3.0 Facility Design

Detailed design requirements for stormwater facilities are provided in the following section. Facility geometry, slope, plumbing, soil amendment/mulch, and planting requirements and specifications are provided. ~~The City reserves the authority to modify, refine, or rescind approved stormwater facility types or associated design criteria based on updated regulatory guidance, observed performance, maintenance experience, or evolving best management practices.~~

3.0.1 Applicability

Table 3-1. Stormwater facility summary. Select facilities that infiltrate, unless prohibited under **section 1.2.2**. Sites that cannot infiltrate shall prioritize a green facility for stormwater quality treatment. Other facilities may be approved for sites that do not infiltrate and/or have other site constraints.

	Requirement		Impervious Surface to be Treated					
Stormwater Facility	**Infiltrate**	**Green**	**Rooftop**	**Driveway**	**Sidewalk/ Patio**	**Artificial ~~Turf~~[3] Turf[4]**	**Parking Lot**	**Street**
Porous Pavement	●	●		●	●		●	●[5]
Ecoroof	●[1]	●	●					
Rain Garden/Swale	●	●	●	●	●	●	●	●[6]
Stormwater Tree Well	●	●	●	●	●	●	●	●[6]
Stormwater Planter	●	●	●	●	●	●	●	●
Vegetated Filter Strip	●	●		●	●		●	●
Downspout Extension[2]	●	●	●					
Drywell[3]	●		●	●	●	●	●	●
Soakage Trench[3]	●		●	●	●	●		
Infiltration Vault[3]	●		●	●	●	●	●	
Centralized Facility (Dry Detention Pond, Wet Pond, subsurface gravel pond)		●	●	●	●	●	●	●
Detention Vault/Pipe			●	●	●	●	●	●
Proprietary Devices			●	●	●	●	●	●

[1] While ecoroofs don't technically infiltrate and require overflow to a conveyance system, they are assumed to be an impervious area reduction method and are given full infiltration credit.

[2] Only allowed for retrofits in areas with infiltration rates $\geq$2"/hour

[3] Stormwater generated from anything other than single detached dwelling unit roof area must be registered with DEQ. A silt basin is typically adequate pre-treatment for roof runoff, but additional pre-treatment is required for ground level impervious surfaces.

[4] Artificial turf fields containing crumb rubber, or other materials of concern, are required to provide water quality treatment for any drainage collected through perforated pipes. Detention and flow control must also be considered for any artificial turf field installed where pre-development hydrology is altered (e.g. asphalt treated base installed, which limits/prevents infiltration).

[5] Use of porous pavement on public streets must be approved by the Transportation Division.

[6] Streets with 10-foot landscape strips shall prioritize swales. Streets with 4 to 6-foot landscape strips shall prioritize planters or stormwater tree wells.

Each stormwater facility has additional applicability criteria related to slopes, soils, setbacks, and geometry included in the following design sections.

3.0.2 Setbacks

Stormwater facilities shall follow the setback distances in **Table 3-2**, unless a geotechnical engineering report is provided and approved by the City. Note that sites noted in **section 1.2.2** may not propose infiltration facilities.

If a stormwater facility is proposed in an area of mapped hydric soils, the applicant must provide a wetland determination, to be reviewed by Gresham staff or representatives, documenting the absence of pre-existing wetlands within the footprint of the proposed facility, in order to ensure the facility will not be considered a jurisdictional wetland, such that routine maintenance can be conducted without permits.

Table 3-2. Stormwater Facility Setbacks. Facilities may be located within these setbacks only with a geotechnical engineering report that is approved by the City.

Stormwater Facility Type	Setback from	Distance (feet)
Permeable pavers, porous asphalt, or porous concrete	Property line or foundation. Liner may be required if located within 5 feet of infrastructure	0
Lined facilities	Foundation, property line, or slope*	0
All infiltration facilities	Property Line**	5
All infiltration facilities	Any foundation	10
All infiltration facilities (including subsurface infiltration facilities***) and ponds	Slopes 20% or greater (or Hillside & Geologic Risk Overlay)	100
All infiltration facilities (including subsurface infiltration facilities) and ponds	Slope greater than 10' high & steeper than 2h:1v	200
Drywell***	Drinking water well	500 (or 2-year time travel)

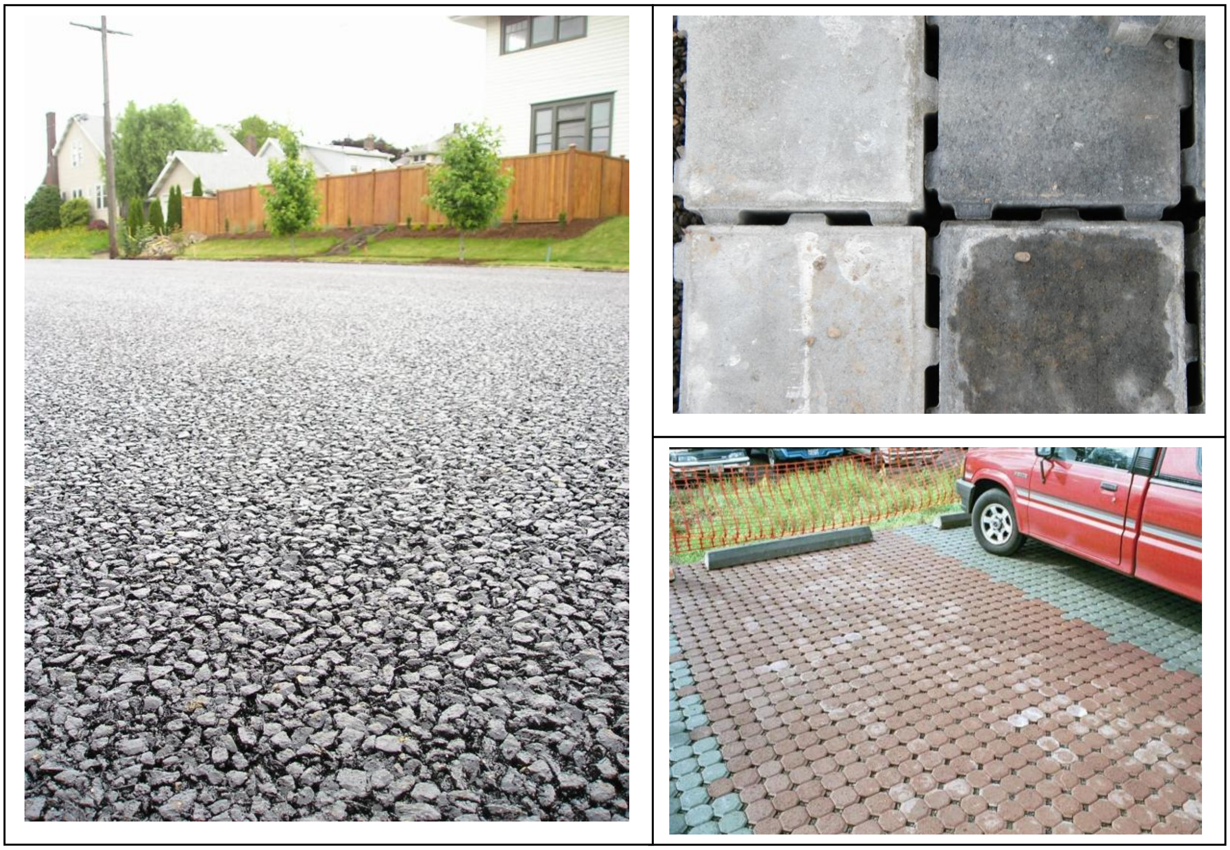
* Even when designed to not infiltrate, ponds must meet the setbacks noted below to reduce slope failure.
** No setback required for portion of property line adjacent to public right-of-way
*** Setbacks for subsurface infiltration facilities are measured from the center of a drywell or from the outside edge of a soakage trench or any surface stormwater facility to the adjacent boundary, structure, or facility.

3.1 Impervious Area Reduction

Porous pavement and ecoroofs are impervious area reduction techniques that can reduce the overall square footage of impervious area that requires stormwater management. These techniques intercept rainfall directly and should not receive stormwater runoff from other areas.

3.1.1 Porous Pavements

Facility Description
Porous pavements, which may also be referred to as permeable or pervious pavements, allow rainwater to pass directly through the paving surface into gravel layers below, where it slowly infiltrates into the native soils. To avoid confusion with the term impervious, this manual refers to all pervious or permeable pavements as "porous pavement."



