes No	• Water during drought conditions or more often if necessary to maintain plant cover • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different rain garden species and water immediately after initial signs of stress appear.
Pest Control				
Mosquitoes	B, S	Standing water remains for more than 3 days after the end of a storm	Yes No	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti)

[a] Frequency: A = Annually; B = Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

Bioretention Facilities

Bioretention facilities are engineered facilities that store and treat stormwater by filtering it through a specified soil profile. 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.

Key Maintenance Considerations

The main components of bioretention facilities are listed below with descriptions of their function and key maintenance considerations.

***Inlet**:* Stormwater can flow into a bioretention facility in a number of ways including dispersed flow across vegetated areas, sheet flow across impervious areas, or concentrated flow through curb cuts and/or piped flow inlets. Inlets must be maintained to be unobstructed to ensure that stormwater enters the facility as designed.

***Facility footprint**:* The facility footprint is typically an earthen depression or another type of basin (e.g., concrete planter box) that provides surface storage for stormwater before it infiltrates into the underlying bioretention soil. If the facility is located on a slope, low permeability check dams may be included (oriented perpendicular to the slope) to encourage ponding.

***Bioretention soil mix**:* Infiltration of stormwater through the engineered bioretention soil mix provides water quality treatment. All maintenance activities must be performed in a manner to prevent compaction of the bioretention soil.

***Mulch**:* The bioretention soil is covered by a layer of mulch, comprised of arborist wood chips, compost, and/or rocks. Mulch reduces weed establishment. Organic mulches regulate soil temperatures and moisture, and add organic matter to soil. The mulch layer must be supplemented regularly.

***Vegetation**:* Bioretention systems rely on vegetation (i.e., grasses, shrubs, and sometimes trees) to intercept, uptake, and evapotranspire stormwater. In addition, plant roots improve soil structure and increase infiltration capacity. Regular maintenance activities associated with vegetation include weeding and pruning. Plants also require irrigation during the first 2 to 3 years of establishment and during extended dry periods.

***Overflow**:* Flows exceeding the capacity of the facility are discharged via an overflow structure (e.g., pipe, curb cut, earthen channel). It is important to maintain clear outlet pipes and overflow structures to ensure that stormwater can be safely conveyed to a designated discharge point (e.g., storm drain system).

***Underdrains (optional)**:* Underdrains are optional components of a bioretention facility that may be included in bioretention systems where, for example, infiltration to underlying soil is not prudent or feasible. Underdrains are installed under the bioretention soil layer to collect and convey treated water. An underdrain system can be comprised of perforated or slotted pipe, wrapped in an aggregate blanket. It is important to maintain clear drains so that water moves through system as designed.

For a bioretention system to function properly, stormwater must infiltrate freely through the bioretention soil. The soil infiltration rate can be reduced if the soil is subject to compaction (e.g., foot and vehicle traffic loads), and therefore these types of traffic should be avoided.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Facility Footprint				
Earthen side slopes and berms	B, S	Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	Yes No	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) • For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. • Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A	Erosion of sides causes slope to become a hazard	Yes No	Take actions to eliminate the hazard and stabilize slopes.
	A, S	Settlement greater than 3 inches (relative to undisturbed sections of berm)	Yes No	Restore to design height.
	A, S	Downstream face of berm wet, seeps or leaks evident	Yes No	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A	Any evidence of rodent holes or water piping in berm	Yes No	• Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A	Cracks or failure of concrete sidewalls	Yes No	• Repair/ seal cracks • Replace if repair is insufficient
Rockery sidewalls	A	Rockery side walls are insecure	Yes No	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Facility Area		Trash and debris present	Yes No	Clean out trash and debris
Facility bottom area	A, S	Accumulated sediment to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted	Yes No	• Remove excess sediment • Replace any vegetation damaged or destroyed by sediment accumulation and removal • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		Accumulated leaves in facility	Yes No	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded.
Low Permeability Check dams and weirs	A, S	Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice.	Yes No	Clear the blockage.
	A, S	Erosion and/or undercutting present.	Yes No	Repair and take preventative measures to prevent future erosion and/or undercutting.
	A	Grade board or top of weir damaged or not level.	Yes No	Restore to level position.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Ponded water	B, S	Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Yes No	Determine cause and resolve in the following order: 1. Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2. Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3. Check for other water inputs (e.g., groundwater, illicit connections). 4. Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Inlets/Outlets/Pipes				
Bioretention soil media	As needed	Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint	Yes No	• Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Splash block inlet	A	Water is not being directed properly to the facility and away from the inlet structure	Yes No	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M (during the wet season and before severe storm is forecasted)	Accumulated leaves at curb cuts	Yes No	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A	Pipe is damaged	Yes No	Repair/ replace
	W	Pipe is clogged	Yes No	Remove roots or debris
	A, S	Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	Yes No	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Accumulated leaves at inlets/outlets	Yes No	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		Maintain access for inspections	Yes No	• Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	A	Concentrated flows are causing erosion	Yes No	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)
Trash rack	S	Trash or other debris present on trash rack	Yes No	Remove/dispose
	A	Bar screen damaged or missing	Yes No	Repair/replace
Overflow	A, S	Capacity reduced by sediment or debris	Yes No	Remove sediment or debris/dispose

