

FIELD GUIDE



MAINTAINING

Rain Gardens, Swales, and Stormwater Planters



Field Guide: Maintaining Rain Gardens, Swales and Stormwater Planters (2013)

This document is available on the Oregon State University Stormwater Solutions website.

<http://extension.oregonstate.edu/stormwater/sites/default/files/fieldguide.pdf>

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TABLE OF CONTENTS

Introduction

Why is stormwater management important?	1
Types of Facilities	1

Preparation

Before going to the site	3
Safety Equipment	4
Hazards	5
Trash	5
Spills	5
Animals/Wildlife	5
Poisonous Plants	7



Take note! Throughout this document, the following symbol is used to highlight issues of special concern.

Inspection and Maintenance

Inspections	8
Maintenance Calendar	9
Trash and Debris	12
Erosion	13
Sediment	14
Vegetation	17
Common Weeds/Invasive Plants	18
Plant Replacement/Moisture Zones	21-22
Pruning	23
Irrigation Systems	24
Structures	24

Appendices

Appendix A: Maintenance Checklist	27
Appendix B: Sample Maintenance Log	30
Appendix C: Resources	32
Appendix D: Jurisdiction contacts	34
Appendix E: Photo Credits	35

Why is Stormwater Management Important?

Before our region was developed, forests and open spaces absorbed rainwater. As we built cities and towns and added hard surfaces (impervious surfaces), the amount and rate of rainwater runoff (also known as stormwater) entering rivers and stormwater pipes increased significantly. That rainwater also picks up pollutants as it flows across impervious areas. If not properly managed, rainwater can carry pollutants to rivers, erode and flood river banks or overload the storm sewer system.

Sustainable stormwater facilities (i.e. Low Impact Development-LID) attempt to mimic the natural water cycle. They function to slow and reduce the amount of stormwater that enters rivers and pipes as well as filter pollutants to protect our infrastructure and watersheds. Many communities require developers to install stormwater facilities, like rain gardens, swales and planters. Further, they require property owners to follow an Operations and Maintenance Plan to ensure that stormwater facilities continue to work over time.

Types of Stormwater Facilities

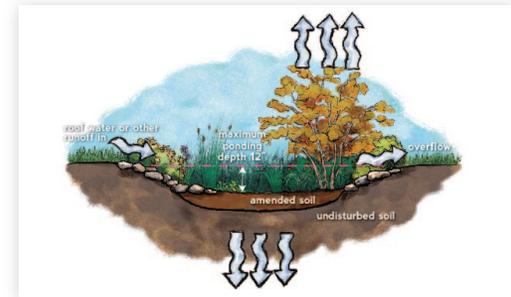
This field guide focuses on the three most common LID facilities used throughout the Portland metropolitan region. While maintenance guidance may apply to all types stormwater facilities, this manual specifically targets the following: rain gardens, swales, and stormwater planters.



Sustainable stormwater facilities mimic the natural water cycle.

Rain Gardens

A rain garden is a sunken, generally flat-bottomed garden bed that collects and treats stormwater runoff from impervious surfaces.



Cross-section of a typical rain garden.

Swales

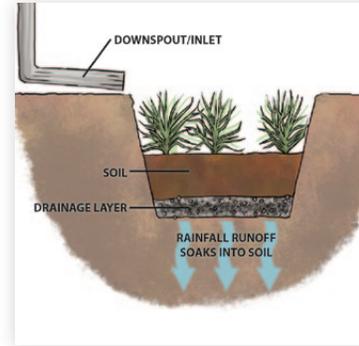
Swales are gently sloping depressions planted with dense vegetation or grass that treat stormwater runoff from impervious surfaces. As the runoff flows along the length of the swale, the vegetation slows and filters the water and allows it to soak into the soil. In areas where it is not advisable to have stormwater soak into the ground (poorly draining soils, steep slopes, limited space, contaminated soils, high groundwater levels, etc.) swales may include a liner that prevents water from soaking in. The runoff is then conveyed to a drywell, soakage trench or to the piped stormwater system. Swales can include check dams to help slow and detain the flow.



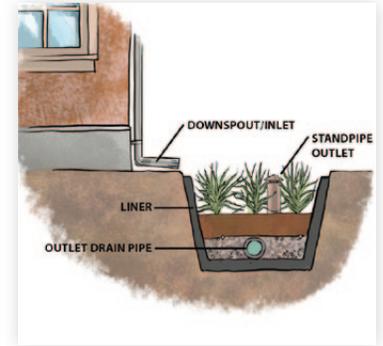
Overhead view of a swale

Stormwater planters

Planters are structures or containers that contain a layer of gravel, soil, and vegetation. Stormwater slowly soaks into the soil and then either makes its way into the ground below (infiltration planter) or into an underdrain system (flow through planter) that flows to the local stormwater pipes. Planters come in many sizes and shapes, and are made of stone, concrete, brick, plastic lumber, or wood. Careful consideration should be given before using infiltration planters in areas with poorly draining soils or in locations near structures such as buildings or streets.