Left: porous asphalt mix. Top-right: SF RIMA™ pavers. Bottom-right: Uni Eco-Stone® pavers

Applicability
Porous pavements that meet all applicable State and City building codes may be used on private property to receive stormwater management credit. Porous pavement proposals in the public right-of-way must be pre-approved by the Transportation Division.

Porous pavement surfaces designed for streets must be designed and stamped by a registered professional engineer in the State of Oregon. Proprietary porous pavement systems must be installed per manufacturer specifications.

Porous pavements shall not be used in areas covered by the 100-year floodplain. Where slopes are greater than 5 percent, the design must be engineered to specifically address under-pavement water retention. If the slope of the area is 10 percent or greater, porous pavement is not allowed.

Design Requirements

Setbacks: No setback is required from property lines or buildings. The designer may opt to install a partial liner when porous pavement is located within 5 feet of structures or infrastructure.

Sizing: Porous pavement areas replace impervious surfaces at a 1:1 ratio. Stormwater from adjacent paved surfaces should not be directed to a porous pavement system.

Edge Restraints: Edge restraints for pavers are required to be permanent (cast-in-place or precast concrete curbs) and a minimum of 6 inches wide and 12 inches deep for private streets, public roadways, and commercial pavements. Residential restraints may be plastic and set with spikes.

Friction/Wearing Course: The depth of the top lift varies depending on the material and surface being paved. Drawing ST-100 lists depths that the surface wearing/friction course for porous concrete, porous asphalt or pavers must be.

Porous pavements installed in parking lots, or places where a large amount of "dry turning" is expected, should prioritize paver systems over porous concrete or asphalt. Porous asphalt is most commonly used for streets, driveways, and parking lots. Details about the porous warm mix asphalt that should be used as the wearing course and the subgrade rock it should be placed on, preferably an Asphalt Treated Permeable Base, are detailed below.

Porous Hot or Warm Mix Asphalt (PHMA/PWMA): When porous asphalt is used, a warm-mix asphalt cement shall be PG 70-22ER polymer modified or higher grade. Hot-mix asphalt containing the same polymer may be used if warm-mix is unavailable at the plant, but warm-mix shall be used, if available. Typical temperature ranges are 250-275°F for warm mix asphalt and 275-300°F for hot mix asphalt containing PG 70-22ER binders.

Binder content shall be between 6.0% and 7.0% by total weight of the mix, and will be the highest percentage that passes both the drain down and void requirements tests at N_{design} = 75 gyrations. The binder content tolerance shall be ±0.3% during production and placement of the asphalt. The contractor shall adjust the aggregate to meet the maximum drain down test requirements within the ranges provided below.

1. Drain down* shall be 0.3 %, maximum, according to ASTM D6390
2. Void ratio shall be 16% to 25% per ASTM D3203 at N_{design} = 75 gyrations.
   *Drain down refers to the downward movement of binder through the open graded aggregate used in the asphalt mixture.

The Contractor may use some recycled asphalt pavement (RAP) in the blend, but it must be 20 percent or less RAP by total weight.

Aggregates for PHMA/PWMA shall meet the following requirements for grading:

Sieve Size	Percent Passing*
¾" square	100
½" square	90 - 100

3/8" square	55 - 90
U.S. No. 4	10 - 40
U.S. No. 8	0 - 20
U.S No. 40	0 - 13
U.S. No. 200	0 - 5

* All percentages are by weight.

The aggregate for PHMA/PWMA shall consist of crushed stone with a percent fracture greater than 90% on two faces on the No. 4 sieve and above.

Choker/Bedding Course: A 3-inch deep layer of small uniformly sized aggregate layer shall be placed on top of the base rock before placement of the porous wearing/friction course. For porous concrete and asphalt, the choker course shall be ¾" to ½" aggregate. For paver systems, the bedding course shall be ¾ to ¼" aggregate. A choker course is not needed if an Asphalt Treated Permeable Base is used.

Base Rock: Open graded aggregate, typically washed, crushed 2 to 3/4-inch or No. 57 rock, shall be placed under the choker/bedding course. The base rock depth needed to store the 25-year event without overflow can be calculated using the Engineered Method (see **section 2.3.2** and **Appendix D**). The needed base rock depth may vary from as little as 4-inch up to 24-inch, with the typical base rock depth being 12 inches. Depending upon the storage volume needed in the base rock section, some, or all, of the base rock can be comprised of Asphalt Treated Permeable Base.

Asphalt Treated Permeable Base: Asphalt treated permeable base (ATPB) consists of a compacted course of open graded aggregate which has been weatherproofed and stabilized by treatment with an asphalt binder. ATPB is a plant mixed blend of washed aggregate combined with 3 to 4% asphalt cement binder that is placed in lifts of 4 to 5-inch depth that are compacted prior to laying additional lifts or the surface/wearing course.

Aggregates for ATPB shall meet one of the following requirements for grading:

Sieve Size	**Percent Passing ***	
	Grading 3/4 (1)	Grading 1-1/2 (2)
1-1/2"		100
1"		90 - 100
¾" square	100	80 - 95
½" square	90 – 100	35 - 65
3/8" square	40 - 80	25 - 45
U.S. No. 4	0 - 30	0 - 30
U.S. No. 8	0 - 20	0 - 20
U.S No. 16	0 - 10	0 - 10
U.S. #200	0 - 4	0 - 4

* All percentages are by weight.
(1) – Minimum asphalt binder content = 3.5%
(2) – Minimum asphalt binder content = 3.0%

The aggregate shall consist of a combination of crushed and natural aggregates with a percent fracture greater than 75% on one face on the No. 4 sieve and above, in accordance with the field operating procedures for AASHTO T 335.

The grade of paving asphalt binder shall be PG58V-22, or higher, unless otherwise specified.

The manufacture of ATPB should include warm mix asphalt, which includes organic additives, chemical additives, and foaming that allow for lower mixing and placement temperatures without impacting the final ATPB pavement properties.

ATPB shall be spread with a spreading machine equipped with a stationary, vibratory, or oscillating screed or cut-off device. The internal temperature of the ATPB mixture at the time final rolling and targeted consolidation is achieved shall be a minimum of 185°F. Rollers shall only be operated in the static mode when the internal temperature of the ATPB is less than 175°F.

A light tack coat (approximately 0.02 gallons/square yard residual asphalt) shall be applied between lifts of ATPB. A heavy application of tack coat shall be applied to all joints.

Rolling and Compaction of ATPB and Porous Asphalt: The wearing course and ATPB shall be consolidated to a firm and unyielding state. The Contractor will develop a roller pattern that will initially consolidate the pavement structure and then use static rolling only thereafter to prevent over compaction. Compaction density shall be 80% or greater (ideally 82% to 85% of maximum theoretical (Rice) density) and target 15% to 18% final air voids.

Pneumatic tire rollers shall not be used.

Underdrain System: Where the native soil is not capable of infiltrating at a rate adequate to keep water from the 25-year, 24-hour storm from filling the base rock layer and backing up into the wearing/friction course, an underdrain system shall be employed to direct excess water to an approved disposal point. Porous pavements installed on type A or B soils should not need an underdrain system. For purposes of receiving pollution reduction credit, underdrain systems will be required where the native soils infiltrate at 0.5”/hr or less (Type C and D soils), or where the slope of the paving surface and gravel base layer may cause water to accumulate and fill the gravel layer quickly in the lower area.

Safety Overflow: Porous pavement systems shall be designed with a safety overflow mechanism to prevent ponding in the event that the surface is clogged with sediment or debris. The overflow mechanism may consist of an inlet drain, catch basin, curb opening, or other method to convey water to an approved disposal point.

3.1.2 Ecoroofs

Facility Description
An ecoroof, also called a green roof, is a lightweight vegetated roof system consisting of waterproofing material, a growing medium, and low growing, drought tolerant plants. An ecoroof can be used in place of a traditional roof as a way to limit impervious site area and to manage stormwater runoff. Ecoroofs reduce post-developed peak runoff rates to near-pre-developed rates and reduce annual runoff volume by about 50 percent. Ecoroofs also help mitigate runoff temperatures by keeping roofs cool and retaining most of the runoff in dry seasons. The design must be self-sustaining.

Applicability
Primarily an option for newly constructed buildings, although retrofits of existing buildings is possible. The structural roof support must be sufficient to hold the additional weight of the ecoroof. For retrofit projects an architect, structural engineer, or roofing consultant can assess the condition of the existing building structure and determine what is needed to support an ecoroof. Alterations might include additional decking, roof trusses, joists, columns and/or foundations. Generally, the building structure must be adequate to hold an additional 15 to 30 pounds per square-foot (psf) saturated weight, including the vegetation and growing medium that will be used (in addition to snow load requirements). Generally, an existing rock ballast roof may be structurally sufficient to hold a 10-20 psf ecoroof (if the ballast is removed).