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Underdrain pipe	Clean pipe as needed	• Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water")	Yes No	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring	Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	Yes No	• Determine cause of poor vegetation growth and correct condition. • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the LID Technical Guidance Manual for Puget Sound). • Confirm that plant selection is appropriate for site growing conditions. • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants.
Vegetation (general)	As needed	Presence of diseased plants and plant material	Yes No	• Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants. • Disinfect gardening tools after pruning to prevent the spread of disease • See Pacific Northwest Plant Disease Management Handbook for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Trees and shrubs		Pruning as needed	Yes No	• Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist.
	A	Large trees and shrubs interfere with operation of the facility or access for maintenance	Yes No	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and shrubs, if necessary.
	Fall and Spring	Standing dead vegetation is present	Yes No	• Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring	Planting beneath mature trees	Yes No	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
	Fall and Spring	Presence of or need for stakes and guys (tree growth, maturation, and support needs).	Yes No	• Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage. • Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. • Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained).	A	Vegetation causes some visibility (line of sight) or driver safety issues.	Yes No	• Maintain appropriate height for sight clearance. • When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. • Remove or transplant if continual safety hazard. • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants.
Flowering plants	As needed	Dead or spent flowers present.	Yes No	Remove spent flowers (deadhead).
Perennials	As needed	Spent plants.	Yes No	Cut back dying or dead and fallen foliage and stems.
Emergent vegetation	As needed	Vegetation compromises conveyance.	Yes No	• Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)	As needed	Dead material from previous year's growing cycle or dead collapsed foliage.	Yes No	• Leave dry foliage for winter interest. • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Ornamental grasses (evergreen)	As needed	Dead growth present in spring.	Yes No	• Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring. • Clean, rake, and comb grasses when they become too tall. • Cut back to ground or thin every 2-3 years as needed.
Noxious weeds	As needed	Listed noxious vegetation is present (refer to current county noxious weed list).	Yes No	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately. • Reasonable attempts must be made to remove and dispose of class C noxious weeds. • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions. • Apply mulch after weed removal (see "Mulch").
Weeds	As needed	Weeds are present	Yes No	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation	As needed	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil.	Yes No	• Edge or trim groundcovers and shrubs at facility edge • Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks • While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Excessive vegetation	As needed	Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety.	Yes No	• Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics. • Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow.) • Remove plants that are weak, broken or not true to form; replace in-kind. • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas. • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants.
	As needed	Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass.	Yes No	• Remove vegetation and sediment buildup.
Mulch				
Mulch	As needed	Bare spots (without mulch cover) are present or mulch depth less than 2 inches		• Supplement mulch with hand tools to a depth of 2 to 3 inches. • Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels). • Keep all mulch away from woody stems.
Watering				
Irrigation system (if any)		Irrigation system present.		• Follow manufacturer's instructions for O&M
	A	Sprinklers or drip irrigation not directed/located to properly water plants.		• Redirect sprinklers or move drip irrigation to desired areas

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Summer watering (first year)		Trees, shrubs and groundcovers in first year of establishment period.		• 10 to 15 gallons per tree. • 3 to 5 gallons per shrub. • 2 gallons water per square foot for groundcover areas. • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist. • Use soaker hoses or spot water with a shower type wand when irrigation system is not present. • Pulse water to enhance soil absorption, when feasible. • Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff. • Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present.