Infiltration planter



Flow through planter

Before going to the site

A little preparation before going to the site will ensure you have the information needed to properly maintain the facility. Review the operations and maintenance plan, the as-built or design report (locations of inlets/outlets, plantings, irrigation system, etc.), as well as past inspection and maintenance reports. Knowing what has occurred at the site in the past will help ensure you know what is likely to be needed when visiting the facility.



Consult design plans and maintenance manuals before heading out on a maintenance visit to the facility.

Safety Equipment

Always use the appropriate safety equipment when maintaining stormwater facilities.

- Boots/Protective footwear
- Eye protection
- Hearing protection

Cut resistant gloves



Always wear cut resistant gloves when working in facilities.

Safety vest



Wear a safety vest when working near traffic or in parking lots.

Hard hat



Wear a hard hat when cutting branches overhead.

First aid kit



A first aid kit should be available to workers in case they are injured on the job.

Rake



Use a rake to gather leaves, trash, etc. from the facility.

Grabber



Use a grabber rather than hands to pick up trash whenever possible.

Hazards

There are a number of safety hazards that can occur in and around stormwater facilities.

Trash

Be sure to use gloves and grabbers to remove dangerous trash (needles, animal carcasses, etc.) and dispose of safely.

Spills

Chemical spills could easily introduce pollutants into facilities and the piped stormwater system. Workers should always have a spill kit on hand in order to prevent any spills from reaching the facility, local water bodies, or stormwater inlets.

Spill kit



Contains:

- Kitty litter (absorbent material to soak up the spilled substance)
- Absorbent pad
- Gloves
- Instructions on how to clean up a spill and contact information for agencies that need to be alerted in the event of a spill

Contact the local jurisdiction spill control hotline for assistance with spills.

- In addition, contact the Oregon Emergency Response System 1-800-452-0311 to report spills.

Animals/Wildlife

Animals found in stormwater facilities can pose a hazard to maintenance workers. Use caution when working in and around a facility to reduce the likelihood of surprise encounters.

- Do not handle animals or wildlife.
- Call an animal control specialist to remove if they are negatively affecting the facility function or pose a hazard to workers.

Animals/wildlife



Bees, wasps, yellow jackets



- Do not use poisons or other toxic baits in a stormwater facility.
- Contact Vector Control in your area for assistance on eradicating pests and vectors of disease.
- Some wildlife species that may be found in a facility are protected in the state of Oregon. Contact Oregon Department of Fish and Wildlife to determine what species are protected by law.

See Appendix C for a list of resources for managing hazards in stormwater facilities.

Needles



Needles found in a facility could pose a serious health risk if workers are stabbed by a sharp object. Use grabbers and gloves to remove needles and dispose of them using methods approved for medical waste.

Dead animals

Use grabbers, gloves and other protective equipment when removing dead animal carcass.

- Double-bag the carcass before disposing it in an appropriate garbage facility.



Prevent spills



When re-fueling equipment in the field, to protect water quality and ensure worker safety, use the following procedures:

- Do not fuel the tank while engine is hot or running.
- Conduct fueling operations over drip pans or other hard surfaces.
- Keep away from storm drain inlets, the stormwater system, and waterways.
- Do not “top off” fuel tanks.
- Keep clean absorbent materials on hand for minor spills.
- Make sure portable fuel tanks are leak free and are secured during transit.

See Appendix C for a list of resources for managing hazards in stormwater facilities.



**To avoid injury,
use caution when
entering facilities
with steep slopes.**



Poisonous Plants

Danger! Use caution when removing these plants!

Always use protective gear (gloves, long sleeves, boots, eye protection, etc.) when removing poisonous plants from a facility to prevent plant material from touching the skin.

Poison oak (Toxicodendron Diversilobum)



Contact with poison oak or the oils from the plant can cause a painful rash.

- Use gloves and protective clothing when removing plants that can irritate the skin.
- All protective clothing should be washed or disposed of after use to prevent exposure to the toxic plant sap at a later time.

Poison hemlock (Conium maculatum L.)



Poison hemlock is toxic and can cause death if eaten! It also has photo toxins that make human skin ultra-sensitive to UV light.

- If you suspect someone has eaten poison hemlock, have them seek medical treatment immediately.
- Use gloves and protective clothing when removing the plant as it can irritate the skin.

Giant hogweed (Heracleum mantegazzianum)



Giant hogweed sap makes human skin ultra-sensitive to UV light. Large, watery, burn-like rashes appear 15-20 hours after contact. If skin is exposed to the plant or sap, cover the area and wash it as soon as possible.

Contact with the eyes can cause temporary and sometimes permanent blindness.

See Appendix C for a list of resources for managing hazards in stormwater facilities.

Inspections

All facilities need to be inspected and maintained seasonally to ensure they are functioning well and to determine what maintenance is needed. The local jurisdiction determines the frequency of required maintenance inspections, but you can always decide to inspect the facility on a more frequent basis.



Refer to the site O&M Plan or contact the local jurisdiction for maintenance activities and schedule specific to the site.

Make sure to document all inspections and maintenance activities in an inspection and maintenance log. The owner of the facility maintains the logs and copies may need to be submitted to the local jurisdiction.