Design Requirements

Sizing: Ecoroofs replace impervious area at a 1:1 ratio. They are not allowed to receive water from other impervious areas.

Slope: Maximum roof slope is 25 percent, unless the applicant provides documentation of runoff control on steeper slopes.

Access: The design must consider safe access for maintenance of the ecoroof and other maintenance needs that require roof access.

Waterproofing: A good-quality waterproofing material, such as modified asphalt, synthetic rubber, or reinforced thermal plastics, must be used on the roof surface. To maximize the life of the ecoroof, no portion of the waterproof membrane may be exposed to sunlight.

Root barrier: A root barrier is sometimes required in addition to waterproofing material, depending on the type used. Root barriers impregnated with pesticides, metals, or other chemicals that may leach into stormwater are not allowed, unless the applicant can provide documentation that leaching does not occur. If a root barrier is used, it must extend under any gravel ballast and the growing medium and up the side of any vertical elements. Some waterproofing materials also act as a root barrier.

Drainage and overflow: A method of drainage must be provided. The drainage layer may include geotextile fabric, gravel, or be the growing medium itself particularly on steeper, fast-draining ecoroofs. Ecoroofs are not a full stormwater disposal system and need to have a conventional drainage system to manage excess runoff from the roof during periods of sustained or heavy rainfall. The applicant must provide roof drains that connect to an approvable discharge location.

Soil: A minimum of 4 inches of growing medium is required for the vegetated portions of the ecoroof, composed of approximately 70 percent porous material and 30 percent organic material (i.e., aged compost) or other mix approved by City.

Vegetation: Drought-tolerant plants from the ecoroof plants listed on the **Gresham List of Stormwater Plants** must achieve 90 percent coverage within 2 years. At least 50 percent of the ecoroof must be composed of evergreen species. Ecoroof vegetation should be:

- Drought-tolerant, requiring no or little irrigation after establishment;
- Self-sustaining, without the need for fertilizers, pesticides, or herbicides;
- Able to withstand heat and cold;
- Very low-maintenance, needing little or no mowing or trimming;
- Perennial or self-sowing;
- Fire-resistant.

A mix of sedum/succulent plant communities is recommended because these plants possess many of these attributes. Although herbs, forbs, grasses and other low groundcovers can provide stormwater and aesthetic benefits, plants that require irrigation beyond what is allowed in this section for survival are not permitted.

Mulch: A method to retain moisture and protect exposed soil from erosion is recommended, such as gravel mulch.

Non-vegetated components: Non-vegetated components may comprise up to 10 percent of the ecoroof while still counting toward the total ecoroof area, though the non-vegetated area should be kept to a minimum. If additional non-vegetated area is necessary to meet fire code requirements, the 10 percent maximum may be exceeded only by that required area. Rooftop features that cannot be considered non-vegetated components of an ecoroof include: mechanical equipment and solar panels (unless vegetation is extended beneath elevated units), elevator overruns, penthouses, and skylights. Runoff from portions of the structure that penetrate the ecoroof (e.g. elevator overruns and penthouses) must meet the provisions of this manual. Examples of non-vegetated components that can be counted within the 10 percent include:

- Decking or porous materials such as gravel or pavers that are placed over sand or alternate substrate for the purpose of providing access to the ecoroof and other rooftop components;
- Ballast along parapets or mechanical units;
- Alternate non-vegetated components may be allowed subject to City review.

3.2 Vegetated Facilities

Vegetated facilities should be prioritized over "Other Facilities" (described in **section 3.4**) since surface facilities utilizing soil and plants to manage stormwater are able to filter pollutants, while also reducing volume through evapotranspiration, as well as infiltration for unlined facilities.

3.2.1 Rain Gardens and Swales

Facility Description

Swales and rain gardens are designed similarly, with the exception being that swales have a gradual slope and convey water, while rain gardens typically hold water temporarily before it infiltrates. Swales are typically long, narrow, gently sloping landscaped depressions that collect and convey stormwater runoff. Both facilities are planted with dense vegetation that treats stormwater from rooftops, parking lots, and streets. As the stormwater flows along the length of the swale, the vegetation and check dams slow the stormwater down, filter it, and allow it to infiltrate into the ground. Where soils do not drain well, a rain garden or swale can overflow to an approved discharge location such as a drywell or a piped conveyance system. The best settings for a vegetated swale are in the landscape strip along a road, in the landscape areas within parking lots, or along a large building.

Applicability

Rain gardens and swales are used to manage stormwater flowing from all types of impervious surfaces, on private property and within the public right-of-way. Infiltration facilities are more effective than filtration/lined facilities at retaining stormwater on-site, so rain gardens and swales shall be designed to infiltrate unless site conditions require it to be lined. If native soils infiltrate at less than 0.5 inches per hour, the facility may need to have an underdrain installed and be a partial infiltration facility. Infiltration facilities need to be located at least 10 feet from building foundations, not immediately upslope of building structures, and on slopes less than 20%. Locating a facility within 10 feet of a building or on slopes greater than 20% requires installation of an impermeable liner and underdrain to create a filtration facility.

Design Requirements

Soil suitability: Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to be conveyed through the facility. The Simple Sizing Form assumes infiltration rates based on soil type and requires an overflow to be installed for Type C and D soils.

Facilities without an overflow are only allowed within the designated UIC area and only if Larger sites (those adding more than 5,000 sf of impervious surface) or those using the Engineered Method need to test infiltration rates, determined by following the procedure in **Appendix E**., are shown to be Based on the infiltration results, the design professional shall include an overflow to an approved discharge location if the facility is not able to store the volume from the 100-year storm event and fully draw down within 48 hours.

Sizing: Sizing varies by design approach. The Simple Sizing Form can be used to determine the size of facilities based on soil type for the Simple Method. Facilities that will be sized using the Engineered Method shall be designed per the following:

- Inflow to the facility shall consist of the post-development water quality design storm per **section 2.0** The design storm is the (water quality event, if a downstream facility is being proposed for flow control, or a larger event if the facility is being designed to meet flow control requirements as well).
- The outflow equals the infiltration rate times the wetted bottom surface area of the facility during the water quality eventdesign storm. If an underdrain is included, use 2 inches per hour as the infiltration rate of the stormwater facility topsoil. If there is no underdrain, use the smaller of the native soil infiltration rate or 2 inches per hour.
- The water quality storage volume consists of the volumeis the ponding depth above the stormwater facility topsoil to the primary outlet (e.g., gutter, beehive, or other outlet). The water quality storage volume shall contain the design storm hydrograph inflow less outflow. The overflow inlet from the water qualitystormwater facility to the stormwater conveyance system (or to the flow control structure if the swale/rain garden is within a dry detention pond) shall be set above the water quality elevation used in facility modeling.
- All stormwater treated by the facility must drain from the surface within 48 hours after a storm event ends.

Dimensions and slopes: The minimum width for rain gardens and swales is 10 feet. Public street projects with a landscape strip that is 10 feet or greater shall prioritize swales for treating street runoff. A minimum 2-foot-wide flat bottom width is required with maximum side slopes of 3 horizontal to 1 vertical. The minimum depth is 6-inches (typical depth is 12-inches) as measured from the top of the growing medium to the overflow inlet elevation. Maximum longitudinal slope is 4 3 percent without adding check dams. Freeboard for rain gardens/swales must be noted on the plans. Public swales shall follow the dimensions shown in the swale plan view (GS-114) and swale section view (GS-115) details in the *Public Works Standards*.

Waterproofing/Geosynthetic Liner: Full or partial liners may be required when facilities are proposed within building/property line setbacks, on steep slopes, in areas with high groundwater, in locations with hazardous materials, and in wellhead protection areas. Waterproofing can consist of a monolithic pour, the same as a stormwater planter, or a 30-mil EPDM, HDPE, or approved equal liner.

Check dams: Required for swales or facilities that are not flat. Generally 4 to 10 inches high, depending on the depth of the facility. Width will vary depending on material. For swales located within the public right-of-way/landscape strip, no check dams are required for slopes <43%. For slopes between greater than 43% and to 8% slope, check dams shall be placed every at a maximum spacing of 7.5 to 1515 feet (evenly spaced through length of swale). For slopes between greater than 8% and to 15% slope, check dams shall be placed every 5 to 10at a maximum spacing of 10' feet (evenly spaced through length of swale). See GS-105 in the *Public Works Standards* for more detail on check dam spacing.

