Stormwater Facility Maintenance Manual BG02.02 March 2019

Public Works Department
Engineering Division
109 SW 1st Street, Suite #122
Battle Ground, WA 98604

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Introduction

Background

Nearly all development, whether residential, commercial or industrial, has some form of stormwater drainage facilities. These stormwater facilities drain to the City of Battle Ground storm sewer system and then to our local waterways. Newer developments include structures such as grassy treatment swales, ponds, oil/water separators, and other structures to control or treat stormwater.

Requirements from the Washington State Department of Ecology and the Clean Water Act require the City to comply with rules to protect our water resources by ensuring that storm drainage facilities are properly operated and maintained. This manual describes the steps you can take to assure that your storm facilities meet water quality requirements.

Purpose

This manual is intended to cover most public and private stormwater facility operation and maintenance requirements under Battle Ground Municipal Code 18.250, the City's NPDES Phase II permit, and the Stormwater Management Manual for Western Washington: Volume II (Washington Department of Ecology, December 2014).

Drainage systems are often in or near areas that are also wildlife habitat. This manual helps make sure that storm facility owners perform their maintenance in a way that conforms to regulations protecting wildlife.

Why Maintain Storm Facilities?

In addition to keeping the site from flooding, properly maintained storm facilities can help protect streams, lakes, wetlands, and groundwater. Proper maintenance helps assure that storm facilities operate as they were designed and that they are cleaned of the pollutants that they trap.

Method for Creating this Manual

This manual draws on other maintenance manuals including the Clark County Stormwater Facilities Maintenance Manual (January 2009), Stormwater Management Manual for Western Washington and the Pierce County Stormwater Maintenance Manual for Private Facilities (2005).

The Low Impact Development portion of this manual draws on the Guidance Document – Western Washington Low Impact Development (LID) Operation and Maintenance (O&M) prepared for the Washington State Department of Ecology Water Quality

Program by Herrera Environmental Consultants, Inc. and Washington Stormwater Center (May 2013).

Emergent Treatment Technologies

Volume V, Chapter 12 of the Western Washington Manual addresses emerging treatment technologies. Since emerging technologies are rapidly evolving and it is not practical to update the manual every time a new device comes out, the Technology Assessment Protocol - Ecology (TAPE) was created as guidance for evaluating emerging stormwater treatment technologies. The TAPE can be found online at https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Stormwater-permittee-guidance-resources/Emerging-stormwater-treatment-technologies.

Ecology assigns a General Use Level Designation (GULD) on emergent technologies that may be used. Maintenance standards in GULD approvals for emergent technologies not found in this Maintenance Manual are adopted by reference and can be found at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

Spill Reporting

The City of Battle Ground Municipal Code requires all spills to the storm sewer system or areas that drain to the storm sewer system to be reported.

In the event of a release of hazardous materials, the City of Battle Ground Department of Public Works and emergency response agencies shall be notified IMMEDIATELY of the occurrence via emergency dispatch services (911).

In the event of a release of non-hazardous materials, the City of Battle Ground Department of Public Works shall be notified in person at 109 SW 1st St or by phone at (360) 342-5070 or facsimile at (360) 342-5057 no later than the next business day. Notifications in person or by phone shall be confirmed by written notice addressed and mailed to the Department within three business days of the phone notice.

Spills shall also be reported to the Washington State Department of Ecology South West Regional office at (360) 407-6300.

If the discharge of materials emanated from a commercial or industrial establishment, the owner or operator of the establishment is required to retain an on-site written record of the discharge and the actions taken to prevent its recurrence. These records must be retained for at least three years.

Detention Pond

A stormwater detention pond is an open basin built by excavating, or by constructing above-ground berms or embankments. The detention pond temporarily stores stormwater runoff during rain events and slowly releases it through a control structure. Detention pond styles can vary greatly from well-manicured to natural appearing. Generally, native vegetation is preferred for reduced maintenance and enhanced wildlife habitat. Some facilities are designed to appear as natural water bodies or are in park-like areas.

Detention Pond – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Any trash and debris which exceed five 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.	Remove trash and debris.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard. Evidence of noxious weeds as defined by State or local regulations.	Remove poisonous or nuisance vegetation. Remove noxious weeds. Comply with State or local eradication policies.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No evidence contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes on berm, or any evidence of water piping through berm via rodent holes.	Rodents eliminated and berm repaired. (Coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in impairment of facility function.	Eliminate beavers. Return facility to design condition. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies.)
	Insects	Insects such as wasps and hornets create problems or pose danger.	Insects destroyed or removed from site. Apply insecticides in compliance with state and federal requirements.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity. Hazard trees such as dead, diseased, or dying trees are identified.	Remove or trim problem trees. Remove hazard Trees.
Side Slopes of Pond	Erosion	Eroded damage over two inches deep.	Stabilize slopes using appropriate permanent erosion control measures.
		Any erosion observed on a compacted berm embankment.	If erosion is occurring on compacted berms a licensed Civil Engineer should be consulted to resolve source of erosion.
	Grass/ Vegetation	Grass exceeds 12 inches in height or vegetation growth becomes excessive.	Mow grass or trim vegetation.
		Poor vegetation coverage.	If bare areas are large (generally greater than 12 inches wide) prepare soil and reseed. For smaller bare areas, over seed or plant plugs of grass at eight inch intervals.

Detention Pond (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inlet or outlet of the facility.	Remove sediment to restore designed pond shape and depth; reseed pond if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4 inch holes in it.	Repair or replace liner. Fully cover liner.
Pond Berms (Dikes)	Settlement	Any part of berm which has settled four inches lower than the design elevation.	Repair berm to the design elevation. 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.
	Soil Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (It is recommended that a Civil engineer is consulted to inspect and evaluate condition of the berm and recommend repair procedure.)	Repair soil piping damage and repair berm to eliminate soil piping condition.
	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over four feet in height may lead to piping through the berm which could lead to failure of the berm.	Remove Trees. If root system is small (base less than four 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.
Emergency Overflow/ Spillway	Rock Missing	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.	Restore rocks and pad depth to design standards.
	Erosion	Eroded damage over two inches deep.	Stabilize slopes using appropriate permanent erosion control measures.
		Any erosion observed on a compacted berm embankment.	If erosion is occurring on compacted berms a licensed Civil Engineer should be consulted to resolve source of erosion.

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Catch Basin

A catch basin is an underground concrete structure to collect stormwater runoff and route it through underground pipes. Catch basins are sometimes used as a junction in a pipe system and in some cases may have a solid lid.

Catch basins typically provide a sump below the outlet pipe to allow sediment and debris to settle out of the stormwater runoff. Some catch basins are also fitted with a spill control device such as an inverted elbow on the outlet pipe to contain large quantities of grease or oils. The most common tool for cleaning catch basins is a vactor truck which is used to remove sediment and debris from the sump.

Catch Basins are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.


NO WASTE
DRAINS TO STREAM

Catch Basins – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin.	Remove trash or debris.
		Trash or debris has accumulated to within six inches of the invert of the lowest pipe.	Remove trash or debris.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Remove trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	Remove dead animals or vegetation.
	Sediment	Sediment has accumulated to within six inches of the invert of the lowest pipe or to within 4 inches of the spill control device.	Remove sediment from catch basin.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than two square inches or cracks wider than 1/4 inch.	Repair or replace top slab.
		Frame not sitting flush on top slab. Separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Repair or replace frame.
	Fractures or Cracks in Basin Walls/ Bottom	Structure is unsound.	Repair or replace basin.
		Grout has separated or cracked wider than 1/2 inch and longer than one foot at the joint of any inlet/outlet pipe or any evidence of soil particles or ground water entering catch basin through cracks.	Re-grout and secure pipe at basin wall.
	Settlement/ Misalignment	Basin has settled or become misaligned creating a safety, function, or design problem.	Repair or replace basin.
	Vegetation	Vegetation growing across and blocking the basin opening.	Remove vegetation.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No evidence contaminants or pollutants present.
	Spill Control Device	Spill control device missing or damaged.	Repair or replace spill control device to design specifications.

Catch Basins (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Catch Basin Cover	Cover Missing	No cover present on structure.	Replace cover.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Repair mechanism so that it operates correctly.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure.	Repair cover.
Metal Grates	Grate Damaged or Missing	Grate missing or has opening wider than 7/8 inch.	Repair or replace grate to design standards.

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Manhole

A manhole is an underground structure to allow access to conveyance pipes for maintenance and inspection purposes. Manholes are used in storm sewer main lines at any change in direction, slope, pipe material or pipe size.

Storm manholes typically provide a storage volume (sump) below the inlet and outlet pipes to allow sediment and debris to settle out of the stormwater runoff. Some manholes are also fitted with stormwater flow control structures such as orifices or weirs.