Take Photos

Inspection documents should include photographs of the project site before and after completing maintenance activities. See Appendices for more information on:

- Appendix B: Sample inspection and maintenance log to track maintenance issues and the actions taken to remedy any problems.
- Appendix C: Resources on photo documentation.
- Appendix D: Contact information for jurisdictions in the Portland metropolitan area.

Maintenance Calendar

Stormwater facilities need maintenance throughout the year to do their job. Below is a calendar that offers general guidelines on the appropriate time of year to do each maintenance activity.

ACTIVITY	HOW OFTEN?	WHEN?	SPRING	SUMMER	FALL	WINTER	NOTES
INSPECTION	After every major storm (1 in. in 24 hrs)*	Any time of year					
Remove TRASH and debris (from the inlets and within the facility)	Monthly (and after every major storm; 1 in. in 24 hrs) (every visit)*	Any time of year					
Fix EROSION problems	After every major storm (1 in. in 24 hrs)*	Any time of year					
Remove accumulated SEDIMENT from the base of the facility	As needed (when sediment reaches 2-3 in. in depth, or once a year) *	Ideally in the dry season					
Remove SEDIMENT and debris (from the inlets)	Monthly (and after every major storm; 1 in. in 24 hrs) (every visit)*	Any time of year					

* Refer to the site O&M Plan or contact the local jurisdiction to determine the site maintenance activities and schedule.

Maintenance Calendar

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ACTIVITY	HOW OFTEN?	WHEN?	SPRING	SUMMER	FALL	WINTER	NOTES
VEGETATION							
WATER plants	Water plants once a month or more until established (re-set irrigation schedule seasonally)*	Summer months					
Remove WEEDS	As needed	Spring, Summer and Fall					See Weeds Section (p.18-20) and Appendix C for more information on weed management.
PLANT REPLACEMENT	As needed; inspect at a minimum, once per year*	Spring (March-May) or Fall (Oct-Nov)					Vegetation planted in the fall (rather than the spring) will have more time to establish before the dry season.
PRUNING							
Trees and Shrubs	As needed; inspect once per year*	Winter is ideal for pruning trees/shrubs.					See Pruning Section (p.23) for more information.

* Refer to the site O&M Plan or contact the local jurisdiction to determine the site maintenance activities and schedule.

Maintenance Calendar

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ACTIVITY	HOW OFTEN?	WHEN?	SPRING	SUMMER	FALL	WINTER	NOTES
PRUNING							
Grasses and grass-like plants	As needed; inspect once per year*	Spring -to prepare for new growth Fall -if plants are blocking inlets/ outlets					Prune as needed to keep inlets and outlets clear or for desired aesthetics. Most grass-like natives do not require pruning unless desired for aesthetics or when blocking inlets or outlets.
IRRIGATION SYSTEM							
Check for leaks, breaks in the system	As needed; at a minimum, once per year*	During the spring before the dry season begins					
Drain lines to prevent freeze/thaw damage	As needed; at a minimum, once per year*	Fall, before first freeze					
STRUCTURES							
Inspect and maintain STRUCTURES	As needed; at a minimum, once per year*	Fall, before rainy season begins					

* Refer to the site O&M Plan or contact the local jurisdiction to determine the site maintenance activities and schedule.

Trash and Debris

Trash and debris can prevent runoff from entering a facility and can add pollutants. Remove all trash and other items that should not be in the facility.



To ensure the safety of workers, use a rake or grabbers to remove debris and trash from the facility. Use puncture resistant gloves to remove trash only as a last resort.



Dispose of trash in an appropriate solid waste bin.



Dispose of vegetation in a yard debris bin or send to a composting facility.

Examples of trash and debris found in facilities



Wooden pallets



Grass clippings



Leaf litter

Erosion

Erosion often occurs in stormwater facilities when the vegetation is insufficient to hold the soil or if the structures in the facility have problems. Adding additional plants or repairing energy dissipaters (e.g. concrete basins, riprap, splash pads) and check dams are common fixes.

Examples:

Problem

Channelization/erosion in the flow path or on side slopes



Erosion at inlet



Solution

Fill erosion channels with approved topsoil or soil mix and apply erosion control matting where appropriate. Add weed free mulch/yard debris compost on slopes of facility to prevent future erosion issues until plants fill in.*



* Not all jurisdictions allow the use of mulch in LID facilities. Check with the local jurisdiction before using mulch.

* Contact local jurisdiction for possible solutions to erosion issues.

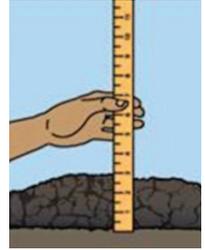


Sediment

Sediment buildup can prevent runoff from entering a facility or increase the amount of time it takes the water to soak into the soil. Most jurisdictions in our region require facilities to drain within 24- 48 hours.

Regularly removing sediment that has accumulated in the facility will allow water to flow through it as designed. It will also keep sediment out of the piped stormwater system.

Remove sediment from facility when it accumulates to a depth of 2-3 in. (or sooner)



Examples:

Problem	Solution	Solution
<p data-bbox="40 425 381 452">Inlet with basin full of sediment</p> 	<p data-bbox="535 425 901 484">Removing debris and sediment from inlet of facility</p> 	<p data-bbox="1039 425 1258 452">Inlet cleaned out</p> 
 <p data-bbox="300 776 430 829">Forebay full of sediment</p>	 <p data-bbox="860 776 1023 904">Sediment has been removed and forebay is now clean</p>	

Examples:

Problem	Problem
<p>Plants choked with sediment</p> 	<p>Sediment accumulated at bottom of facility.</p> 

Removing Sediment Manually

Step 1:

Worker scraping sediment manually from the bottom of a swale.