Inlets: Facilities located adjacent to ground level impervious surface (e.g. driveways, streets, parking lots) shall use a curb inlet with sufficient drop to ensure that stormwater enters the facility. Public street-side swales are required use the GS-104B inlet from the *Public Works Standards*; this inlet is highly recommended for private parking lots and streets. Inlets should not typically be placed closer together than 30 feet apart.

When pipe is required to deliver stormwater to a private rain garden or swale, the pipe must follow Oregon Plumbing Specialty Code and be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch minimum diameter pipe is required.

When pipe is used to deliver private stormwater to a public rain garden or swale, the pipe shall be mitered to match the planned soil surface, protruding a minimum of 2 inches beyond final soil surface elevation, and have adequate energy dissipation to prevent soil erosion. Jute or other fabric is required if water will enter facility prior to landscaping. An 8-inch deep section of 2- to 4-inch river rock that extends downslope for at least 12 inches is recommended to prevent erosion and keep vegetation from encroaching into the pipe.

When a perforated pipe is required as part of the overflow/outlet of a public facility, the pipe shall be a minimum of 6-inch ASTM 3034 SDR 35 PVC.

A splash pad shall be used for energy dissipation at any curb inlet, or piped discharge point to a rain garden or swale. See GS-104 in the *Public Works Standards* for more detail on splash pads.Public swales shall use an inlet with a concrete splash pad with a lip (see GS-104B).

Outlets: An overflow drain shall be constructed to allow at least 9 but not more than 18 inches of water to pond in the swale or rain garden prior to overflow. On private property, this overflow drain and piping must meet Oregon Plumbing Specialty Code requirements and shall direct excess stormwater to an approved disposal point.

Within the public street right-of-way, the overflow drain and piping must meet City of Gresham *Public Works Standards* and shall direct excess stormwater to an approved discharge point, typically using a beehive overflow structure. For streets with multiple swales with inlets and outlets overflowing to the gutter: 1) gutter flow must not exceed the width from face of curb required in *Public Works Standards*, and 2) a beehive, or other approved overflow, connected to a piped stormwater conveyance system must be installed every 400 feet or at the end of each block, whichever is less.

Underdrains: For lined facilities designed for filtration, a perforated pipe (3660-inch maximum length) shall be constructed extending out from the outlet of the facility to drain water that has filtered through the topsoil and prevent long-term ponding.

Drainage Layer: 9 to 12" depth of ¾" – 1 ½" washed drain rock must be used around the underdrain pipe of filtration/lined facilities. A drainage layer may be placed under facilities in Type C soils for storage without the use of an underdrain. Drainage layers are not allowed for facilities in Type A and B soils, optional for Type C soils, and required for Type D soils. When used, drain rock and growing medium must be separated by a 2- to 3-inch layer of ¼" - #10 rock. Trees are not allowed in facilities where a drainage layer is installed.

Soil/Mulch: A minimum of 18 inches of stormwater facility topsoil shall be added to all rain gardens and swales. Per the soil specifications in **Appendix F**, this can be accomplished by importing a 3-way soil blend or by amending native topsoil with a mix of one part imported organic compost and one part gravelly sand, such that there are equal parts compost, sand, and native soil. The specification included in **Appendix F** shall be used for this purpose and included on the permit plans. A 2 to 3-inch layer of shredded bark mulch (not bark dust or bark chips) shall be used over the amended soil and between the plantings to completely cover the soil and prevent erosion or weed intrusion.

Vegetation: The entire facility area must be planted with vegetation. The facility area is equivalent to the total area of the rain garden/swale, including bottom and side slopes, as developed in the sizing calculations. Rain gardens/swales should generally be designed so they do not require mowing, however, for swales designed to have trees as the primary vegetation (which requires trees planted every 25-feet or other spacing as recommended by city) may use turf grass between trees. Plants shall be selected from the **Gresham List of Stormwater Plants** following the requirements in **Appendix G**. Minimum container size is #1 container.

Post installation testing: Rain gardens and swales installed outside the designated UIC area that are designed to infiltrate the 100-year storm event must conduct post-installation infiltration testing following the method in **Appendix E**.

3.2.2 Stormwater Tree Wells

Facility Description
Stormwater tree wells are structural reservoirs used to collect, filter, and infiltrate stormwater, allowing pollutants to settle and filter out as the water percolates through growing medium. These facilities are similar to a stormwater planter, except the primary vegetation is a street tree. In order to increase facility capacity and create better growing conditions for the tree, these facilities also include structural soil under the adjacent sidewalk. Depending on site conditions, tree wells can be designed to completely or partially infiltrate the stormwater they receive. These facilities are typically not lined, as the goal is to allow tree roots to grow deep and wide.

Applicability
Stormwater tree wells are primarily used to manage stormwater from the public right-of-way (ROW). They are the preferred vegetated facility that should be used within the ROW. Since these are typically infiltration facilities, they should be located 10 feet from building foundations, not immediately upslope of building structures, and on slopes less than 20%.

Design Requirements

Soil suitability: The soil type or infiltration rates determine if the facility can be designed to achieve full or partial infiltration. Sites with Type C and D soils, or tested infiltration rates less than 0.5 inches per hour, may want to install an underdrain within the structural soil layer to provide an outlet for treated stormwater.

Sizing: Sizing varies by design approach. The Simple Sizing Form can be used to determine the size of facilities based on soil type for the Simple Method. Facilities that will be sized using the Engineered Method shall be designed per the following:

- Inflow to the facility shall consist of the post-development ~~water quality~~ design storm per **section 2.0** ~~(~~The design storm is the water quality event, if a downstream facility is being proposed for flow control, or a larger event if the facility is being designed to meet flow control requirements as well~~)~~.~~.~~

- The outflow equals the infiltration rate times the wetted bottom surface area of the facility during the water quality eventdesign storm. If an underdrain is included, use 2 inches per hour as the filtration rate of the stormwater facility topsoil. If there is no underdrain, use the smaller of the native soil infiltration rate or 2 inches per hour.
- The water quality storage volume consists of the volume is the ponding depth above the stormwater facility topsoil to the primary gutter (unless another outlet type is approved). The water quality storage volume shall contain the design storm hydrograph inflow less outflow. The overflow inlet from the water quality stormwater facility to the stormwater conveyance system shall be set above the water quality elevation used in facility modeling.
- All stormwater treated by the facility must drain from the surface within 48 hours after a storm event ends.

Geometry: The typical detail for the Stormwater Tree Well is in *Public Works Standards* (GS-111).

- There is no shape requirement for stormwater tree wells, although they are typically designed as square or rectangle with vertical side walls.
- The minimum width and length for any stormwater planter shall be 4 feet.
- The minimum ponding depth shall be 6 inches. The maximum ponding depth shall be 18 inches.
- The minimum depth of the excavation below the gutter level shall be 20 inches to allow for a minimum of 6 inch ponding depth, 2 inches of mulch, and the root ball to be placed on a pedestal of native soil (and then surrounded by stormwater facility topsoil).
- A minimum depth of 24 inches of structural soil shall be installed under the sidewalk for the width of the stormwater tree well. See note in "structural soil" section below and more in **Appendix A.8** for projects where sidewalks will not be poured within a week of structural soil placement.

Setbacks: Stormwater tree wells are typically set back 10 feet from adjacent building foundations.

Piping:

Inlets: Stormwater trees wells typically receive flow from curb inlet detail GS-104A in the City of Gresham *Public Works Standards*. For installations where the tree well is going to be covered with a grate, a catch basin shall be used to trap sediment prior to discharge into the facility.

Outlets: Facilities not able to store the volume from the 100-year storm event and fully draw down within 48 hours shall ensure there is an overflow to an approved discharge location (this may be gutter flow to a standard catch basin).

As stormwater tree wells are typically located within the public street right-of-way, the overflow must meet Gresham *Public Works Standards* and shall direct excess stormwater to an approved discharge point. The most typical overflow for on-grade facilities is down the gutterline, which is designed using the modified curb and gutter detail GS-103. For streets with multiple stormwater tree wells with inlets and outlets overflowing to the gutter: 1) gutter flow must not exceed the width from face of curb required in *Public Works Standards*, and 2) an inlet to the piped stormwater conveyance system must be installed immediately downstream of a tree well, so that an inlet is spaced every 400 feet or at the end of each block, whichever is less.