Manholes are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.

Manhole – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Remove trash or debris.
		Trash or debris has accumulated to within six inches of the invert of the lowest pipe.	Remove trash or debris.
	Sediment	Sediment has accumulated to within six inches of the invert of the lowest pipe.	Remove sediment.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than two square inches or cracks wider than 1/4 inch.	Repair or replace top slab.
		Frame not sitting flush on top slab. Separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Repair or replace frame.
	Fractures or Cracks in Structure Walls/ Bottom	Structure is unsound.	Repair or replace manhole.
		Grout has separated or cracked wider than 1/2 inch and longer than one foot at the joint of any inlet/outlet pipe or any evidence of soil particles or ground water entering manhole through cracks.	Re-grout and secure pipe at manhole wall.
	Settlement/ Misalignment	Manhole has settled or become misaligned creating a safety, function, or design problem.	Repair or replace manhole.
Cover	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Replace cover.
	Locking Mechanism Not Working	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).	Repair or replace locking mechanism or lid.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Repair cover.
Ladder	Ladder Rungs Unsafe	Ladder is corroded or deteriorated, has sharp edges, is not securely attached to structure wall, missing rungs, cracked, or misaligned.	Repair or replace ladder to design specifications.
Control Structure/ Flow Restrictor	See Control Structure/Flow Restrictor requirements.		

Detention Tanks and Vaults

A closed detention system functions similarly to a detention pond but with the storage volume provided by an underground structure. The structure is typically constructed of large diameter pipe, plastic chamber structure or a concrete vault. These systems are typically utilized for sites that do not have space available for an above-ground system and are more commonly associated with commercial sites.

Underground detention systems are enclosed spaces where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual trained and certified to work in hazardous confined spaces.

Detention Tanks and Vaults – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Detention Tank	Plugged Air Vents	More than 1/2 of the cross section of a vent is blocked at any point or the vent is damaged.	Unplug or repair vent.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the height of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72 inch diameter storage tank would require cleaning when sediment reaches depth of seven inches for more than 1/2 length of tank.)	Remove all sediment and debris from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing soil or ground water to enter facility.	Repair all joints between tank/pipe sections.
	Tank/Pipe Bent Out of Shape	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).	Repair or replace tank/pipe to design specifications.
	Damage to Vault Structure	Cracks wider than 1/2 inch and any evidence of soil particles or ground water entering the structure through the cracks. Vault is not structurally sound.	Replace or repair vault to design specifications. Vault is structurally sound.
Cover	Cover Missing	No cover present on structure.	Replace cover.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Repair mechanism so that it operates correctly.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure.	Repair cover.
	Ladder Rungs Unsafe	Ladder is corroded or deteriorated, has sharp edges, is not securely attached to structure wall, missing rungs, cracked, or misaligned.	Repair or replace ladder to design specifications.

Control Structure/Flow Restrictor

Flow control structures, also known as flow restrictors, direct or restrict flow in to or out of facility components. The flow is regulated by a combination of orifices and/or weirs. Lack of maintenance of the control structure can result in the plugging of an orifice or weir. If these flow controls are damaged, plugged, bypassed, or not working properly, the facility could overtop or release water too quickly potentially damaging streams, habitat, and property.

Control Structure/Flow Restrictor – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash, Debris and Sediment	Material has accumulated to within one foot of below orifice plate or weir.	Remove all sediment and debris.
	Structural Damage	Flow control structure is not securely attached to manhole wall.	Repair structure support.
		Structure is not in upright position.	Repair structure to correct position.
		Connections to outlet pipe are not watertight.	Repair connections to outlet pipe to water tight; structure repaired or replaced and works as designed.
		Damage to flow control structure.	Repair or replace flow control structure.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Repair or replace gate to design specifications.
		Gate cannot be moved up and down by one maintenance person.	Repair gate.
		Chain/rod leading to gate is missing or damaged.	Repair or replace chain or rod.
Orifice or Weir Plate	Plate Damaged or Missing	Control device is not working properly due to missing, out of place, or bent plate.	Repair or replace plate to design specifications.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Remove all sediment and/or debris.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Remove all trash and debris.
Manhole	See Manhole requirements		

Trash Screen

A trash screen is a grate over the open end of a culvert or stormwater conveyance pipe. Their function is to prevent debris and unauthorized access into the storm conveyance pipe. Trash screens are required on open pipe ends that exceed 15 inches in diameter. Only qualified personnel should attempt to maintain or remove debris from the barrier when water is flowing through the conveyance pipe.

Trash Screen – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings.	Clear trash or debris to restore design flow capacity.
	Damaged/ Missing Bars.	Bars are bent out of shape more than three inches.	Repair or replace bars.
		Bars are missing.	Repair or replace bars.
		Bars are loose.	Repair or replace bars.
	Missing Trash Screen	Trash screen missing or not attached to pipe.	Repair or replace trash screen.
Lock and Hinges	Lock Missing or Damaged	Lock is not present or does not operate correctly.	Repair or replace lock.
	Cover Difficult to Open	One maintenance person cannot open trash screen barrier using hinges after applying normal lifting pressure.	Repair hinges.

Energy Dissipater

An energy dissipater is installed at the outlet of a closed pipe system to prevent erosion. Energy dissipaters can be made from rip rap or concrete. Rip rap energy dissipaters are constructed of three to eight inch diameter rocks and are lined with filter fabric. The rip rap pad should extend past the end of the pipe a minimum of six times the diameter of the pipe.

Energy Dissipaters – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Rip Rap	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Replace rip rap to design standards.
	Erosion	Soil erosion in or adjacent to rip rap.	Replace rip rap to design standards. Repair erosion and permanently stabilize area around pad.
Concrete Pad	Structural Damage to Pad	Slab has holes larger than two square inches or cracks wider than 1/4 inch.	Repair or replace pad.
	Erosion	Soil erosion adjacent to concrete pad.	Repair erosion and permanently stabilize area around pad.

Biofiltration Swale

A biofiltration swale uses grass or other dense vegetation to filter sediment and pollutants out of stormwater. They often look like flat-bottomed channels with grass or landscaping in them. Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As 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 swale.

Biofiltration Swale – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment Accumulation on Grass	Sediment inhibits grass growth in greater than 10% of the swale. Sediment is blocking entry and distribution of water in swale.	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. Re-vegetate if necessary.
	Standing Water	Standing water in the swale between storms due to swale not draining freely.	Repair cause of poor drainage. This may include, but is not limited to the following activities: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add under-drains or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and/or clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	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.	Eliminate source of baseflow. If not possible add a low-flow pea-gravel drain the length of the swale.
	Poor Vegetation Coverage	Grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Replant with plugs of grass from the upper slope or reseed.
	Vegetation and Grass	Grass is excessively tall (greater than six inches). Nuisance weeds and other vegetation start to take over swale.	Mow vegetation and/or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of three to four inches.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Tree Growth	Trees are present in swale.	Remove trees.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Any trash and debris which exceed five 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.	Remove trash and debris from bioswale.
	Erosion/ Scouring	Eroded or scoured swale bottom due to flow channelization, or higher than design flows.	If bare areas are large (generally greater than 12 inches wide) the swale should be re-graded and reseeded. For smaller bare areas, over seed or plant plugs of grass in the swale at eight inch intervals.

Wet Biofiltration Swale

A wet biofiltration swale is a variation of a basic biofiltration swale for use where there is minimal slope, groundwater tables are high, or a continuous low base flow is likely to result in wet soil conditions for long periods of time. Where constant moist conditions are present vegetation specifically adapted to wet soil conditions are required.

Wet Biofiltration Swale – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment Accumulation	Sediment inhibits plant growth in greater than 10% of the swale. Sediment is blocking entry and distribution of water in swale.	Remove sediment deposits in treatment area. When finished, swale should be level from side to side and drain freely toward outlet. Re-vegetate if necessary.
	Wetland Vegetation	Wetland vegetation becomes sparse and does not provide adequate filtration.	Determine cause of lack of vigor of wetland vegetation and correct.
		Wetland vegetation is crowded out by weeds.	Remove weeds. Replant wetland vegetation as needed.
	Cattail Growth	Dense clumps of cattail, which does not allow water to pass.	Remove and control cattails. Cat tails may be controlled by cutting or pulling cattail shoots below water level, or by other methods. Compost cattail debris off-site.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	Any trash and debris which exceed five 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.	Remove trash and debris from wet swale.
	Erosion/ Scouring	Swale has eroded or scoured due to flow channelization, or high flows.	Check design flows to assure swale is large enough to handle flows. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

Stormwater Treatment Wetland

A stormwater treatment wetland is a shallow man-made pond that is designed to treat stormwater through the biological processes associated with emergent aquatic plants. These facilities use dense wetland vegetation and settling to filter sediment and pollutants out of stormwater.