Step 2:

Put sediment in a bucket or wheel barrow and then dispose of it in an appropriate manner.



Step 3:

Loosen the soil surface at the bottom of the swale with a rake.



In small facilities, remove sediment with a shovel. In larger facilities, machinery may be used to remove sediment, but always use caution to prevent compaction of the soil.



In general, sediment removal should occur during the dry season when it is not wet.

But, in some instances, sediment that is removed from the bottom of a facility will be wet and needs to be dewatered before disposal. This prevents pollutants from dripping onto the hard surfaces nearby and entering the stormwater system and local water bodies. DO NOT DRAIN WET SEDIMENT OUTSIDE THE FACILITY!

For example:

The sediment has been scraped from the bottom of this facility and has been mounded in a pile in the inlet. Once the water has drained, the sediment can be removed and disposed of in an appropriate manner. To ensure compliance with erosion control laws, do not place sediment outside the facility to drain.



Sediment Disposal

- Sediment from stormwater facilities should be disposed of in garbage bins along with other solid waste/trash. Contact your solid waste hauler for guidance on the weight restrictions for garbage/solid waste bins.
- **Sediment MAY NOT be added to yard debris bins.**

Questions? Call the Oregon Department of Environmental Quality at 503-229-5263 or 800-452-4011 and ask for the Solid Waste duty officer.

Disposal

Do not dispose of sediment in yard debris bins.

Sediment can be disposed of in garbage bins.



The recommendations on the handling and disposal of sediment are current as of the printing date of this document. Contact the local jurisdiction and the Oregon Department of Environmental Quality to determine if the regulations and guidance has changed.

See Appendix C for contacts and resources on the disposal of sediment.



Always visually inspect sediment before determining the appropriate disposal method. Note any onsite activities that may contaminate sediment (i.e., fueling, hazardous material storage/handling/disposal, auto maintenance). If sediment is off color, has an odor or sheen, have it tested to determine if it is hazardous. Contaminated sediment must be disposed of at a hazardous waste facility.

Vegetation

Watering Plants

As the plants in a stormwater facility establish (a two to three year period after planting), they will need watering during the summer dry season. In some cases a facility may need to be watered even after

the plants are established. Using native plants in stormwater facilities is encouraged to reduce the need for supplemental watering after plant establishment.



Water high exposure areas (surrounded by pavement, little shade, significant wind, etc.) through the summer, even after the plant establishment period. For example, this facility is surrounded by pavement and may need supplemental watering during the summer even after the plants are established.



Water vegetation when plants show signs of drought stress (drooping leaves, leaf drop, leaves brown and brittle). This facility has not been watered in months and some of the plants may not recover due to severe drought stress.

How much water is needed? How often to water?

Deep, infrequent watering that moistens the top 12-18 inch root zone is recommended to keep plant alive and healthy and to promote deep roots.

For the first three years, deeply water plants once a month (or more) in hot, dry weather. Small plants may need more frequent watering in hot weather.

After 3-5 years, plants should be well-established, deep rooted and drought tolerant. Watering plants then becomes an infrequent task – only needed when plants begin show signs of stress.

Watering Tip

Water in the morning or evening. Water evaporates during midday heat.

Common Weeds/Invasive Plants

Weeds and invasive plants can overtake desirable plants needed for stormwater filtering and absorption. It is critical to remove any weeds and invasive plants from the facility so they don't spread when the facility overflows into the stormwater system.

Mulch can be used to suppress weeds until the vegetation is established and fills the facility. (Check with the local jurisdiction to determine whether mulch may be used in LID facilities.)

Integrated Pest Management (IPM) is generally the preferred approach for managing weeds and invasive plants. IPM is an effective and environmentally sensitive approach to pest management. IPM

programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property, and the environment.



Removing weeds by hand

Common Weeds and Invasive Plants



Himalayan blackberry
(*Rubus armeniacus*)



Reed canary grass
(*Phalaris arundinacea*)



Scotch broom
(*Cytisus scoparius*)



Knotweed
(*Polygonum spp.*)

Common Weeds and Invasive Plants



Canada thistle
(*Cirsium arvense*)



Red clover
(*Trifolium pratense*)



Garlic mustard
(*Alliaria petiolata*)



Yellow flag iris
(*Iris pseudacorus*)



Purple loosestrife
(*Lythrum salicaria*)



Nightshade
(*Solanum dulcamara*)



Hairy vetch
(*Vicia villosa*)



Poison hemlock
(*Conium maculatum* L.)