Underdrains: For partial infiltration facilities in Type C and D soils, a perforated pipe (36-inch maximum length) may be proposed within the structural soil under the sidewalk to drain water that has filtered

~~through the topsoil and prevent long-term ponding. Any proposed underdrain system shall be accessible for maintenance, follow *Public Works Standards*, and be approved by the Manager.~~

Soil/Mulch: Stormwater tree wells use a combination of structural soil under the sidewalk, as well as stormwater facility topsoil in the tree well surrounding the tree root ball. Drawing GS-111 shows how the layers relate to the tree, curb, and sidewalk elevations. The specifications included in **Appendix F** detail the soil, mulch, and structural soil and shall be included on the permit plans.

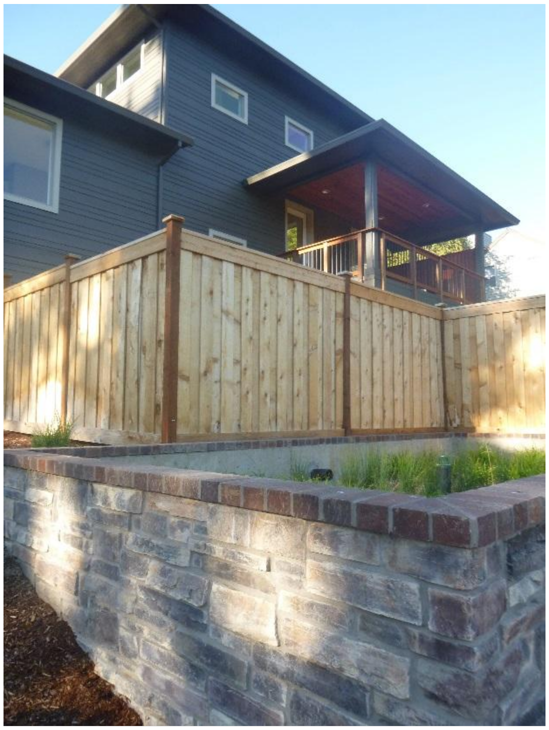
Structural Soil: A minimum of 24-inch depth structural soil meeting the requirements specified in **Appendix F** is required under the sidewalk adjacent to the stormwater tree well. The structural soil shall be at least the same length as the tree well, with additional length or depth being allowed for engineering these facilities to manage runoff from the contributing drainage area. The goal for including structural soil is to allow pathways for roots to move under sidewalks without causing damage, while also providing additional temporary stormwater storage.

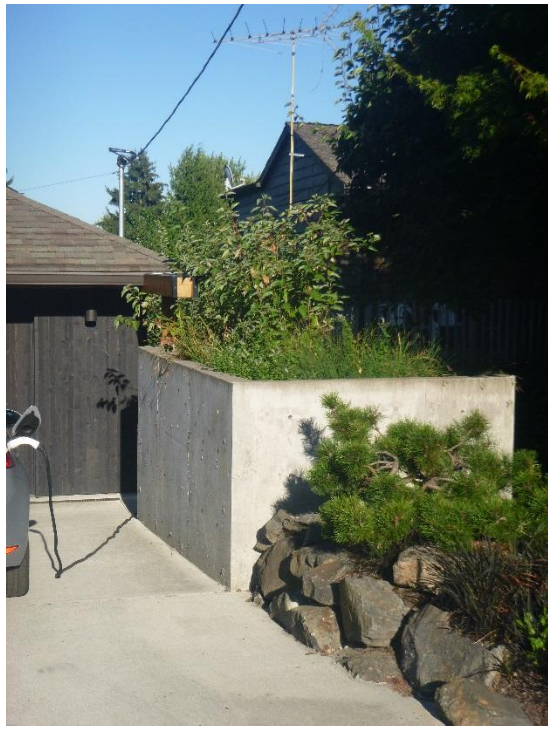
Structural soil that is placed under the sidewalk zone more than a week prior to sidewalk construction must follow the soil and facility protection during construction requirements in **Appendix F.8**.

Vegetation: Stormwater Tree Wells are designed to support a single street tree. Trees on the **Gresham List of Stormwater Plants** are pre-approved, but other trees may also be proposed and approved by the manager.

Post installation testing: Stormwater tree wells installed outside the designated UIC area that are designed to infiltrate the 100-year storm event must conduct post-installation infiltration testing following the method in **Appendix E**.

3.2.3 Stormwater Planters





Facility Description
Planters are structural landscaped reservoirs used to collect, filter, and infiltrate stormwater, allowing pollutants to settle and filter out as the water percolates through the vegetation, growing medium, and gravel. Depending on site conditions, planters can be designed to completely or partially infiltrate the stormwater they receive. They can also be designed as lined facilities where stormwater is temporarily stored. In lined planters, stormwater filters through the soil and excess water drains to an approved discharge location.

Private stormwater planters can be used to help fulfill a site's required landscaping area requirement and should be integrated into the overall site design. Numerous design variations of shape, wall treatment, and planting scheme can be used to fit the character of a site. Because lined planters can be constructed immediately next to buildings, they are ideal for sites with setback requirements, poorly draining soils, steep slopes, or other constraints.

Applicability
Stormwater planters are used to manage stormwater flowing from all types of impervious surfaces, on private property and within the public right-of-way. Infiltration planters are more effective than filtration/lined planters at retaining large volumes of stormwater on-site, so planters shall be designed to infiltrate unless site conditions require the facility to be lined. If native soils infiltrate at less than 0.5 inches per hour (Type C and D soils), the facility may need to have an underdrain installed and be a partial infiltration facility. Infiltration facilities should be located 10 feet from building foundations, not immediately upslope of building structures, and on slopes less than 20%. Locating a stormwater planter within 10 feet of a building, within 5 feet of a property line, or on slopes requires waterproofing/lining and an underdrain to create a filtration planter.

Planters are still a great option for private development, but the City has de-prioritized the use of stormwater planters for treating public right-of-way. Development projects required to treat public streets should use swales or stormwater tree wells following the prioritization in **Table 3-1**.

Design Requirements

Soil suitability: Existing infiltration rates will determine if the facility can be designed to achieve infiltration, partial infiltration, or allow the stormwater to be conveyed through the facility. The Simple Sizing Form assumes infiltration rates based on soil type and requires an overflow to be installed for Type C and D soils.

Larger sites (>10,000 sf) or those using the Engineered Method need to testFacilities without an overflow are only allowed within the designated UIC area and only if infiltration rates, determined by following the procedure in **Appendix E**., are shown to be Based on the infiltration results, the design professional shall include an overflow to an approved discharge location if the facility is not able to store the volume from the 100-year storm event and fully draw down within 48 hours.

Sizing: Sizing varies by design approach. The Simple Sizing Form can be used to determine the size of facilities based on soil type for the Simple Method. Facilities that will be sized using the Engineered Method shall be designed per the following:

- Inflow to the facility shall consist of the post-development water quality design storm per **section 2.0** (The design storm is the water quality event, if a downstream facility is being proposed for flow control, or a larger event if the facility is being designed to meet retentionflow control requirements as well).
- The outflow equals the infiltration rate times the wetted bottom surface area of the facility during the water quality eventdesign storm. If an underdrain is included, use 2 inches per hour as the infiltration rate of the stormwater facility topsoil. If there is no underdrain, use the smaller of the native soil infiltration rate or 2 inches per hour.
- The water quality storage volume consists of the volumeis the ponding depth above the stormwater facility topsoil to the primary outlet (e.g. gutter, beehive, or other outlet). The water quality storage storage volume shall contain the design storm hydrograph inflow less outflow. The overflow inlet from the water qualitystormwater facility to the stormwater conveyance system shall be set above the water quality elevation used in facility modeling.
- All stormwater treated by the facility must drain from the surface within 48 hours after a storm event ends.

Geometry/Slopes: See the typical details in **Appendix H** for infiltration and filtration stormwater planters.

- There is no shape requirement for stormwater planters, although they are typically designed as square or rectangular with vertical side walls.
- The minimum width for any stormwater planter shall be 24 inches.
- The minimum ponding depth for stormwater planters shall be 9 inches (typical is 12 inches). The maximum ponding depth shall be 18 inches.
- The minimum depth of stormwater facility blended soil for stormwater planters shall be 18 inches. See **Appendix F** for the required soil amendment specification to be included with the permit plans.