Stormwater treatment wetlands are used to capture pollutants in a managed environment so that they will not reach natural wetlands and other ecologically important habitats. Vegetation must occasionally be maintained and sediment removed from the treatment wetland.

Stormwater Treatment Wetland – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment Accumulation	Sediment accumulation exceeds design standards in pre-settling cell. Sediment accumulation in wetland cell.	Remove sediment deposits.
	Water Depth	Water not retained during the wet season.	Repair outlet so that water is retained in the treatment wetland.
	Wetland Vegetation	Wetland vegetation becomes sparse and does not provide adequate filtration.	Determine cause of lack of vigor of wetland vegetation and correct. Replant as needed.
		Nuisance plant species becomes abundant.	Remove nuisance plant species and replace with appropriate species.
	Cattail Growth	Dense clumps of cattail, which does not allow water to pass.	Remove and control cattails. Cat tails may be controlled by cutting or pulling cattail shoots below water level, or by other methods. Compost cattail debris off-site.
	Trash and Debris Accumulation	Any trash and debris which exceed five 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.	Remove trash and debris from wetland area.

Filter Strip

A filter strip is a linear strip of grass that removes sediment and pollutants from stormwater. Stormwater is treated as it runs across the filter. Usually, filter strips are placed along the edge of linear paved areas such as parking lots and roads. Where filter strips are installed, road shoulders or parking lot edges must be graded to maintain level flow off of the paved surface.

Filter Strip – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment Accumulation on Grass	Sediment inhibits grass growth in greater than 10% of the filter strip. Sediment is blocking entry and distribution of water in the filter strip.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10 inches); when nuisance weeds and other vegetation start to take over.	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	Any trash and debris which exceed five 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.	Remove trash and debris from filter strip.
	Erosion/ Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	If bare areas are large (generally greater than 12 inches wide) the filter strip should be re-graded and reseeded. For smaller bare areas, over seed or plant plugs of grass at eight inch intervals.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through the entire filter strip width.	Level the spreader and clean so that flows are spread evenly over the entire filter strip width.

Wetpond

A wetpond is an open basin that retains a permanent pool of water year round or in some cases only during the wet season. The volume of the wetpond allows sediment and other pollutants to settle out of the runoff. Wetland vegetation is typically planted within the wetpond to provide additional treatment through nutrient (i.e. nitrogen) removal. Detention quantity control can be provided with additional temporary storage volume above the permanent pool elevation.

Wetponds – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Any trash and debris which exceed five 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.	Remove trash and debris.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard. Evidence of noxious weeds as defined by State or local regulations.	Remove poisonous or nuisance vegetation. Remove noxious weeds. Comply with State or local eradication policies.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity. Hazard trees such as dead, diseased, or dying trees are identified.	Remove or trim problem trees. Remove hazard Trees.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No evidence contaminants or pollutants present. If chronic oil sheen persists, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Eroded damage over two inches deep. Any erosion observed on a compacted berm embankment.	Stabilize slopes using appropriate permanent erosion control measures. If erosion is occurring on compacted berms a licensed Civil Engineer should be consulted to resolve source of erosion.
Side Slopes of Pond	Grass/ Vegetation	Grass exceeds 12 inches in height or vegetation growth becomes excessive.	Mow grass or trim vegetation.
		Poor vegetation coverage.	If bare areas are large (generally greater than 12 inches wide) prepare soil and reseed. For smaller bare areas, over seed or plant plugs of grass at eight inch intervals.
Emergency Overflow/ Spillway	Rock Missing	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.	Restore rocks and pad depth to design standards.
Storage Area	Water level	First cell does not hold water.	Repair the first cell to maintain design depth of water.
	Sediment Accumulation in Pond Bottom	Sediment depth exceeds1.5 feet in first cell.	Remove sediment from pond bottom. Sediment should be tested for toxicants and disposed of in accordance with health department requirements.
	Liner (If Applicable)	Liner is visible and has more than three 1/4 inch holes in it.	Repair or replace liner. Fully cover liner.

Wetpond (Continued)			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Pond Berms (Dikes)	Settlement	Any part of berm which has settled four inches lower than the design elevation.	Repair berm to the design elevation. 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.
	Internal Berm	Berm is not level. Water flows over berm unevenly.	Level berm surface is so that water flows evenly over entire length of berm.
	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over four feet in height may lead to piping through the berm which could lead to failure of the berm.	Remove Trees. If root system is small (base less than four 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.
	Soil Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (It is recommended that a Civil engineer is consulted to inspect and evaluate condition of the berm and recommend repair procedure.)	Repair soil piping damage and repair berm to eliminate soil piping condition.

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Sand Filter

A sand filter functions by filtering stormwater through a sand bed. A typical sand filtration system consists of a pretreatment system for removing larger sediment and debris from the runoff, a flow spreader, a sand bed, and an underdrain piping. The sand filter bed typically includes a woven (geotextile) fabric between the sand bed and the underdrain system. Sand filters may be located above ground, or in a subsurface vault.

Sand Filter – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment Accumulation on Sand	Sediment depth exceeding 1/2 inch accumulated on sand filter bed.	Remove sediment from stand filter bed. Sediment should be tested for toxicants and disposed of in accordance with health department requirements.
	Trash and Debris	Trash and debris accumulated on sand filter bed.	Remove trash and debris from sand filter bed.
	Sand Filter Plugged	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Remove and replace top several inches of sand. May require replacement of entire sand filter depth depending on extent of plugging
	Short Circuiting	Flows are concentrated over one section of the sand filter rather than dispersed.	Repair cause of short circuiting. Repair any damage to sand filter bed.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Repair or replace pipe.
Above Ground Sand Filter	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Level and/or clean the spreader and so that flows are spread evenly over the entire sand filter.
	Erosion Damage to Slopes	Erosion damage over two inches deep.	Stabilize slopes using proper erosion control measures.
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Limit low, continuous flows to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Sediment/ Debris in Clean-Outs	Clean-outs are full or partially plugged with sediment and/or debris.	Remove sediment from clean-outs.
Below Ground Sand Filter	Sediment Accumulation in Pre-Settling Cell	Sediment accumulation in pre-settling cell of vault bottom exceeds the maximum allowable design depth.	Remove sediment deposits. Sediment should be tested for toxicants and disposed of in accordance with health department requirements.
	Access Cover Damaged/Not Working	Maintenance person cannot remove cover using normal lifting pressure.	Repair or Replace cover.
	Ventilation	Ventilation area blocked or plugged.	Clear vent.
	Baffles/Internal Walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure.	Repair or replace baffles to design specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, has sharp edges, is not securely attached to structure wall, missing rungs, cracked, or misaligned.	Replace or repair ladder to design specifications.
	Damage to Vault Structure	Cracks wider than 1/2 inch and any evidence of soil particles or ground water entering the structure through the cracks. Vault is not structurally sound.	Replace or repair vault to design specifications Vault is structurally sound.
	Joints Between Vault and Pipes	Any openings or voids allowing soil to enter facility.	Repair all joints between tank/pipe sections.

Stormwater Media Filter

A stormwater media filter is a passive, flow-through, stormwater filtration system. The system is comprised of one or more vaults that house replaceable, media-filled filter cartridges. A stormwater media filter works by passing stormwater through the filtering medium, which traps particulates and/or adsorb pollutants such as dissolved metals and hydrocarbons. Once filtered through the media, the treated stormwater is directed to a collection pipe or discharged into an open channel drainage way.