English ivy
(*Hedera helix*)



Morning glory
(*Convolvulus sepium*)



Bird's-foot trefoil
(*Lotus corniculatus L.*)

Removing weeds from stormwater facilities

1. Remove weeds by hand. Pull and dig out roots.
2. If this is not possible, contact the local jurisdiction and follow their recommendation for weed removal and control.
3. Remove all weeds and vegetative debris from the facility and dispose of properly. If weedy plant material is to be composted, send it to a high temperature/professional composting facility. This ensures weed seeds are destroyed.
4. Replace weeds with plants that are growing well in the facility. For more plant options, see the Plant Replacement Section for a list of plants that are known to grow well in stormwater facilities.

Because the use of herbicides can have negative impacts to water quality, it is important to use them only as necessary and with extreme caution. If using herbicides:

- Check with local jurisdiction on herbicide restrictions and application requirements.
- Always follow local Integrated Pest Management guidelines.
- Only use herbicides approved for aquatic use.
- Don't apply herbicides when there is standing water in a facility.
- Only apply herbicides during dry weather and ideally before the weeds have gone to seed.
- Don't apply herbicides below the high water mark.

See Appendix C for more resources on weeds, invasive plants and integrated pest management.

Plant Replacement

Facilities work best with dense vegetation to absorb and filter runoff. Most jurisdictions expect 75-90% plant coverage for established facilities. When additional plants are needed, consult the original planting plan for the facility (contact the facility owner or the local jurisdiction for the original plans). In addition, the local jurisdiction can offer plant suggestions. Make sure to select the right plant for the right moisture zone.

Examples:

Problem

Dead plants in facility



Solution

Install new plants to replace dead ones



Animal Damage?

Wrap saplings in 3 ft. diameter 14 gage steel wire cages fit snug to the ground.



Moisture Zones (Top, Slope, Bottom)

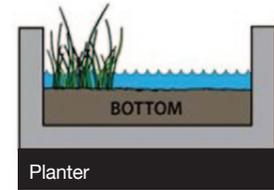
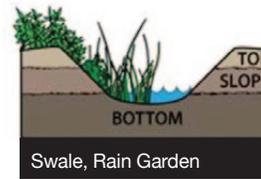
Always choose plants that can handle the moisture levels of the zone where it will be planted.

Bottom- Soil around roots may be saturated after every rain event.

Slope- Soil around roots may be moist and become saturated only during very large rain events.

Top- Soil around roots is generally not saturated.

The following is a list of plants that have proven to work well in rain gardens, swales and stormwater planters in the Portland metropolitan region (listed by moisture zone- Bottom, Slope, Top).



Bottom	Slope and Top	Top
Rushes / Grasses / Sedges	Ground Covers	Ground Covers
Spreading rush (<i>Juncus patens</i>)	Coastal strawberry (<i>Fragaria chiloensis</i>)	Kinnickinnick (<i>Arctostaphylos uva-ursi</i>)
Slough sedge (<i>Carex obnupta</i>)	Shrubs	Shrubs
Slender rush (<i>Juncus tenuis</i>)	Dwarf redbud dogwood (<i>Cornus sericea Kelsyi</i>)(2 ft)	Common Snowberry (<i>Symphoricarpos albus</i>)(6 ft)
Tufted hairgrass (<i>Deschampsia ceaspitosa</i>)	Swamp rose (<i>Rosa pisocarpa</i>)(8 ft) **	Tall Oregon grape (<i>Mahonia aquifolium</i>)(5 ft)
	Douglas spiraea (<i>Spiraea douglasii</i>)(7 ft)	Red-flowering currant (<i>Ribes sanguineum</i>)(9 ft) *
	Tall shrubs	Small/Medium Trees
*not suitable in height restricted areas	Red twig dogwood (<i>Cornus sericea</i>)(20 by 25 ft) *	Bitter cherry (<i>Prunus emarginata</i>)(50 ft) *
**not suitable in space limited areas	Pacific ninebark (<i>Physocarpus capitatus</i>) (15 by 15 ft) *, **	Cascara (<i>Rhamnus purshiana</i>)(30 ft) *
		Pacific crab apple (<i>Malus fusca</i>)(30 ft) *
		Vine maple (<i>Acer circinatum</i>)(15-20 ft) *

See Appendix C for additional Resources for Selecting Plants.

Pruning

Prune vegetation as needed to ensure the facility functions well. Vegetation should not pose a safety hazard or block visibility within transportation corridors.

Examples:

Problem	Problem	Solution
<p>The grasses in the swale are flopping over and blocking the walkway. They need to be pruned.</p> 	<p>Plants pruned too severely</p> 	<p>Grasses pruned to 10 inches</p> 
<p>Vegetation clogging an inlet.</p> 	<p>Vegetation removed; the inlet is now open.</p> 	

Height Guidelines

Overgrown trees and shrubs can create safety problems by blocking views of traffic signs, pedestrians and other vehicles. Vegetation needs to be pruned to allow for clear sightlines.



To ensure safe passage for everyone, tree limbs must hang no lower than:

- 7 ½ feet above a sidewalk
- 11 feet above residential streets
- 14 feet above main arterial streets.

From: “Pruning and Care of Young and Mature Trees”, Portland Parks and Recreation.

See Appendix C for additional resources on Pruning.

Irrigation System

If a facility has an irrigation system, maintaining it regularly will ensure it works correctly during the drought season when the plants may need to be watered. A well maintained irrigation system will support healthy plant development and reduce unnecessary water use.