Summer watering (second and third years)		Trees, shrubs and groundcovers in second or third year of establishment period.		• 10 to 15 gallons per tree
				• to 5 gallons per shrub
				• gallons water per square foot for groundcover areas
				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ○ Pulse water to enhance soil absorption, when feasible.
				  ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Summer watering (after establishment)		Established vegetation (after 3 years).		• Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established. • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear. • Water during drought conditions or more often if necessary to maintain plant cover.
Pest Control				
Mosquitoes	B, S	Standing water remains for more than 3 days after the end of a storm.		• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water"). • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti).
Nuisance animals	As needed	Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces.		• Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.

Bioretention Facilities

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Insect pests	Every site visit associated with vegetation mgmt.	Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators.		• Reduce hiding places for pests by removing diseased and dead plants. • For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols).

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

Permeable Pavements

Permeable pavements allow water to infiltrate into layers of gravel placed below the paving surface and then into soil and groundwater below. By infiltrating most of the storm water on-site, the amount of water and pollution flowing into storm drains and directly to rivers and streams is greatly reduced. This, in turn, protects water quality, maintains more stable base flows to streams, reduces flood peaks, and reduces stream bank erosion. With infiltration, groundwater is recharged and streams are replenished with cool, clean groundwater in a more natural way. Permeable pavements are one component of Low Impact Development (LID).

Key Maintenance Considerations

The main components of permeable pavement facilities are listed below with descriptions of their function and key maintenance considerations.

Wearing course: The surface layer of any permeable pavement system is the wearing course. A critical component of a successful maintenance program is regular removal of sediment and debris, excessive moss from the facility surface to prevent clogging of the permeable wearing course. Categories of wearing courses include:

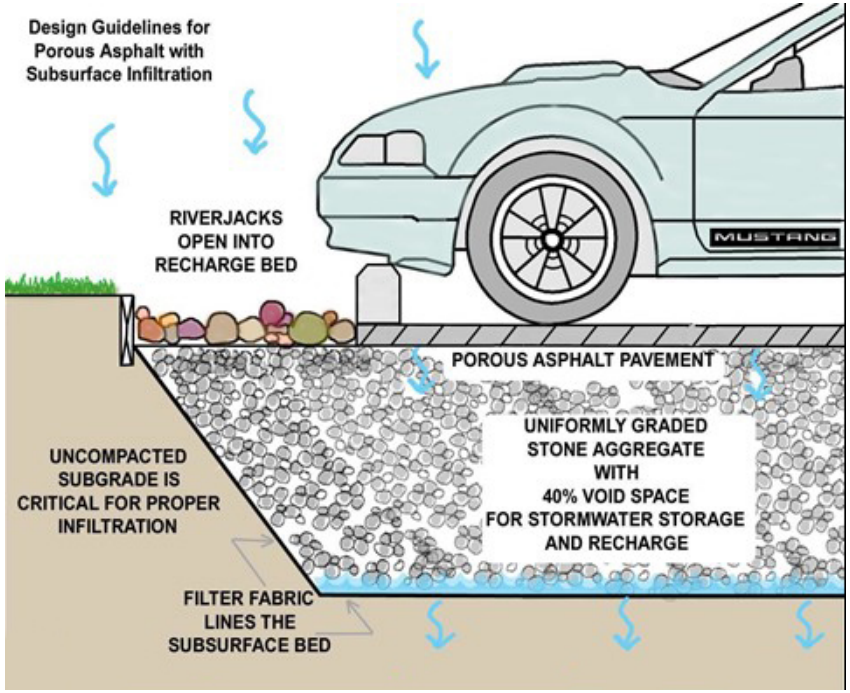
- *Porous asphalt:* A flexible pavement similar to standard asphalt that uses a bituminous binder to adhere aggregate. However, the fine material (sand and finer) is reduced or eliminated, resulting in the formation of voids between the aggregate in the pavement surface that allows water to infiltrate to the underlying aggregate base.
- *Pervious concrete:* A rigid pavement similar to conventional concrete that uses a cementitious material to bind aggregate together. However, the fine aggregate (sand) component is reduced or eliminated in the gradation, resulting in the formation of voids between the aggregate in the pavement surface that allows water to infiltrate to the underlying aggregate base.
- *Interlocking concrete paver blocks:* Solid, precast, manufactured modular units. Pavements constructed with these units create joints that are filled with permeable aggregate and installed on an open-graded aggregate base.
- *Aggregate Pavers (or Pervious Pavers):* Modular precast paving units made with uniformly sized aggregates and bound with Portland cement concrete using a high strength adhesive. Unlike concrete paver blocks, these pavers are permeable. Pavements constructed with these units create joints that are filled with permeable aggregate and installed on an open-graded aggregate base.
- *Open-celled paving grid with gravel:* Concrete or plastic grids that are filled with permeable aggregate. The system can be installed on an open-graded aggregate base.
- *Open-celled paving grid with grass:* Concrete or plastic grids that are filled with a mix of sand, gravel, and topsoil for planting vegetation. The cells can be planted with a variety of non-turf forming grasses or low-growing groundcovers. The system can be installed on an open-graded aggregate base.