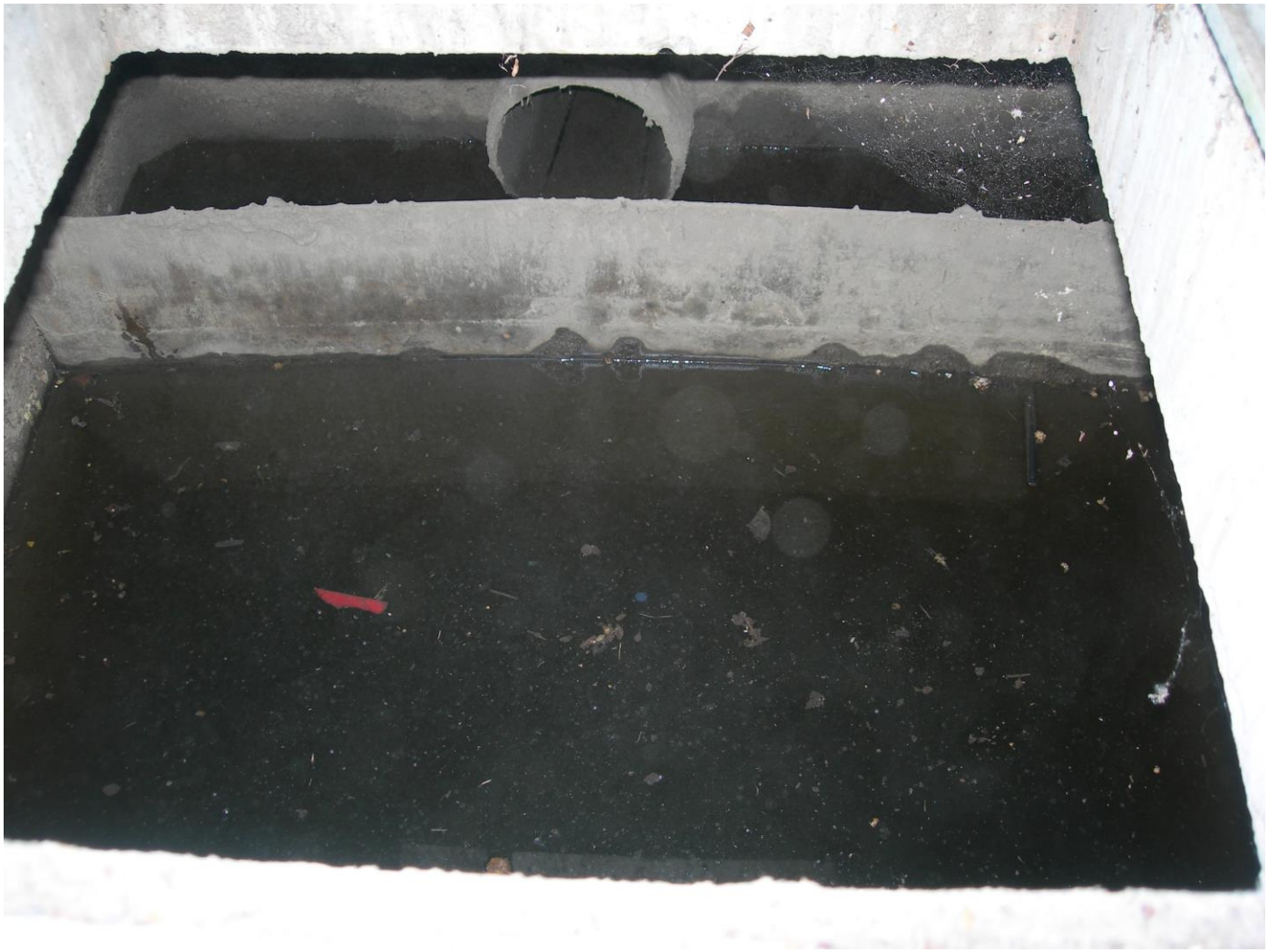
The filter media can be housed in cartridge filters enclosed in concrete vaults or catch basin-like structures. Various types of filter media are available.

Stormwater media filter units are proprietary manufactured systems. See manufacturer's publications for additional maintenance information.

Stormwater Media Filter – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Fore bay	Sediment Accumulation	Sediment has accumulated to within six inches of the invert of the lowest pipe.	Remove sediment.
Filter Vault	Sediment Accumulation on Top of Filter Cartridges.	Sediment depth exceeds 1/4 inch on top of filter cartridges.	Remove sediment. Look for other indicators of clogged cartridges or overflow.
	Sediment Accumulation in Vault	Sediment depth exceeds four inches on the vault floor.	Remove sediment from vault. Look for other indicators of clogged cartridges or overflow.
	Trash and Debris Accumulation	Excessive trash and debris accumulation in vault.	Remove trash and debris.
	Access Cover Damaged/Not Working	Maintenance person cannot remove cover using normal lifting pressure.	Repair or Replace cover.
	Vault Structure Damage	Structure is unsound.	Repair or replace vault.
		Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles or ground water entering through the cracks.	Repair cracks.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure.	Repair or replace baffles to design specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, has sharp edges, is not securely attached to structure wall, missing rungs, cracked, or misaligned.	Repair or replace ladder to design specifications.
Media Cartridge	Media	Pore space between media granules is absent.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Replace filter cartridges.
	Filter cartridges Submerged.	Filter cartages remain submerged and flow bypasses cartages during average rainfall event.	Replace filter cartridges.

Oil/Water Separator

An oil/water separator is an underground vault that treats stormwater by mechanically separating oil from water. The oil rises to the surface and floats on the water and sediment settles to the bottom. Oil/water separators are most commonly used as the first pre-treatment facility in a series of stormwater management facilities.



Oil/Water Separator – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Monitoring	Discharge water shows obvious signs of poor water quality (i.e. obvious oil or other contaminants present).	Determine cause of separator failure and repair.
	Sediment Accumulation	Sediment in bottom of vault exceeds six inches in depth.	Remove sediment from separator. Sediment should be tested for toxicants and disposed of in accordance with health department requirements.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Remove trash and debris from vault and/or inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed one inch on the surface of the water.	Remove oil from vault. Dispose in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Repair or replace pipe.
	Access Cover Damaged/Not Working	Maintenance person cannot remove cover using normal lifting pressure.	Repair or replace cover.
	Vault Structure Damage	Top slab has holes larger than two square inches or cracks wider than 1/4 inch.	Repair or replace vault top.
		Frame not sitting flush on top slab. Separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Repair or replace top and/or frame.
		Structure is unsound.	Repair or replace vault.
		Grout has separated or cracked wider than 1/2 inch and longer than one foot at the joint of any inlet/outlet pipe or any evidence of soil particles or ground water entering oil/water separator through cracks.	Re-grout pipe and secure at basin wall.
		Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles or ground water entering through the cracks.	Repair cracks.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure.	Repair or replace baffles to design specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, has sharp edges, is not securely attached to structure wall, missing rungs, cracked, or misaligned.	Repair or replace ladder to design specifications.

Vortex Sedimentation Vault

A vortex sedimentation vault consists of a cylindrical vessel where the inlet flow spirals around the perimeter in a vortex-type action causing the heavier particles to settle out of the stormwater. It uses a vortex-enhanced settling mechanism (swirl-concentration) to capture settleable solids, floatables, and oil and grease. Vortex sedimentation vaults are most commonly used as the first pre-treatment facility in a series of stormwater management facilities.

Vortex sedimentation vaults are proprietary manufactured systems. See manufacturer's publications for additional maintenance information.

Vortex Sedimentation Vault – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment, Trash and Debris Accumulation	Sediment, trash and debris accumulations fill more than 80% of the sump.	Remove sediment.
	Floatable Trash Accumulation	Floatable trash accumulation that exceeds eight inches at the water surface.	Remove floatable trash.
	Oil Accumulation	Oil accumulation that exceeds 1/2 inch at the water surface.	Remove oil from vault. Dispose in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure.	Repair or replace baffles to design specifications.
	Vault Structure Damage	Structure is unsound.	Repair or replace vault.
		Cracks wider than 1/2 inch at the joint of any inlet/outlet pipe or evidence of soil particles or ground water entering through the cracks.	Repair cracks.
	Access Ladder Damaged	Ladder is corroded or deteriorated, has sharp edges, is not securely attached to structure wall, missing rungs, cracked, or misaligned.	Repair or replace ladder to design specifications.

Bioswale Sedimentation Trap

A bioswale sedimentation trap is a concrete structure typically fitted with a slotted grate or multiple slotted grates to act as debris barriers. The concrete structure provides a storage volume (sump) below the outlet pipe to allow sediment and debris to settle out of the stormwater runoff.

Bioswale Sedimentation Trap – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Trash or debris which is located immediately in front of the sediment trap opening or is blocking inletting capacity of the basin.	Remove trash and debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	Remove dead animals or vegetation.
	Sediment	Sediment (in the trap) that exceeds 2.5 inches.	Remove sediment from trap.
	Fractures or Cracks in Basin Walls/ Bottom	Structure is unsound.	Repair or replace sediment trap to design standards.
		Grout has separated or cracked wider than 1/2 inch and longer than one foot at the joint of any inlet/outlet pipe.	Re-grout pipe and secure to wall of trap.
	Settlement/ Misalignment	Sediment trap has settled or become misaligned creating a safety, function, or design problem.	Repair or replace sediment trap.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	Remove vegetation.
	Contaminants and Pollution	Any evidence of oil, gasoline, sewage or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No evidence of contaminants or pollutants present.
Debris barrier	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Remove trash and debris.
	Damaged or Missing.	Grate missing or damaged.	Repair or replace grate to design specifications.