General maintenance items on an irrigation system include:

- Inspect the system components for breaks, leaks and blockages and repair them as needed. It is best to do this while the system is running so leaks and other issues are easier to identify.
- Drain the irrigation lines in preparation for the winter season.
- Adjust the system to prevent overspray outside the facility.

Structures

Many of the structures in a facility can become damaged, vandalized, clogged or simply fail over time. All need to be inspected regularly and maintained if there is a problem.

Examples of structural problems:

Problem	Solution	Problem	Solution
Elbow detached from stand pipe	Elbow re-attached to stand pipe	Liner not attached to wall of facility; downspout pipes not connected to one another	Liner attached to facility wall; splash block added to downspout to reduce erosion
			

Problem

Not only is the street getting irrigated by this system, but the irrigation is running in the winter, a time when most landscapes in Oregon don't need irrigation.



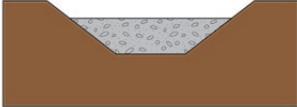
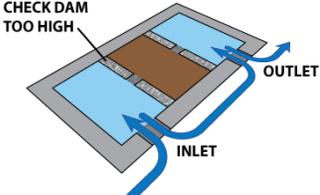
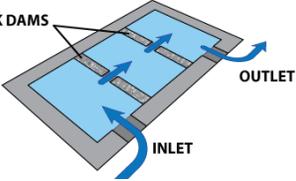


When maintaining a facility, always determine whether it has a liner. If it does, use extra caution to ensure the liner is not punctured during routine maintenance.

Examples of structural problems:

Problem	Solution	Problem	Solution
<p>Stand pipe cover missing</p> 	<p>Stand pipe with basket cover in place</p> 	<p>Overflow pipe placed too high; excess stormwater runoff will overflow outside the facility and could cause a public safety hazard.</p> 	<p>Overflow pipe at correct height (lower than the outlet) so stormwater can exit the facility safely through the goose neck outlet pipe.</p> 
<p>Problem</p>  <p>These check dams have fallen apart and no longer slow down the flow of stormwater in the facility. Rebuild to slow and spread the flow.</p>	<p>Solution</p>  <p>This check dam is intact. It prevents erosion, improves filtration and allows water to soak into the ground.</p>		

Examples of structural problems (continued):

Problem	Solution
<p>A check dam that has not been properly installed can cause erosion problems in the facility.</p> <p>Problems:</p> <ul style="list-style-type: none"> • Check dam material (in this case soil and rock) has NOT been trenched into the swale. This can lead to erosion as the water finds its way around or under the check dam. • No notch in the center of the check dam to direct flow away from sides of the swale. 	<p>Properly installed check dam</p> <ul style="list-style-type: none"> • Check dam material (in this case soil and rock) has been trenched into the swale. • Notch in the center of the check dam directs water to overflow in the center of the check dam and not on the sides. <p><i>(Graphics are not to scale and are not intended to function as check dam specifications. See the facility design plans or contact the local jurisdiction for guidance on check dam installation requirements)</i></p> 
<p>In this facility, the first check dam has been built too high and is preventing water from entering the middle cell of the swale. Therefore, the facility is not able to manage all the runoff it was designed to treat.</p> 	<p>In this facility, all the check dams are built at the correct height so the water flows into each cell of the swale for treatment.</p> 

See Appendix A for a checklist of structural elements that need to be inspected and maintained in a facility.



All structural repairs need to be implemented by a qualified professional. Tasks that modify the function of the facility or that deviate from the approved plans may need to go through the plan review and permitting process with the local jurisdiction.

Appendix A: Inspection/Maintenance Checklist*

This checklist reflects the inspection and maintenance activities that are generally recommended for rain gardens, swales and stormwater planters.

Before visiting the site

- _____ Review the operations and maintenance plan.
- _____ Review the as-built or design report (locations of inlets/outlets, plantings, irrigation, etc.)
- _____ Review past inspection and maintenance reports (historical problems, previous observations, etc.)

Hazards

Spills

- _____ Record the nature and extent of any spills and the response if it has or could negatively affect stormwater.

Animals/Wildlife

- _____ Record any indication of rodents, mosquitoes, other insects or pests.
- _____ Fill holes and burrows in and around facility.
- _____ Contact animal control specialist to remove or trap animals if they are negatively affecting facility function.

Trash/Debris

- _____ Remove trash, debris and other items and dispose of appropriately.

Erosion

- _____ Fill erosion channels with approved topsoil or soil mix and stabilize using appropriate methods (erosion control matting, etc.). †
- _____ Install or repair energy dissipater at inlet if erosion is occurring there. †
- _____ Add/repair check dams (as appropriate). Re-construct check dams as needed to slow flows and spread stormwater across full surface of facility. †
- _____ In facilities where mulch is appropriate (e.g. exposed soils), add 2-4 inches mulch above high water mark to prevent erosion. (Check with local jurisdiction on the use of mulch in facilities)
- _____ Sweep catchment area to prevent sediment from entering facility (as appropriate).