Setbacks: Infiltration planters are typically set back 5 feet from property lines and 10 feet from building foundations. No setbacks are required for lined planters where the height above finished grade is 30 inches or less. Lined planters can be used next to foundation walls, adjacent to property lines, or on slopes when they include a waterproof lining.

Waterproofing/Lining: Lined facilities that require an impervious bottom must be a single-pour concrete box, or approved equivalent. Trees are not allowed in lined facilities.

Check dams: Required for facilities that are not flat. Generally 4 to 10 inches high, depending on the depth of the facility. Width will vary depending on material. For planters located within the public right-of-way/landscape strip, no check dams are required for slopes <4%. For slopes between 4 and 8% slope, check dams shall be placed every 7.5 to 15 feet (evenly spaced through length of swale). For slopes between 8 and 15% slope, check dams shall be placed every 5 to 10 feet (evenly spaced through length of swale).

Inlets: Facilities located adjacent to ground level impervious surface (e.g. driveways, streets, parking lots) shall use a curb inlet with sufficient drop to ensure that stormwater enters the facility. Public street-side planters are required use the GS-104A inlet from the *Public Works Standards*; this inlet is highly recommended for private parking lots and streets.

When pipe is required to deliver stormwater to a private stormwater planter, the pipe must follow Oregon Plumbing Specialty Code and be cast iron, ABS SCH40, or PVC SCH40. Three-inch pipe is required for facilities draining up to 1,500 square feet of impervious area; otherwise, a 4-inch minimum diameter pipe is required.

When pipe is used to deliver stormwater to a public stormwater planter, or when a perforated pipe is required as part of the overflow/outlet, the pipe shall be a minimum of 6-inchASTM 3034 SDR 35 PVC.

A splash pad shall be used for energy dissipation at any curb inlet, or piped discharge point to a stormwater planter.

Outlets: An overflow drain shall be constructed to allow at least 9 but not more than 18 inches of water to pond in the planter prior to overflow. On private property, this overflow drain and piping must meet Oregon Plumbing Specialty Code requirements and shall direct excess stormwater to an approved disposal point.

Within the public street right-of-way, the overflow drain and piping must meet City of Gresham *Public Works Standards* and shall direct excess stormwater to an approved discharge point, typically using a beehive overflow structure. For streets with multiple stormwater planters with inlets and outlets overflowing to the gutter: 1) gutter flow must not exceed the width from face of curb required in *Public Works Standards*, and 2) a beehive overflow connected to a piped stormwater conveyance system must be installed every 400 feet or at the end of each block, whichever is less. Beehive outlets from one stormwater planter shall not be connected to a beehive serving as an inlet to another stormwater planter.

Underdrains: For lined facilities designed for filtration, a perforated pipe (36-inch maximum length) shall be constructed extending out from the outlet of the facility to drain water that has filtered through the topsoil and prevent long-term ponding. Drain rock shall only be placed surrounding the underdrain.

The downstream end of an underdrain system shall end at a beehive structure following *Public Works Standards*.

Drainage Layer: 9" depth of ¾" – 1 ½" washed drain rock must be used around the underdrain pipe for private filtration/lined facilities. 12" of drain rock required for public filtration/lined facilities. Not allowed for Type A and B soils, optional for Type C soils, and required for Type D soils. When used, drain rock and growing medium must be separated by a 2- to 3-inch layer of ¼" - #10 rock. Trees cannot be planted above a drainage layer.

Soil/Mulch: A minimum of 18 inches of stormwater facility topsoil shall be added to all stormwater planters, although stormwater planters within the public right-of-way may have variable depths, depending upon slope and existing soils, so these facilities shall refer to GS-107 for required soil depths. Per the soil specifications in **Appendix F**, the stormwater facility topsoil requirement can be met by importing a 3-way soil blend or by amending native topsoil with a mix of one part imported organic compost and one-part gravelly sand, such that there are equal parts compost, sand, and native soil. The specification included in **Appendix F** shall be used for this purpose and included on the permit plans. A 2 to 3-inch layer of shredded bark mulch (not bark dust or bark chips) shall be used over the blended soil and between the plantings to completely cover the soil and prevent erosion or weed intrusion.

When trees will be placed in stormwater planters, the root ball of the tree must be placed on structural soil that follows the requirements in **Appendix F**. The depth of structural soil needed shall ensure that a minimum of 1 to 2 inches of the root ball will extend above the planned topsoil surface elevation. The structural soil "pad" shall be 6-feet in length by the width of the planter. The area above the structural soil and surrounding the tree shall be filled with stormwater facility blended soil.

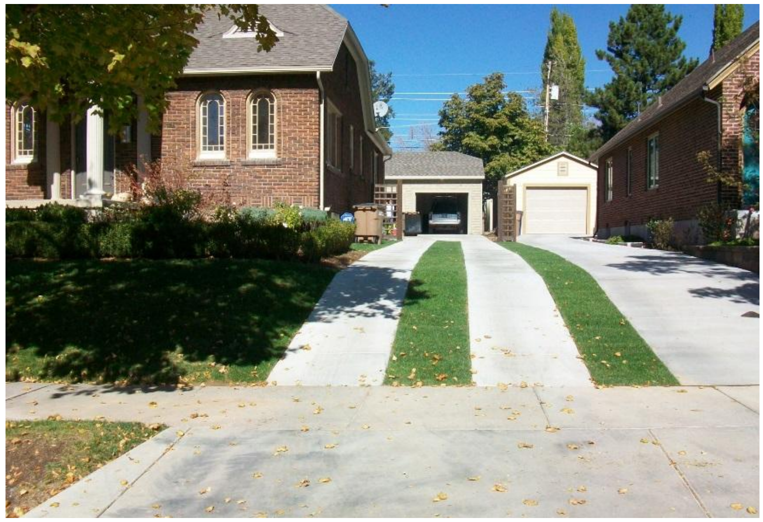
Vegetation: The entire facility area must be planted with vegetation. The facility area is equivalent to the bottom area of the stormwater planter. Stormwater planters should be designed so they do not require mowing. Plants shall be selected from the **Gresham List of Stormwater Plants** following the requirements in **Appendix G**. Minimum container size is #1 container.

Street trees placed in stormwater planters within the right-of-way shall follow GS-112. Tree root balls much be placed on structural soil following the requirements above in soil/mulch.

Post installation testing: Stormwater planters installed outside the designated UIC area that are designed to infiltrate the 100-year storm event must conduct post-installation infiltration testing following the method in **Appendix E**.

3.2.4 Vegetated Filter Strip

Facility Description
Vegetated filter strips are gently sloped areas that are designed to receive sheet flows. They are typically linear facilities that run parallel to the impervious surface and are commonly used to receive the runoff from walkways and driveways. Filter strips are covered with vegetation, including grasses and groundcovers, which filter and reduce the velocity of the stormwater. As the stormwater travels downhill, it infiltrates into the soils below.



Driveway center filter strips are used between the drive aisles of residential driveways. They are typically 3 feet wide and placed between two 3-foot-wide paved sections. (The minimum width of a residential driveway is 9 feet, of which the inner 3-foot section could be pervious and used for infiltration as long as all other code requirements are met.) The strip is used exclusively to treat and infiltrate the stormwater from the impervious area of the drive aisles. The drive aisles must be sloped toward the driveway center filter strip. The driveway center filter strip must be maintained to the required design requirements (including 100 percent landscaping coverage) stated below.

Applicability
The most common uses of vegetated filter strips are as the driveway center strip described above, or the landscape strip between the curb and sidewalk treating sidewalk runoff. Roads or parking areas with large areas downslope from them can also be suitable areas for treatment by a vegetated filter strip.

Design Requirements

Soil Suitability: Filter strips are appropriate for all soil types.

Sizing: The landscape area utilized for disposal of stormwater must be at least 20 percent of the impervious area treated, for a maximum of 500 square feet of impervious area to be managed by the filter strip.

Dimensions and slopes: Filter strips must slope between 0.5 and 6 percent. Slope of pavement area draining to the strip must be less than 6 percent. Filter strips must have a minimum length of 3 feet, measured in the direction of the flow.

Level spreaders: A grade board or sand/gravel trench may be required to disperse the runoff evenly across the filter strip. The top of the level spreader must be horizontal and at an appropriate height to provide sheet flow directly to the soil without scour. Level spreaders must not hold a permanent volume of runoff. Grade boards can be made of any material that will withstand weather and solar degradation. Trenches used as level spreaders can be filled with washed crushed rock, pea gravel, or sand.