Field/Area Inlet

A field/area inlet is a concrete, plastic or steel structure fitted with a slotted grate to collect stormwater runoff and route it through underground pipes.

Field/area inlets typically provide a storage volume (sump) below the outlet pipe to allow sediment and debris to settle out of the stormwater runoff. Typically field/area inlets are fitted with a spill control device (inverted elbow on outlet pipe) intended to contain large quantities of grease or oils.

The most common tool for cleaning a field/area inlet is a vactor truck which is used to remove sediment and debris from the sump. A field/area inlet may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a confined space, it should be conducted by an individual trained and certified to work in hazardous confined spaces.

Field/Area Inlet – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Problem**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Trash or debris blocking capacity of the field inlet.	Remove trash and debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	Remove dead animals or vegetation.
	Sediment	Sediment has accumulated to within six inches of the invert of the lowest pipe or to within 4 inches of the spill control device.	Remove sediment.
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than two square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin).	Repair or replace top slab.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Repair or replace top frame.
	Fractures or Cracks in Basin Walls/ Bottom	Structure is unsound.	Repair or replace inlet.
		Grout has separated or cracked wider than 1/2 inch and longer than one foot at the joint of any inlet/outlet pipe or any evidence of soil particles or ground water entering field inlet through cracks.	Re-grout pipe and secure at inlet wall.
	Settlement/ Misalignment	Field inlet has settled or become misaligned creating a safety, function, or design problem.	Repair or replace inlet.
	Vegetation	Vegetation growing across and blocking more than 10% of the inlet opening.	Remove vegetation.
	Contaminants and Pollution	Any evidence of oil, gasoline, sewage or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No evidence of contaminants or pollutants present.
	Spill Control Device	Spill control device missing or damaged.	Repair or replace spill control device to design specifications.
Metal Grates	Grate Not in Place	Cover is missing or only partially in place or missing.	Repair or replace grate.
	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Repair or replace grate.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Repair or replace grate.

Access Road and Easement

Many stormwater facilities have access roads to bring in heavy equipment for facility maintenance. These roads should be maintained for inspection access and ease of equipment access.

All facilities should allow access for the inspection process.

The easement area should be adequately landscaped or otherwise stabilized. Bare soil areas will generate higher levels of stormwater runoff and increase erosion and sedimentation in stormwater facilities.

Access Road/Easement – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Erosion	Soils are bare or eroded.	Seed or use other stabilization BMP.
	Road Surface	Condition of road surface limits access.	Repair road.
	Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Identify causes of erosion and steps taken to slow down/spread out the water. Fill, contour, and seed eroded areas. If needed, re-grade affected areas.
	Trash & Debris / Litter	Any trash and debris which exceed five 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.	Remove trash and debris.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public.	No danger of poisonous vegetation.
		Evidence of noxious weeds as defined by State or local regulations.	Remove noxious weeds. Comply with State or local eradication policies.
	Tree Growth and Hazard Trees	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.	Remove trees that hinder maintenance activities.
		If dead, diseased, or dying trees are identified.	Remove hazard trees.
	Weeds (Non-poisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Remove weeds.

Fence, Gate, and/or Water Quality Sign

Stormwater facilities such as detention ponds or treatment wetlands often have fences to protect them from damage. Most facilities are also required to have informational signs identifying the area as a stormwater facility.

Fence, Gate and/or Water Quality Sign – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Gate or Fence Allows Unauthorized Entry	Openings in fence, missing gate, or openings beneath fence.	Repair fence or gate.
	Locking Mechanism	Locking mechanism cannot be opened by one maintenance person with proper tools.	Repair or replace locking mechanism.
		Lock is not present or does not operate correctly.	Repair or replace lock.
	Damaged Parts	Posts out of plumb.	Plumb posts.
	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Replace soil under fence so that no opening exceeds four inches in height. Eliminate source or erosion.
	Water Quality Sign	Water quality sign is not properly attached.	Reattach water quality sign.
		Water quality sign is missing or 20% of the surface is unreadable.	Replace sign.

Conveyance Stormwater Pipe

Stormwater pipes must be cleaned to remove sediment or blockages when problems are identified. Stormwater pipes must be clear of obstructions and breaks to prevent localized flooding.

Conveyance Storm Pipe – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Obstructions, Including Roots	Obstruction exists in pipe, reducing flow capacity.	Use mechanical methods to remove obstruction. Do not put root-dissolving chemicals in storm sewer pipes. If necessary, remove the vegetation over the line.
	Pipe Dented or Broken	Inlet/outlet piping damaged or broken and in need of repair.	Repair or replace pipe.
	Pipe Rusted or Deteriorated	Any part of the piping that is crushed or deformed excessively or any other failure to the piping.	Repair or replace pipe.
	Sediment & Debris	Sediment depth is greater than 15% of pipe diameter.	Clean pipe. Evaluate source of sediment upstream of the pipe and stabilize if possible.
	Trash screen Missing	Open ended stormwater pipes greater than 15 inches need a trash screen.	Install trash screen.
	Contaminants and Pollution	Any evidence of oil, gasoline, sewage or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No evidence of contaminants or pollutants present.

Conveyance Ditch

Conveyance ditches must be occasionally maintained to allow them to continue to operate as they were designed to. Ditches must be kept clear of obstructions and excessive sediment and vegetation to prevent localized flooding.

Conveyance Ditch – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Sediment Accumulation	Sediment depth exceeds six inches.	Remove sediment deposits. When finished, ditch should be level from side to side and drain freely in intended direction. There should be no areas of standing water once inflow has ceased.
	Standing Water	Excessive standing water in the ditch between storms due to ditch not draining freely.	If possible repair cause of poor drainage. This may include, but is not limited to the following activities: remove sediment or trash blockages, improve grade of ditch.
	Eroded or Unstable Side Slopes	When grass is sparse or bare or eroded patches occur in more than 20% of the ditch.	Determine why grass growth is poor and correct that condition. Replant with plugs of grass at eight inch intervals or reseed. If cause is excessive moisture replace grass with wetland plantings.
	Vegetation	Grass is excessively tall (greater than 15 inches). Nuisance weeds and other vegetation start to take over ditch.	Mow vegetation and/or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of three to four inches.
	Inlet/Outlet pipes or culverts	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Any trash and debris which exceed five 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.	Remove trash and debris from ditch.
	Erosion/ Scouring	Eroded or scoured ditch bottom.	Permanently stabilize ditch bottom.

Stormwater Facility Discharge Points

Stormwater facility discharge points convey stormwater from the stormwater facility into drainage trenches and receiving waters or other drainage areas. Stormwater facility discharge points need to be assessed to make sure stormwater is not causing any negative impacts to these drainage areas.

Facility Discharge Point – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Monitoring	Obvious Signs of Poor Water Quality	Any evidence of oil, gasoline, sewage or other pollutants.	Effluent discharge from facility should be clear. Identify and remove source or report to City of Battle Ground Illicit Discharge Program.
	Off Site Assessment	Erosion or scouring in ditch or stream banks due to flow channelization, or higher flows.	Stabilize ditch or stream banks. Report to City of Battle Ground for Engineer Evaluation.
General	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to discharge point.	Repair erosion and permanently stabilize area.
	Obstructions, Including Roots	Obstruction exists in pipe, reducing flow capacity.	Use mechanical methods to remove obstruction. Do not put root-dissolving chemicals in storm sewer pipes. If necessary, remove the vegetation over the line.
	Pipe Rusted or Deteriorated	Any part of the piping that is crushed or deformed excessively as determined by an inspector or any other failure to the piping.	Pipe repaired or replaced.
	Contaminants and Pollution	Any evidence of oil, gasoline, sewage or other pollutants beyond typical levels. For major spills coordinate removal/cleanup with the Department of Ecology at (360) 407-6300.	No contaminants or pollutants present.
Internal (If Applicable)			
Energy Dissipater	See Energy Dissipater Requirements		

Tree Box Filters

Tree Box Filters are stormwater treatment systems that use biofiltration media to remove pollutants from stormwater.