Sediment

- _____ Remove sediment from the surface of the facility when it reaches 2-3 inches in depth.
- _____ Remove sediment from inlets (trench drains, curb cuts, area drains and pipes) so water is not prevented from entering facility.
- _____ Rake areas of bare soil after removing sediment.
- _____ Replace any plants that may have been removed during sediment removal. (see Vegetation section)

* Refer to the site O&M Plan or contact the local jurisdiction to determine the site inspection maintenance checklist required for the facility you are working on.

† Contact the local jurisdiction for possible solutions to erosion issues.

Vegetation

Watering

- _____ If the facility has an irrigation system, adjust the irrigation schedule for each season.
- _____ Inspect plantings during dry periods and look for signs of stress.
- _____ Water plants as needed.
- _____ Adjust irrigation system if there is evidence of overspray outside the facility.

Common Weeds and Invasive Plants

- _____ Remove weeds from the facility (In facilities with liners, this includes volunteer trees that seed themselves into the facility whose roots could damage the underground plumbing and liner).
- _____ To reduce future weeds, add 2-4 inches of mulch above the high water mark (Keeping mulch out of the wet zone prevents it from washing out of the facility and clogging outlets).

Plant Replacement

- _____ Note dead vegetation and determine the reason plant died (lack of water, wrong plant for location, disease, etc.).
- _____ Replace dead vegetation with plants appropriate for the moisture zone and solar exposure. To choose replacement vegetation, see the original planting plan, contact the local jurisdiction, or see the Plant Replacement Section of the Field Guide for plants that work well in LID stormwater facilities.

- _____ Add vegetation to cover large areas of exposed soil or in flow path to prevent erosion.
- _____ When adding new vegetation to the facility, spread 2-4 inches of mulch above the high water mark to reduce competition from weeds (To prevent mulch from washing out of the facility and clogging outlets, do not add mulch to the wet zone of the facility).
- _____ Protect vegetation if there is evidence of animal damage.

Pruning

- _____ Trim trees, shrubs and herbaceous plants as needed (follow height guidelines on p. 23 of the Field Guide).
- _____ Cut and remove grasses that are lying down (cut to a height of 10 inches).
- _____ Trim plants to clear inlets and outlets. Clear a 12 inch area at the inlet & outlet.
- _____ Remove pruned material and dispose of appropriately or compost outside the facility.

Irrigation System

- _____ Inspect the system components for breaks, leaks and blockages. Repair as needed.
- _____ Drain the lines in preparation for the winter season.

Structures

_____ Note-document any structures that are damaged or broken.

Pipes and Under Drains

_____ Clean out sediment from clogged pipes, trench drains, underdrains and outlets.

_____ Replace outlet covers, as appropriate.

_____ Attach screens on outlet stand pipes to prevent pests and debris from entering storm pipes.

_____ Jet clean or rotary cut debris/roots from under drains so the pipes can drain and standing water is not present during dry weather.

Liners

_____ Re-attach liners to planter walls to protect building foundations.

_____ Repair and/or reposition downspout extensions and splash pads to direct stormwater away from building foundations.

_____ Cover exposed liners with 2 to 4 inches of soil to prevent solar damage.

Check Dams

_____ Replace pipes, as appropriate.

_____ Repair check dams as needed.

- Check dams need to spread the flow of stormwater across the entire surface of the facility (or through the notch in the middle) to prevent erosion.
- Make sure the check dam is at the right height. A check dam that is too high can force water to flow back out of the facility.

Appendix B: Sample Inspection and Maintenance Log*

This maintenance log reflects the types of inspection and maintenance activities that are generally recommended for rain gardens, swales and stormwater planters.

Site name:			
Site address:			
		Date: (mm/dd/yy)	Crew (names):
		Hours since last storm:	# of staff hours at the facility:
		What did you see?	What did you do?
Safety Concerns			
Can you access the facility easily?			
Foreign/dangerous objects?			
Any spilled material/spill potential?			
Vandalism, undesirable activity?			
Evidence of the public entering facility?			
Trash			
Trash, debris, pet waste, etc.?			
Animals/Wildlife			
Any burrows or nests?			
Mosquitoe larvae?			
Animal droppings?			
Vegetation			
Overgrown vegetation?			

*Refer to the site O&M Plan or contact the local jurisdiction to determine the site inspection maintenance log required for the facility you are working on.

Vegetation	What did you see?	What did you do?
Dead plant count (Trees, shrubs, grasses, etc.)		
Large areas of bare soil?		
Weeds? What species? (see Weeds/Invasives section)		
How much of facility covered in weeds?		
Vegetation or debris obstructing inlets/outlets?		
Soil/Erosion		
Erosion, undercutting, scouring?		
Sediment		
How many inches of accumulated sediment?		
How much of the surface area is covered by sediment?		
Any unusual odors, colors, sheen on the soil?		
Is the facility flowing and draining as designed?		
Standing water? (Hours since last rainfall)		
Structures		
Inlet/Outlet (rusting, cracked, misaligned?)		
Pipes (clogged, damaged, etc.?)		
Any problems with other structures?(liner, curb, check dams, grates, fence, etc.)		
Other Observations		

Appendix C: Resources

Photo documentation

A good reference for choosing viewpoints and using photo documentation is *The Oregon Watershed Enhancement Board (OWEB) "Guide to Photo Point Monitoring,"* found at http://www.oregon.gov/OWEB/docs/pubs/PhotoPoint_Monitoring_Doc_July2007.pdf?ga=t.