Permeable Pavements (cont.)

Inlet (optional): While permeable pavement facilities often manage only the rain falling directly on the pavement surface, they may also be designed to accept stormwater runoff from additional areas (e.g., adjacent impervious areas, nearby rooftops). Runoff can be directed to the facility by two main methods:

- *Sheet flow to the surface:* Surface areas of the facility receiving runoff contributions will likely be prone to clogging due to sediment inputs, particularly in areas of concentrated inflow. These areas should be carefully inspected and corrective maintenance should be performed as necessary to maintain the function of the pavement at these sites. In addition, the source of the sediment loads should be evaluated to determine if modifications to features in the drainage area landscape (e.g., stabilization of adjacent planted areas) would help to prevent clogging.
- *Piped flow into the aggregate base*: Pipes dispersing water into the aggregate bed should be designed with cleanout access to allow pipe maintenance. Runoff that is piped into the aggregate base should be pretreated for sediment removal (e.g., screens, sumps) to protect the subbase from sedimentation and clogging. The pretreatment system must be maintained to remove accumulated sediment.

Aggregate Base / Storage Reservoir: Stormwater passes through the wearing course to an underlying aggregate storage reservoir where it is stored prior to infiltration into the underlying soil. This aggregate bed also provides the structural function of supporting design loads (e.g., vehicle loading) for flexible pavement systems. To allow inspection of the aggregate course, some facilities have an observation port (typically installed during construction) that allows monitoring of the water levels in the aggregate bed to determine if the facility is draining properly.



Overflow: Unless designed to provide full infiltration of stormwater, permeable pavement facilities have an overflow. Facility overflow can be provided by subsurface slotted drain pipe(s) (elevated in the aggregate bed) routed to an inlet or catch basin structure or by lateral flow through the storage reservoir to a daylighted drainage system.

Underdrain with flow restrictor (optional): A slotted drain pipe with flow restrictor assembly may be installed at the bottom of or elevated within the aggregate storage reservoir. Permeable pavement facilities with underdrains and flow restrictors operate as underground detention systems with some infiltration.

Permeable Pavements (cont.)

Key Operations to Preserve Facility Function

There are several permeable pavement operational actions that can limit the likelihood of corrective maintenance actions or replacement including the following:

- Prohibiting use of sealant on porous asphalt
- Protecting from construction site runoff with proper temporary erosion and sediment controls and flow diversion measures
- Modifying utility cut procedures for permeable pavements. Protocols should recommend restoring permeable pavement section in-kind, where feasible, and require restoring permeable pavement section in-kind where replacement with conventional pavement would affect overall facility function. Replacing permeable pavement with conventional pavement is acceptable if it is a small percentage of the total facility area and does not affect the overall facility function. That determination should be made by a licensed engineer with approval by the City.
- Modifying snow removal procedures such as:
    - Using a snow plow with skids or rollers to slightly raise the blade above permeable pavers or open-celled paving grid systems to prevent loss of top course aggregate and damage to paver blocks or grids
    - Avoiding stockpiling plowed snow (i.e., dirty snow) directly on top of permeable pavement
    - Avoiding application of sand to pervious pavement and adjacent streets where vehicles may track it onto the pervious pavement. If sand is applied, on an emergency basis during snowy conditions, vacuum sweep surface as soon as possible after the sand is no longer needed.
    - Use alternative deicers in moderation (e.g., salt, molasses-based and chemical deicers).
- Protecting the surface from stockpiles of landscaping materials (e.g., mulch, soil, compost) being used for adjacent pervious areas
- Stabilizing adjacent landscaped areas to avoid eroding soil and clogging surfaces or sloping adjacent landscaped areas away from permeable pavement , if possible.
- Signage or pavement marking can also be used to identify permeable pavement as a stormwater BMP and inform maintenance crews and the general public about protecting the facility's function (e.g., no stockpiling of soils or mulch on pavement surface).

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Surface/Wearing Course				
Permeable Pavements, all	A, S	Runoff from adjacent pervious areas deposits soil, mulch or sediment on paving.	Yes No	• Clean deposited soil or other materials from permeable pavement or other adjacent surfacing. • Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place). • Mulch and/or plant all exposed soils that may erode to pavement surface.
Porous asphalt or pervious concrete		None (routine maintenance)	Yes No	Clean surface debris from pavement surface using one or a combination of the following methods: • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves). • Vacuum/sweep permeable paving installation using: o Walk-behind vacuum (sidewalks). o High efficiency regenerative air or vacuum sweeper (roadways, parking lots). o ShopVac or brush brooms (small areas). • Hand held pressure washer or power washer with rotating brushes. Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Porous asphalt or pervious concrete	A[b]	Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate).	Yes No	• Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility). • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, but not less than 1 test per 2,500 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods: • Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate. • Hand held pressure washer or power washer with rotating brushes. • Pure vacuum sweepers. Note: If the annual/biannual routine maintenance standard to clean the pavement surface is conducted using equipment from the list above, corrective maintenance may not be needed.
	A	Sediment present at the surface of the pavement.	Yes No	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding then see above. • Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Porous asphalt or pervious concrete	Summer	Moss growth inhibits infiltration or poses slip safety hazard.	Yes No	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: .Pressure wash, vacuum sweep, or use a combination of the two for cleaning moss from pavement surface. May require stiff broom or power brush in areas of heavy moss.
	A	Major cracks or trip hazards and concrete spalling and raveling.	Yes No	• Fill potholes or small cracks with patching mixes. • Large cracks and settlement may require cutting and replacing the pavement section. Replace in-kind where feasible. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function. • Take appropriate precautions during pavement repair and replacement efforts to prevent clogging of adjacent porous materials.

Interlocking concrete paver blocks and aggregate pavers		None (routine maintenance)	Yes
			No
				Clean pavement surface using one or a combination of the following methods:
				• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves).
				• Vacuum/sweep permeable paving installation using:
				  ○ Walk-behind vacuum (sidewalks).
				  ○ High efficiency regenerative air or vacuum sweeper (roadways, parking lots).
				  ○ ShopVac or brush brooms (small areas).

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Interlocking concrete paver blocks and aggregate pavers		None (routine maintenance)	Yes No	Note: Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.
	A [b]	Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)].	Yes No	Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility). Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, but not less than one test per 2,500 square feet. If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. Clogging is usually an issue in the upper 2 to 3 centimeters of aggregate. Remove the upper layer of encrusted sediment, and fines, and/or vegetation from openings and joints between the pavers by mechanical means and/or suction equipment (e.g., pure vacuum sweeper). Replace aggregate in paver cells, joints, or openings per manufacturer's recommendations.
	A	Sediment present at the surface of the pavement.	Yes No	Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding, then see above. Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Interlocking concrete paver blocks and aggregate pavers	Summer	Moss growth inhibits infiltration or poses slip safety hazard.	Yes No	Sidewalks: Use a stiff broom to remove moss in the summer when it is dry. Parking lots and roadways: Vacuum sweep or stiff broom/power brush for cleaning moss from pavement surface.
	A	Paver block missing or damaged.	Yes No	Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations.
	A	Loss of aggregate material between paver blocks.	Yes No	Refill per manufacturer's recommendations for interlocking paver sections.
	A	Settlement of surface.	Yes No	May require resetting.
Open-celled paving grid with gravel		None (routine maintenance)	Yes No	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves). • Follow equipment manufacturer guidelines for cleaning surface.
	A b	Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)].	Yes No	• Use vacuum truck to remove and replace top course aggregate. • Replace aggregate in paving grid per manufacturer's recommendations.
	A	Paving grid missing or damaged.	Yes No	• Remove pins, pry up grid segments, and replace gravel. • Replace grid segments where three or more adjacent rings are broken or damaged. • Follow manufacturer guidelines for repairing surface.
	A	Settlement of surface.	Yes No	May require resetting