Tree Box Filters – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Tree Box Filter and Surrounding Area	Clogged mulch	Standing Water	• Replace mulch
	Cracks in structure	Damage to box structure	• Repair vault if cracks are wider than ½ inch or evidence of soil entering through cracks
	Damaged grate	Damage to grate	• Replace grate
	Clogged bypass	Bypass clogged	•
Tree Grate and Erosion Control Stones	Broken or damaged grates or erosion control stones	Broken or damaged grates or erosion control stones	• Remove and clean tree grates and erosion control stones
Debris, trash and mulch	Silt/clay in media	Silt/clay in media	• Remove media to depth of silt/clay and replace with new media
	Trash in box structure	Trash in box structure	• Remove trash
	Leaves in box structure	Leaves in box structure	• Remove leaves
	Every 6 months	Every 6 months	• Replenish media as needed • Replace mulch with double shredded mulch evenly across the entire unit to a depth of 3”. • Ensure correct positioning of erosion control stones • Replace grates
Facility Area	Refuse around Tree Box Filter	Excessive refuse around tree box planter	• Remove all refuse and dispose of appropriately
Inlet	Excessive Sediment or Trash Accumulation	Accumulated sediments or trash impair free flow of water into tree box filter	• Sediments or trash should be removed • Inlet should be free of obstructions allowing free distributed flow of water into the tree box filter
Mulch Cover	Trash and floatable debris accumulation	Excessive trash and/or debris accumulation	• Trash and debris should be removed and mulch cover raked level. Ensure bark nugget much is not used • Minimal trash or other debris on mulch
	Ponding of water on mulch cover	Ponding in tree box planter could indicate clogging due to excessive fine sediment accumulation or spill of petroleum oils	• Replace mulch • Stormwater should drain freely and evenly through mulch cover
Vegetation	Plants not growing or in poor condition	Soil/mulch too wet, evidence of spill, Incorrect plant selection, pest infestation, vandalism of plants.	• Plants should be healthy and pest free • Contact manufacturer for advice
	Plant growth excessive	Plants should be appropriate to the species and location	• Trim/prune plants in accordance with typical landscaping and safety needs
Structure	Structure has visible cracks	Cracks wider than ½ inch or evidence of soil particles entering the structure through the cracks	• Repair cracks or damage to vault

Vegetation Management

Use Only Appropriate Plants

Use native species of plants where ever possible to reduce maintenance, watering requirements, and pesticide usage.

Generally, vegetation should be maintained to blend into surrounding areas. Stormwater facilities can provide habitat for aquatic life and birds. Promoting natural vegetation where feasible improves habitat. With careful design stormwater facilities can blend into and complement the site's landscaping.

Practices

Successful vegetation management will focus on establishing and maintaining healthy low-maintenance native plantings and sustaining the design function of vegetated filters such as biofiltration swales. This includes controlling invasive plants where feasible, and planting cover on bare soils.

In some cases, the original plantings may not be appropriate for the actual condition at a facility. One example is a frequently flooded swale that cannot support normal turf. In cases such as this, replace turf with appropriate wetland plants if the underlying drainage problem cannot be fixed.

Limit mulch use to covering bare soil while establishing plantings. Consider the use of soil amendments such as compost before using fertilizer. The use of pesticides and, in most cases fertilizer, is not compatible with the task of pollutant removal or the direct connection of stormwater facilities to streams and groundwater. Chemical use should be avoided within 25 feet of any area that holds or conveys surface water or stormwater. This includes the base of a biofiltration swale.

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Low Impact Development (LID) BMPs

LID best management practices are distributed stormwater management practices that model the pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration. LID BMPs include bioretention, rain gardens, permeable pavements, roof downspout controls, dispersion, soil quality and depth and vegetated roofs.

Low Impact Development BMPs – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Spill Prevention	None.	• All sites must implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater.
	Spill Cleanup	Release of pollutants.	• Call your local or regional hotline number to report any spills or other illicit discharges. • Clean up spills as soon as possible to prevent contamination of stormwater. • Restore BMP facility design and function per the record drawings.
	Pests	Pest of concern is present and impacting BMP facility function.	• Pesticide use should be generally discouraged, even conditionally prohibited in some cases. • Pesticides include the following: herbicides, fungicides, insecticides, rodenticides, and pediculicides. • If pesticide use is planned in or near LID BMPs, make sure to check the following current regulations: 1) Federal- Environmental Protection Agency (EPA) Federal Insecticide and Rodenticide Act. 2) State- Ecology, Washington State Department of Agriculture, Washington State Department of Fish and Wildlife, Natural Resources Conservation Services. 3) Local city or county ordinances/codes, and/or applicable Integrated Pest Management (IPM) plan. • For the protection of health and safety, check the following: 1) Washington State Department of Labor & Industries. 2) Washington State Department of Health (local branch if applicable).

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 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. Bioretention facilities are considered Stormwater Treatment and Flow Control BMPs/Facilities when used to help meet Minimum Requirements #6 (treatment) and #7 (flow control), or both.

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Earthen Side Slopes and Berms	Erosion	Erosion (gullies/rills) greater than 2 inches deep around inlets, outlets, and alongside slopes.	• 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. 3) Flow dissipation and erosion strategies at the facility inlet.
	Erosion	Erosion of sides causes slope to become a hazard.	• Take actions to eliminate the hazard and stabilize the slopes.
	Settlement	Settlement greater than 3 inches (relative to undisturbed section of berm)	• Restore to design height.
	Piping	Downstream face of berm wet, seeps or leaks evident.	• Plug any holes and compact berm (may require consultation with engineer, particularly on larger berms).
	Rodents	Any evidence of rodent holes or water piping in berm.	• Eradicate rodents (see “Pest Control”). • Fill holes and compact (may require consultation with engineer, particularly on larger berms).
Concrete Sidewalls	Cracks or failure of concrete sidewalls	Cracks or failure of concrete sidewalls.	• Repair/seal cracks • Replace if repair is insufficient
Rockery Sidewalls	Insecure sidewalls	Rockery side walls are insecure.	• Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height).
Facility Area	Trash/Debris	Trash and debris present.	• Clean out trash and debris.
Facility bottom area	Sediment	Accumulated sediment to extent that infiltration rate is reduced (see “Ponded Water”) or surface storage capacity significantly impacted.	• 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 accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet.
	Leaves	Accumulated leaves in facility.	• Remove leaves if there is a risk of clogging outlet structure or water flow is impeded.

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Low Permeability Check Dams and Weirs	Sediment, Vegetation or Debris	Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice.	• Clear blockage.
	Erosion	Erosion and/or undercutting present.	• Repair and take preventative measures to prevent future erosion and/or undercutting.
	Weir Damaged	Grade board or top of weir damaged or not level.	• Restore to level position.
Ponded Water	Ponded Water	Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours after the end of a storm.	Determine cause and resolve in the following order: 1) Confirm leaf or debris buildup in the facility is not impeding infiltration, remove leaf litter/debris. 2) Ensure the 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.
Bioretention Soil Media	Compacted Soil Media	Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint.	• 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.
Splash Block Inlet	Damaged Splash Blocks	Water is not being directed properly to the facility and away from the inlet structure.	• Reconfigure/repair blocks to direct water to facility and away from structure.
Curb Cut Inlet/Outlet	Leaf Clogging	Accumulated leaves at curb cuts.	• Clear leaves (particularly important for key inlets and low points along long, linear facilities).

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Pipe Inlet/Outlet	Damaged Pipe	Pipe is damaged.	• Repair/replace.
	Clogged Pipe	Pipe is clogged.	• Remove roots or debris.
	Reduced Capacity	Sediment, debris, trash, or mulch reducing capacity of inlet/outlet.	• Clear blockage • Identify source of the blockage and take actions to prevent future blockages.
	Accumulated Leaves	Accumulated leaves at inlets/outlets.	• Clear leaves (particularly important for key inlets and low points along long, linear facilities.)
	Inaccessible Facility	Maintain access for inspection.	• Clear vegetation (transplant vegetation when possible) 1 foot from inlets and outlets, maintain access pathways. • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants.
Erosion Control at Inlet	Erosion at Inlet	Concentrated flows are causing erosion.	• 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	Trash/Debris	Trash or other debris present on trash rack.	• Remove and dispose of trash/debris.
	Damaged screen	Bar screen damaged or missing.	• Repair or replace bar screen.
Overflow	Sediment/ Debris	Capacity reduced by sediment or debris.	• Remove sediment or debris and dispose.
Underdrain Pipe	Clogging	Plant roots, sediment or debris reducing capacity of underdrain. Prolonged surface ponding (see “Ponded Water”).	• 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.
Facility Bottom Area and Upland Slope Vegetation	Poor Vegetation Growth	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).	• 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.

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Vegetation (General)	Diseased Plants	Presence of diseased plants and plant material.	• 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".
Trees and Shrubs	Pruning Needed	Pruning as needed.	• 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 direct guidance of an ISA certified arborist.
	Overgrown Trees and Shrubs	Large trees and shrubs interfere with operation of the facility or access for maintenance.	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and shrubs, if necessary.
	Dead Vegetation	Standing dead vegetation is present.	• 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.
	Planting beneath mature trees	Planting beneath mature trees.	• 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 no larger than 1-gallon containers.