Hazards

Toxic and Poisonous Plants

AMA Handbook of Poisonous and Injurious Plants (available for purchase online)

Animal and Wildlife

See the **Stormwater Facility Operations & Maintenance: Best Practices Manual**, <http://extension.oregonstate.edu/stormwater/sites/default/files/bestpracticesmanual.pdf> for more detailed information on managing animals and wildlife in a facility.

Resources for vector control and animal/wildlife issues

	Organization:	Phone:	Website:
Bees/swarms	Oregon Beekeepers Association		http://www.orsba.org/htdocs/home.php
Coyotes and other urban wildlife	Portland Audubon Society	503-292-0304	http://audubonportland.org/wcc
Other wildlife	Clackamas office Oregon Department of Fish and Wildlife	971-673-6000	Clackamas ODFW office (use if east of Willamette River) http://www.dfw.state.or.us/
		503-621-3488	Sauvie Island ODFW office (use if west of Willamette River) http://www.dfw.state.or.us/
Vector Control	Clackamas County	503-655-8394	http://www.clackamas.us/vector/
	Multnomah County	503-988-3464	http://web.multco.us/health/pest-prevention-and-control

Sediment

Sediment Disposal

Contact Metro or the Oregon Department of Environmental Quality on the disposal of sediment.

Metro Recycling and Solid Waste Hotline 503-234-3000
<http://www.oregonmetro.gov/index.cfm/go/index.cfm/go/by/web/id=571>

Oregon Department of Environmental Quality
 Call 503-229-5263 or 800-452-4011 and ask for the Solid Waste duty officer.

Vegetation

Weeds, Invasive Plants and Integrated Pest Management

- For information on early detection and rapid response (EDRR) weeds and recommended treatment methods, see the Oregon Department of Agriculture EDRR website: <http://oregon.gov/ODA/PLANT/WEEDS/edrr.shtml>
- Weed management schedule, Clean Water Services IPM Plan, Appendix A <http://tinyurl.com/cesnydj>
- Grow Smart, Grow Safe: A Consumer Guide to Lawn and Garden Projects <http://www.lhwmp.org/home/gsgs/>

- Integrated Pest Management, State of Oregon or as approved by the local jurisdiction. <http://www.oregon.gov/ODA/PEST/ipm.shtml>
- OSU Extension. 2003 *Pacific Northwest's Least Wanted List: INVASIVE WEED IDENTIFICATION AND MANAGEMENT*. EC 1563.
- Clean Water Services, Non-Native Invaders, <http://www.cleanwaterservices.org/Residents/JoinTheCycle/InYourYard/Invasives/Invaders.aspx>

Selecting Plants

Portland Plant List, <http://www.portlandonline.com/bps/index.cfm?c=45131>
 Portland Green Street Plant List:
<http://www.portlandonline.com/bes/index.cfm?c=47962&a=380500>
 Clean Water Services Design & Construction Standards, Appendix A
<http://www.cleanwaterservices.org/PermitCenter/DesignAndConstruction/DandCTable.aspx>

Pruning

Pruning and Care of Young and Mature Trees, Portland Parks and Recreation
<http://www.portlandonline.com/parks/index.cfm?a=179897&c=39712>

International Society Arboriculture Pruning Standards
http://www.treesaregood.com/treecare/pruning_mature.aspx

Appendix D: Jurisdiction Contacts

Maintenance requirements for LID facilities vary by jurisdiction. Be sure to contact the appropriate local government representative to determine what is required for the facility.

Jurisdiction	Department	Phone	Website
Clackamas County Water Environment Services	Development Services	503-742-4567	http://www.clackamas.us/wes/dreview.html
Fairview	Public Works	503-665-9320	http://fairvieworegon.gov/index.aspx?NID=181
Clean Water Services (Washington County)	Service Delivery Planning Department	503-681-3600	http://cleanwaterservices.org/pwqf
Gladstone	Public Works	503-656-7957	http://www.ci.gladstone.or.us
Gresham	Watershed Division	503-618-2525	http://greshamoregon.gov/watershed/
Lake Oswego	Engineering/Public Works	503-635-0270	http://www.ci.oswego.or.us
Milwaukie	Public Works	503-786-7555	http://www.ci.milwaukie.or.us/
Oregon City	Public Works	503-657-0891	http://www.orcity.org
Portland	Environmental Services, Maintenance Inspection	503-823-7383	http://www.portlandonline.com/bes/index.cfm?c=45464&
Sandy	Public Works	503-668-5533	http://www.ci.sandy.or.us
Troutdale	Stormwater	503-674-3300	http://www.ci.troutdale.or.us
Wilsonville	Natural Resources	503-682-4960	http://www.ci.wilsonville.or.us
Wood Village	Public Works	503-489-6859	http://www.ci.wood-village.or.us

Appendix E: Photo Credits

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Abbreviations: EMSWCD - East Multnomah Soil and Water Conservation District. BES - Bureau of Environmental Services. CWS - Clean Water Services.

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INTRODUCTION

PREPARATION

INSPECTION &
MAINTENANCE

APPENDICES