Check dams: If necessary, check dams must be constructed of durable, nontoxic materials such as rock or brick or graded into the native soils. Check dams must be 3 to 5 inches high and run the length of the filter.

Soil: The stormwater facility topsoil must be 12 inches deep for filter strips. Per the soil specifications in **Appendix F**, the stormwater facility topsoil requirement can be met by importing a 3-way soil blend or by amending native topsoil with a mix of one part imported organic compost and one-part gravelly sand, such that there are equal parts compost, sand, and native soil.

Vegetation: The entire filter strip must have 100 percent coverage by grasses, ground covers, or any combination thereof.

3.2.5 Downspout Extension

Facility Description

Directing downspouts to splash blocks is a method of stormwater management suitable for retrofitting existing properties constructed prior to stormwater requirements (not new construction). Downspout disconnection allows roof runoff to flow into vegetated or mulched landscape areas for properties with good onsite infiltration. Roof runoff is directed to existing landscaping where it can spread out and safely soak into the soils and remain on the property. Site conditions will determine if this is a suitable method for managing stormwater onsite. Property line and building setbacks as well as surface grade and available landscaped areas for infiltration must be considered. Proposed downspout locations and roof/gutter alignments will impact the feasibility of this option. As such, a preliminary site visit by City staff is recommended to determine if downspout extensions are a viable option.

Applicability

Downspout extensions are suitable for retrofitting existing properties (primarily single family residential) that have well-draining soils (≥2 inches/hour) and have an overall slope of 10 percent or less.

Design Requirements

Setbacks: Downspouts typically discharge 3 feet from slab on grade and structures with crawl spaces and 5 feet from all foundations with basements. Splash blocks are not considered part of the downspout extension and are included for erosion control and flow dispersal only. The point of discharge must be set back 5 feet from property lines and 10 feet from all neighboring structures or buildings and retaining walls over 36 inches in height.

Sizing and grade: The landscape area utilized for disposal of stormwater must be at least 10 percent of the roof area that drains to each downspout. A maximum of 500 square feet of roof area is allowed to drain to each downspout. The grade of the landscape area must gently slope away from the foundation and neighboring properties and allow stormwater to spread out over the required 10 percent infiltration area. Setback requirements must be retained over the entire infiltration area.

Materials: Durable, gutter-grade materials such as aluminum, steel, copper, vinyl, and plastic downspouts can be utilized for extensions. Downspouts need to be secured to the structure and connections securely fastened together with appropriate materials (i.e., sheet metal or similar screws). Flexible downspout extensions are not approvable materials. Rain chains must be securely fastened to the structure and the ground in a vertical alignment and must meet setback standards in order to be approved. Splash blocks, rock, or flagstone must be utilized for erosion control and flow dispersal at the location of discharge. Downspouts can be directed to drain onto grass without additional erosion control measures.

Other Considerations: Downspouts must not be directed to drain onto or over impervious areas, including walkways, driveways, and patios or onto neighboring properties, including public sidewalks and streets. Downspouts and gutters may be regraded, piped, or redirected in order to convey water to a safe infiltration area. Downspouts need to drain directly to landscape areas intended for infiltration. Landscaped areas above buried oil tanks or adjacent to retaining walls over 36 inches high cannot be utilized as infiltration areas.

3.2.6 Ponds/Centralized Facilities

Facility Description

There are ~~two~~ three facility types which can be installed to meet the centralized facility requirements for water quality and/or detention – dry detention ponds with a swale or raingarden bottom, ~~or~~ wet ponds, or sub~~merged~~surface gravel ponds. Pond basins are designed to store water above the surface of the growing medium. The *Public Works Standards* has conceptual drawings showing various components of ponds described further in this section.

- 415 – Dry Pond Plan View
- 416 – Dry Pond Profile View
- 417 – Wet Pond Plan View
- 418 – Wet Pond Profile View
- 419 – Subsurface Gravel Pond Plan View
- 420 – Subsurface Gravel Pond Profile View

Wet ponds are constructed with a permanent pool of water (commonly referred to as pool storage or dead storage). Stormwater enters the pond at one end and displaces water from the permanent pool. Pollutants are removed from stormwater through gravitational settling and biological processes. In order to meet detention requirements as well, the wet pond must be designed with additional storage beyond the permanent pool. Wet ponds that have additional detention storage beyond the permanent pool are often called extended wet detention ponds. Wet ponds designed to meet water quality and detention requirements require plantings around the perimeter of the pond ~~(within a vegetated shelf)~~ following the requirements in **Appendix G**.

Dry detention ponds ~~-~~drain between storm events and do not have a permanent pool of water. They fill during storm events and slowly release the water over a number of hours. A dry pond shall be selected versus a wet pond or subsurface gravel pond when soil infiltration rates are greater than 0.5 inches per hour and when groundwater flows do not maintain a permanent pool. In order to receive credit for both detention/flow control and stormwater quality treatment, the bottom of a dry pond must be sized following the swale/rain garden design criteria. The swale ~~or rain garden~~ area in the bottom of a dry pond must be able to contain and/or infiltrate the water quality storm without engaging the overflow structure. An~~-~~ underdrain may be incorporated into the design to ensure that the water quality event can infiltrate through the soil media and drawdown within 48 hours.

Subsurface gravel ponds are a hybrid between a wet pond and dry pond, where the permanent pool is located beneath the soil surface, but the bottom of the pond gets planted like a dry pond. Water quality is provided by vegetation and soil in the pond bottom, as well as from water flowing through the subsurface gravel layer, where anaerobic conditions allow for filtration of pollutants and denitrification.

Applicability
Centralized facilities may be constructed on large commercial and industrial developments, or on residential land divisions. Centralized facilities are appropriate for larger drainage areas (greater than 7~~5~~ acres).

Ponds following the design requirements in **section 3.2.6** are most appropriate for sites with slow draining soils (less than 2"/hour tested). It is recommended that ~~S~~sites with well-draining soils (at or over 2"/hour tested) should install a rain garden that infiltrates (see **section 3.2.1**). It is also recommended that ~~S~~sites with infiltration rates between 0.5 and 2"/hour should design a dry pond, and sites less than 0.5"/hour should design a wet pond or subsurface gravel pond. Since ponds are not designed for full infiltration, all ponds require flow control and a conveyance system.

Design Requirements

Location and Ownership: All centralized facilities/ponds to be maintained by the City must be located in a separate tract, including maintenance access to the public street system, that is either deeded to the City or has a public stormwater easement granted to the City. Except for Commercial or Industrial uses, any pond designed to serve more than one lot must be a public facility and designed and built as such. Land deeded to the City, or easements granted to the City, shall include the entirety of the public facility and the surrounding area up to boundaries of rights-of-way and/or individual private lots unless otherwise agreed to by the City. In order to ensure the maintainability of the facility, tracts or lots under common ownership cannot be formed between the pond and rights-of-way and/or private lots unless otherwise agreed to by the City.

Ponds must be constructed in uplands and are not allowed to be placed instream or within an existing wetland. Follow the requirements in **section 3.02** for any facility being planned in areas with hydric soils.

If the facility is located within a natural resource overlay area, a Geotechnical Engineer's evaluation of the proposed facility must be submitted and approved by the City.

Setbacks: The pond, as defined by the footprint of the freeboard elevation (one foot above the emergency overflow structure or spillway set at the ~~100~~25-year event elevation), must be at least 5 feet from the nearest property line. Where berms are used to constrain the pond the nearest property line must be 5 feet from the outside toe of the berm.

~~Minimum distance from the edge of the maximum water surface to the top of a slope greater than 20 percent is 100 feet, or 200 feet from a slope greater than 10-feet high and steeper than 2H:1V, unless a geotechnical report indicating that water adjacent to the slope will not cause slope failure or negatively impact other properties. The Geotech evaluation of the proposed facility must submitted to and approved by the City.~~

Sizing: Ponds shall be sized to fully store the volume of the post-development ~~100~~25-year storm with a maximum of 1 foot of freeboard above the emergency spillway, using the depths and side slopes specified in this section.

If there is groundwater or additional flow upstream of the development that will be routed to the facility, the facility sizing and flow control shall account for all of the contributing flow to the facility. Facility sizing for any drainage area outside the proposed development shall assume full build-out.

Wet ponds designed for water quality: The permanent pool (or dead) storage volume is equivalent to the runoff volume generated by a storm of 1.2 inch over 24 hours (NRCS Type 1A rainfall distribution). Maximum depth of the permanent pool shall be 30 inches. The pond volume required for flow control is in addition to the permanent pool/dead storage.