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Trees and Shrubs	Need for Tree Support.	Presence of or need for stakes and guys (tree growth, maturation, and support needs)	• 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 (stake, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.
Trees and Shrubs – Visibility Needs	Reduced Visibility	Vegetation causes some visibility (line of sight) or driver safety issues.	• 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	Dead Flowers	Dead or spent flowers present.	• Remove spent flowers (deadhead).
Perennials	Spent Plants	Spent plants.	• Cut back dying or dead and fallen foliage and stems.
Emergent Vegetation	Compromised Conveyance	Vegetation compromises conveyance.	• 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)	Dead Plant Material	Dead material from previous year's growing cycle or dead collapsed foliage.	• 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.
Ornamental Grasses (Evergreen)	Dead Growth	Dead growth present in spring.	• 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

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Noxious Weeds	Noxious Weeds	Listed noxious vegetation is present (refer to current Clark County Noxious Weed List)	• 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	Weeds are present	Weeds are present	• 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
Excessive Vegetation	Low-lying vegetation growing beyond facility edge	Low-lying vegetation growing beyond facility edge	• Edge or trim groundcovers and shrubs at edge of facility • Some clippings can be left to replenish organic material in the soil. Excessive leaf litter may cause clogging.
	Vegetation inhibiting flow	Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	• 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
	Vegetation blocking flow	Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	• Remove vegetation and sediment buildup
Mulch	Bare Spots	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
Irrigation System (if any)	Irrigation System	Irrigation system present	• Follow manufacturer's instructions for O&M
	Irrigation System not watering properly	Sprinklers or drip irrigation not directed/located to properly water plants	• Redirect sprinklers or move drip irrigation to desired areas

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Summer Watering (first year)	First year establishment Plants	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 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 perforated bottom) for watering newly installed trees when irrigation system is not present.
Summer Watering (second and third years)	Second-third year establishment Plants	Trees, shrubs and groundcovers in second or third 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 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.
Summer Watering (after establish-ment)	Drought	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.

Bioretention Facilities – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Mosquitoes	Mosquitoes	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	Nuisance animals	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. • Remove pet waste regularly. • For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect Pests	Insect pests	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.

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Rain Gardens

Rain gardens are non-engineered, shallow, landscaped depressions with compost-amended soils and adapted plants. The depression temporarily stores storm water 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.

Rain Gardens – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Earthen Side Slopes	Erosion	Persistent soil erosion on slopes.	• 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	Unstable Sidewalls	Rockery side walls are insecure.	• Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height).
Rain Garden Footprint	Trash and Debris	Trash and debris present.	• Cleanout trash and debris.
Rain Garden Bottom Area	Sediment	Visible sediment deposition in the rain garden that reduces drawdown time of water in the rain garden.	• Remove sediment accumulation. • If sediment is deposited from water entering the rain garden, determine the source and stabilize the area.
	Leaves	Accumulated leaves in rain garden (may reduce infiltration capacity of rain garden or clog overflow).	• Remove leaves.
Ponded Water	Ponded Water	Excessive ponding water: Ponded water remains in the basin more than 3 days after the end of a storm.	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.
Splash Block Inlet	Improper Water Direction	Water is not being directed properly to the rain garden and away from the building.	• Reconfigure / repair blocks to direct water to the rain garden and away from the building.
Pipe Inlet / Outlet	Blocked pipes	Pipe capacity is reduced by sediment or debris (can cause backups and flooding).	• Clear pipes of sediment and debris.
	Damaged Pipes	Damaged or cracked pipes.	• Repair / seal cracks. • Replace when repair is insufficient.
Erosion Control at Inlet	Missing Erosion Control	Rock or cobble is removed or missing and concentrated flows are contacting soil.	• 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	Dead or Dying Plants	Dying, dead or unhealthy plants.	• 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.

Rain Gardens – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Vegetation Continued	Overgrown Vegetation	Vegetation inhibits sight distances and sidewalks.	• Keep sidewalks and sight distances on roadways clear.
	Dead Vegetation	Broken, dead, or sucker vegetation is present.	• Remove broken or dead branches and suckers.
	Overgrown Vegetation	Vegetation is crowding inlets and outlets.	• Keep water inlets and outlets in the rain garden clear of vegetation.
	Nutrient Deficiencies	• 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.	• 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.	• 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	Bare Spots	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. • 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.
Summer Watering (First Year)	Lack of Water	Trees, shrubs and groundcovers in first year of establishment period.	• Water once every 1-2 weeks or as needed during prolonged dry periods • 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. • 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)	Lack of Water	Trees, shrubs and groundcovers in second or third year of establishment period.	• Water once every 2-4 weeks or as needed during prolonged dry periods • 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.

Rain Gardens – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Summer Watering (After Establish-ment)	Lack of Water	Established vegetation (after 3 years).	• 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.
Mosquitoes	Mosquitoes	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”). • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti).

Downspout, Sheet Flow, and Concentrated Dispersion Systems

Dispersion attenuates 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 BMP 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 attenuation and treatment.

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

Downspout, Sheet Flow, and Concentrated Dispersion Systems – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Splash Block (Downspout Dispersion)	Water being directed towards building	Water is being directed toward building structure.	• Reconfigure/repair blocks to direct water away from building structure.
	Erosion	Water disrupts soil media.	• Reconfigure/repair blocks.
Transition Zone (Sheet Flow Dispersion)	Erosion	Adjacent soil erosion; uneven surface creating concentrated flow discharge; or less than 2 foot of width.	• Repair/replace transition zone to meet design criteria and eliminate concentrated flows.
Dispersion Trench (Downspout Dispersion)	Concentrated Flows	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).	• 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 (Downspout Dispersion)	Trash, Debris, Sediment	• Fall and spring. • Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow from facility.	• Remove/dispose in accordance with local solid waste requirements.
	Vegetation, Moss	Vegetation/moss present on drain rock surface impedes sheet flow from facility.	• Maintain open, freely draining rock surface.
Pipes(s) to Trench (Downspout Dispersion)	Trash, Debris, Sediment	Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc.	• Remove/dispose.
	Plugged Pipe	Pipe from sump to trench or drywell has accumulated sediment or is plugged.	• Clear sediment from inlet/outlet pipe screen and inlet/outlet pipe.
	Damaged Pipe	Cracked, collapsed, broken, or misaligned drain pipes.	• Repair/seal cracks. • Replace when repair is insufficient.
Sump (Downspout Dispersion)	Sediment	Sediment in sump.	• Remove/dispose in accordance with local solid waste requirements. • Clear sediment from inlet/outlet pipe screen and or inlet/outlet pipe.
Access Lid	Cannot easily open Lid	Cannot be easily opened.	• Repair/replace.
	Buried Lid	Buried.	• Refer to record drawings for design intent. If the access lid was designed to be exposed, expose and restore to surface grade.
	Missing Lid	Cover missing.	• Replace.
Rock Pad (Concentrated Flow Dispersion)	Missing Rock	Only one layer of rock exists above native soil in area 6 square feet or larger, or any exposure of native soil.	• Repair/replace rock pad to meet design standards. • Enlarge pad size or add additional courses of rock, if necessary.
	Erosion	Soil erosion in or adjacent to rock pad.	• Repair/replace rock pad to meet design standards.

Downspout, Sheet Flow, and Concentrated Dispersion Systems – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Dispersal Area (General)	Erosion	Erosion (gullies/rills) greater than 2 inches deep in dispersal area.	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, revegetate).
	Sediment or Debris	Accumulated sediment or debris to extent that blocks or channelizes flow path.	• Remove excess sediment or debris. • Identify and control the sediment source (if feasible).
Ponded Water (Dispersal Area)	Standing Water	Standing surface water in dispersion area remains for more than 3 days after the end of a storm event.	• 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).
Plant Establishment (Dispersal Area)	Lack of Water	Dispersal area vegetation in establishment period (1-2 year, or additional 3rd year during extreme dry weather).	• Water weekly during periods of no rain to ensure plant establishment.
Vegetation (Dispersal Area)	Erosion	Poor vegetation cover such that erosion is occurring.	• 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.
	Overgrown Vegetation	Vegetation inhibits dispersed flow along flow path.	• Trim, weed or replant to restore dispersed flow path.
Sump	Sediment	Accumulated sediment in the sump.	• Remove/dispose in accordance with local solid waste requirements. • Clear sediment from inlet/outlet pipe screen and/or pipe.
Sump Access Lid	Lid cannot be easily opened	Cannot be easily opened.	• Repair/replace.
	Buried Lid	Buried.	• Expose and restore to surface grade.
	Missing Lid	Cover missing.	• Replace.
General Pests	Pest Infestation	Signs of pest infestations (IPM protocol threshold(s) are exceeded).	• Follow IPM protocols for weed and pest management.
Mosquitoes	Mosquitoes	Standing surface water in dispersion area 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”). • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti).
Rodents	Rodents	Rodent holes or mounds disturb dispersion flow paths.	• Fill and compact soil around the holes and vegetate to restore flow path.