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Open-celled paving grid with gravel	A	Loss of aggregate material in paving grid.	Yes No	Replenish aggregate material by spreading gravel with a rake (gravel level should be maintained at the same level as the plastic rings or no more than 1/4 inch above the top of rings). See manufacturer's recommendations.
		Weeds present.	Yes No	• Manually remove weeds. • Presence of weeds may indicate that too many fines are present (refer to Actions Needed under "Aggregate is clogged" to address this issue).
Open-celled paving grid with grass		None (routine maintenance)	Yes No	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves). • Follow equipment manufacturer guidelines for cleaning surface.
	A b	Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)].	Yes No	• Rehabilitate per manufacturer's recommendations.
	A	Paving grid missing or damaged.	Yes No	• Remove pins, pry up grid segments, and replace grass. • Replace grid segments where three or more adjacent rings are broken or damaged. • Follow manufacturer guidelines for repairing surface.
	A	Settlement of surface.	Yes No	• May require resetting.
	A	Poor grass coverage in paving grid.	Yes No	• Restore growing medium, reseed or plant, aerate, and/or amend vegetated area as needed. • Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible.

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Open-celled paving grid with grass		None (routine maintenance)	Yes No	• Use a mulch mower to mow grass.
		None (routine maintenance)	Yes No	• Sprinkle a thin layer of compost on top of grass surface (1/2" top dressing) and sweep it in. • Do not use fertilizer.
		Weeds present	Yes No	• Manually remove weeds. • Mow, torch, or inoculate and replace with preferred vegetation.
Inlets/Outlets/Pipes				
Inlet/outlet pipe	A	Pipe is damaged.	Yes No	Repair/replace.
	A	Pipe is clogged.	Yes No	Remove roots or debris.
Underdrain pipe	Clean pipe as needed	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period).	Yes No	• Jet clean or rotary cut debris/roots from underdrain(s). • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Raised subsurface overflow pipe	Clean pipe as needed	Plant roots, sediment or debris reducing capacity of underdrain.	Yes No	• Jet clean or rotary cut debris/roots from under-drain(s). • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Outlet structure	A, S	Sediment, vegetation, or debris reducing capacity of outlet structure.	Yes No	• Clear the blockage. • Identify the source of the blockage and take actions to prevent future blockages.
Overflow	B	Native soil is exposed or other signs of erosion damage are present at discharge point.	Yes No	Repair erosion and stabilize surface.

Permeable Pavements

Component	Required Inspection Frequency[1]	Issue or Condition Requiring Maintenance (Standards)	Issue Exists?	Corrective Action (Procedures)
Aggregate Storage Reservoir				
Observation Port	A, S	Water remains in the storage aggregate longer than anticipated by design after the end of a storm.	Yes No	If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Vegetation				
Adjacent large shrubs or trees		Vegetation related fallout clogs or will potentially clog voids.	Yes No	• Sweep leaf litter and sediment to prevent surface clogging and ponding. • Prevent large root systems from damaging subsurface structural components.
		Vegetation growing beyond facility edge onto sidewalks, paths, and street edge.	Yes No	Edging and trimming of planted areas to control groundcovers and shrubs from overreaching the sidewalks, paths and street edge improves appearance and reduces clogging of permeable pavements by leaf litter, mulch and soil.
Leaves, needles, and organic debris		Accumulation of organic debris and leaf litter.	Yes No	Use leaf blower or vacuum to blow or remove leaves, evergreen needles, and debris (i.e., flowers, blossoms) off of and away from permeable pavement.

[a] Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.