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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 soil's 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 matter can be attained through numerous amendments such as compost, composted woody material, biosolids, and forest product residuals.

Compost-amended Soils – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Soil Media (Maintain High Organic Soil Content)	Vegetation in Poor Health	Vegetation not fully covering ground surface or vegetation health is poor.	• 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.
	Unhealthy Vegetation	Routine Maintenance.	• Return leaf fall and shredded woody materials from the landscape to the site when possible in order to replenish soil nutrients and structure.
	Unhealthy Vegetation	Routine Maintenance.	• On turf areas, “grasscycle” (mulch-mow or leave the clippings) to build turf health.
	Pest, Weeds	Routine Maintenance.	• Avoiding use of pesticides (bug and weed killers), like “weed and feed”, which damage the soil.
	Unhealthy Vegetation	Routing Maintenance.	• 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.
Soil Media (Maintain Infiltration)	Compacted Soils	Soils become waterlogged, do not appear to be infiltrating.	• 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 top-dress them with ¼ to ½ 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.
Erosion / Scouring	Erosion	Areas of potential erosion are visible.	• Identify and address cause of erosion (e.g., concentrated 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	Unhealthy Vegetation	Less than 75% of planted vegetation is healthy with a generally good appearance.	• 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).

Compost-amended Soils – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Noxious Weeds	Noxious Weeds	• Routine Maintenance (March – September). • Listed noxious vegetation is present (refer to current Clark County Noxious Weed List).	• By law, class A and B noxious weeds must be removed 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 not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions.
Weeds	Weeds	• Routine Maintenance (March – October, as needed). • Weeds are present.	• 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.

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Permeable Pavement

Permeable pavement is a paving system which allows rainfall to percolate through the surface into the underlying soil or an aggregate bed, where stormwater is stored and infiltrated to underlying subgrade, or removed by an overflow drainage system. Permeable pavement facilities are considered Stormwater Treatment and Flow Control BMPs and can be used to meet Minimum Requirements #6 (treatment), #7 (flow control), or both. To satisfy Minimum Requirement #6, stormwater must be infiltrated into underlying soils that meet Ecology's soil treatment requirements or filtered through an engineered treatment layer included in the pavement section.

Permeable Pavement – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Permeable Pavements (All)	Deposits on pavement	Runoff from adjacent pervious areas deposits soil, mulch or sediment on paving	• 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	Debris on pavement	None (Routine Maintenance)	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:
			  ○ Walk-behind vacuum (sidewalks)
			  ○ High efficiency regenerative air or vacuum sweeper (roadways, parking lots)
			  ○ 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.

	Surface is clogged	Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Review the overall performance of the facility (note that small clogged areas may not reduce the overall performance of the facility) • Test the surface infiltration 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 a combination of the following methods: • Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate. • Hand held pressure washer or pressure 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.

Permeable Pavement – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Porous Asphalt or Pervious Concrete	Sediment present at the surface of the pavement	Sediment present at the surface of the pavement	• 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).
	Moss growth	Moss growth inhibits infiltration or poses slip safety hazard	• 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.
	Major cracks	Major cracks or trip hazards and concrete spalling and raveling	• 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	Routine maintenance needed	Routine maintenance needed	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: o Walk-behind vacuum (sidewalks) o High efficiency regenerative air or vacuum sweeper (roadways, parking lots) o ShopVac or brush brooms (small areas) 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.

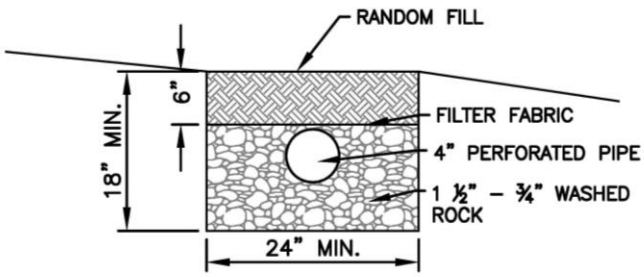
Permeable Pavement – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Interlocking Concrete Paver Blocks and Aggregate Pavers	Surface is Clogged	Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Review the overall performance of the facility (note that small clogged areas may not reduce the overall performance of the 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 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.
	Sediment Present at the Surface of the Pavement	Sediment present at the surface of the pavement	• 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).
	Moss Growth	Moss growth inhibits infiltration or poses slip safety hazard	• 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
	Missing or Damaged Paver Block	Paver block missing or damaged	• Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations
	Loss of Aggregate between Paver Blocks	Loss of aggregate between paver blocks	• Refill per manufacturer's recommendations for interlocking paver sections.
	Surface Settlement	Settlement of surface	• May require resetting
Open-celled Paving Grid with Gravel	Sediment, Debris	Routine maintenance	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer's guidelines for cleaning surface.
	Clogged Aggregate	Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Use vacuum truck to remove and replace top course aggregate • Replace aggregate in paving grid per manufacturer's recommendations

Permeable Pavement – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Open-celled Paving Grid with Gravel	Missing or Damaged Paving Grid	Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace gravel • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer's guidelines for repairing surface
	Surface Settlement	Settlement of surface	• May require resetting
	Loss of Aggregate	Loss of aggregate material in paving grid	• 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 ¼ inch above the top of rings). See manufacturer's recommendations.
	Weeds	Weeds present	• Manually remove weeds • Presence of weeds may indicate that too many fines are present (refer to Action Needed under "Aggregate is Clogged" to address this issue)
	Poor Grass Coverage	Poor grass coverage in paving grid	• 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
	Excessive Grass Growth	Routine maintenance	• Use mulch mower to mow grass
	Lost Soil	Routine maintenance	• Sprinkle a thin layer of compost on top of grass surface (1/2" top dressing) and sweep it in • Do not use fertilizer
	Weeds	Weeds present	• Manually remove weeds • Mow, torch, or inoculate and replace with preferred vegetation
Inlet/Outlet Pipe	Damaged Pipe	Pipe is damaged	• Repair/replace
	Clogged Pipe	Pipe is clogged	• Remove roots or debris
Underdrain Pipe	Clean Orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period)	• 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 Orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain	• 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

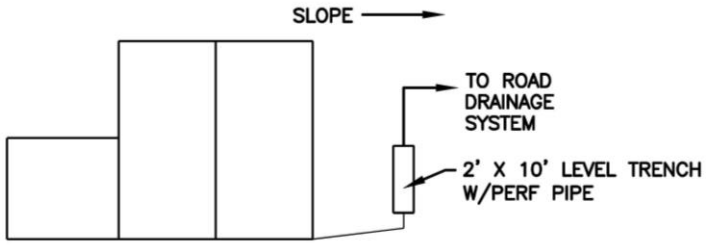
Permeable Pavement – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
Outlet Structure	Blocked Outlet Structure	Sediment, vegetation, or debris reducing capacity of outlet structure	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
Overflow	Erosion	Native soil is exposed or other signs of erosion damage are present at discharge point	• Repair erosion and stabilize surface
Observation Port	Subsurface Ponding	Water remains in the storage aggregate longer than anticipated by design after the end of a storm	• If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Adjacent Large Shrubs or Trees	Large Vegetation	Vegetation related fallout clogs or will potentially clog voids	• Sweep leaf litter and sediment to prevent surface clogging and ponding • Prevent large systems from damaging subsurface structural components
	Large Vegetation	Once in May and once in September Vegetation growing beyond facility edge onto sidewalk, paths and street edge	• 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	Leaf Litter	In fall (October to December) after leaf drop (1-3 times, depending on canopy cover) Accumulation of organic debris and leaf litter	• 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

Perforated Stub-out Connection

A perforated stub-out connection is a length of perforated pipe within a gravel-filled trench that is placed between roof downspouts and a stub-out to the local drainage system. The figure below illustrates a perforated stub-out connection. These systems are intended to provide some infiltration during drier months. During the wet winter months, they may provide little or no flow control.



TRENCH CROSS SECTION



PLAN VIEW OF ROOF

Perforated Stub-out Connections – Recommended Maintenance Protocols			
Drainage System Feature	**Potential Defect**	**Conditions When Maintenance Is Needed**	**Required Maintenance and Expected Results**
General	Trash and Debris	Any trash and debris which exceed 1 cubic foot per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris should be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous/ Noxious Vegetation	Any poisonous our 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).	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 polices required.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency.	No contaminant or pollutants present.
	Rodent Holes	Any evidence of rodent holes	Holes filled.
Storage Area	Sediment	Water ponding in infiltration area after rainfall ceases and appropriate time allowed for infiltration.	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.