Dry detention ponds designed for water quality: The bottom of the pond must be designed following the rain garden/swale requirements in **section 3.2.1**. Water quality is accomplished when the facility contains and infiltrates the water quality event without engaging the outlet structure. Facilities that cannot infiltrate the design storm within 48 hours should be designed as partial infiltration facilities and use an underdrain to ensure the water quality event is fully filtered through the stormwater soil prior to release. The underdrain shall follow the design criteria in the "underdrain for dry ponds with swale/raingarden" section.

Subsurface gravel ponds designed for water quality: The entire water quality storm (1.2 inch over 24 hours, NRCS Type 1A rainfall distribution) shall be routed through the pond's gravel layer. The water may back up into the pond, but the elevation of the piped outlet shall not be set below the maximum elevation ponded elevation of the water quality storm. See public works details 419 and 420 and for more information.

Dimensions and slopes: Slopes and depthSide slopes should be kept as mild as possible to avoid safety risks and allow access for maintenance. Slopes within the City's tract or easement shall be a maximum of 3H:1V (horizonal to vertical). However, the slopes from the bottom of a wet pond -to an elevation 1-foot above the top of the permanent pool will be 4H:1V, or less steep, if the permanent pool depth is greater than 18".

The distance between all inlets and the outlet shall be maximized to facilitate sedimentation within the facility. The length-to-width ratio shall be a minimum of 3:1, unless an exception is granted. If area constraints make this ratio unworkable, baffles, islands, or peninsulas may be installed, with City approval, to increase the flow path and prevent short circuiting. The volume of material used to form any internal berms, islands, or other structures must be accounted for in sizing the volume of the facility.

The pond bottom shall be generally level, but particularly in the case of dry ponds, shall be uniformly graded toward the outlet structure to ensure positive drainage.

Dry and wet pPonds shall be divided into a minimum of two cells. The first cell (-sometimes referred to as a forebay) is shall be approximately 10 approximately 25 percent of the design surface area and should be designed in a way that all inlets enter the first cell whenever practicable. The forebay first cell should be a minimum of 18-inches deep to trap sediment entering the facility. A forebay shall be provided at each inlet, unless the inlet provides less than 20% of the total design flow to the pond. The forebay first cell shall have an internal berm that separates itbe separated from the main pool under normal conditions by an internal berm; see the "internal berm" section for design criteria that will disperse stormwater throughout the facility without causing erosion to the berm.

Wet ponds with side slopes steeper than 4H:1V shall incorporate a vegetated shelf around the perimeter of the facility that begins just below the depth of the permanent pool. The vegetated shelf shall be a minimum of 10-feet wide for ponds draining up to 30 acres, and a minimum of 20-feet wide for ponds draining greater than 30 acres. The gradient of the vegetated shelf shall be 15:1 (horizontal to vertical), unless an exception is granted.

External pond berm embankments: Pond berm embankments must be designed by a civil engineer or professional geotechnical engineer licensed in the State of Oregon. Embankments include all slopes surrounding a pond, not just those below the functional portion of the facility where water will be stored temporarily.

Pond berm embankments shall be constructed by excavating a key equal to 50 percent of the berm embankment cross-sectional height and width, measured through the center of the berm. The berm must be keyed into the native soil, free of loose surface soil materials, roots, and other organic debris, by excavating a trench below the berm. This keys the berm into the native soil and prevents it from sliding. Topsoil is required over the consolidated soil to support required plantings.

Pond berm embankments must be constructed on native consolidated soil (or compacted and stable fill soil) that is free of loose surface soil materials, roots, and other organic debris. Topsoil is required over the consolidated soil to support required plantings.

Pond berm embankments shall be constructed by excavating a key equal to 50 percent of the berm embankment cross-sectional height and width, measured through the center of the berm. The berm must be keyed into the native soil by excavating a trench below the berm. This keys the berm into the native soil and prevents it from sliding.

External pond berm embankments Embankments shall be constructed of compacted soil (95 percent maximum dry density, Modified Proctor Method per ASTM D1557) placed in 6- to 8- inch lifts with hand-held equipment, or 10- to 12-inch lifts with heavy equipment.

Anti-seepage collars shall be placed on outflow pipes in berm embankments that impound water greater than the designed depth of the pond. During construction, exposed earth on the pond side slopes must be seeded with appropriate seed mixture. Establishment of protective vegetative cover must be ensured with appropriate surface-protection best management practices (BMPs) and reseeded as necessary. See the City's Erosion Prevention and Sediment Control Manual.

Pond berm embankments 6 feet or less in height (including freeboard), measured through the center of the berm, shall have a minimum top width of 6 feet. Where maintenance access is provided along the top of berm, the minimum width of the top of berm shall be 15 feet.

Internal berms: Berms created for foreballsto separate pond cells shall have a native soil base that is covered with a geotextile fabric and then the upper portion of the berm is created using 1 to 4-inch angular ballast rock.

Berms separating pond cells shall be placed on native soil, except for subsurface gravel ponds, where hydrologic connectivity of the subsurface gravel is integral to the functioning of the system. Berms separating cells in subsurface gravel ponds shall be placed directly upon the choker course creating the rock gallery. The berm shall consist of a clay soil core that is wrapped in a geotextile, with the upper portion covered in 1 to 4-inch angular ballast rock. When the internal berm cannot be placed on the rock gallery, piped connections allowing surface flows to enter the subsurface gravel and flow into the gravel beneath the second cell shall be installed. See drawing 420 in the Public Works Standards.

Retaining walls: Retaining walls are not allowed below the freeboard level of a pond. Walls must be a minimum distance of 5-feet horizontally beyond the freeboard elevation, and, for publicly maintained walls, must be set back from the nearest property line at least the distance equal to the horizontal length of any wall restraints plus the height of the tallest part of the wall. See drawing 419 421 in the *Public Works Standards*.

- Any wall adjacent to a public pond that would require access to the public pond parcel for maintenance or replacement shall be included within the public tract;
- Walls shall not exceed one-third75% of the perimeter of the pond;
- Any wall shall not inhibit maintenance access into the facility, particularly the forebays;
- The designer shall ensure that any area on the upper side of a wall is accessible for maintenance;
- Walls shall incorporate geotextile and drain rock behind wall;

- Perforations through walls for private storm lines shall be limited and must be approved by cityare not allowed;
- Detailed structural design calculations must be submitted with every retaining wall proposal, and the wall must be stamped by a structural engineer.

Pretreatment: A sedimentation manhole shall be installed upstream of the facility per. Sedimentation manholes shall follow Public Works Standard drawing 413. The volume of the sump needed shall be sized based on a 2-year event assuming 20 cubic feet per 1.0 cfs of flow into the sedimentation manhole. An upstream flow splitter may be installed that bypasses any flows exceeding the 2-year event and routes them to the pond forebay. If a flow splitter is not used, the sedimentation manhole shall be designed based on the 25-year flow it receives. The maximum depth from the manhole rim to the sump bottom shall be 16 ft. The following flow rates for different sump volumes are provided for ease of calculation:

Table 3-3. Design Flow Rates for Sedimentation Manholes

Diameter	4-foot sump depth	5-foot sump depth	6-foot sump depth	7-foot sump depth
60-inch	3.93 cfs	4.91 cfs	5.89 cfs	6.87 cfs
72-inch	5.65 cfs	7.07 cfs	8.48 cfs	9.90 cfs
84-inch	7.70 cfs	9.62 cfs	11.55 cfs	13.47 cfs

If a sedimentation manhole would require more sump volume than a 7-foot sump depth in an 84-inch diameter structure would provide, then an accessible concrete forebay or other alternative structure may be approved by the Watershed Manager.

Flow control for extended wet detention and dry detention ponds: To restrict flow rates exiting the pond to those required by **Section 1.2.5**, a control structure must be used per PWS detail 405A. Refer to PWS Drawings 415-418 for more Forinformation. extended wet detention pondssurface, theis lowest orifice in the control structure must be located above at the permanent pool elevation. The outlet orifice must be designed to minimize clogging (see details under Orifices).

Control structure design: Weir and orifice structures must be enclosed in a manhole, or vault and must be accessible for maintenance. See "Access" info below for detail.

The methods and equations for the design of flow-restricting control structures, for use with extended wet detention ponds, and dry detention ponds are below.

Orifices: Orifices shall be designed to prevent clogging. Orifices shall be a minimum of 1 inch diameter, unless an exception is granted. If the required detention design parameters would result in an orifice sized to less than 1 inch, a 1-inch orifice shall be used.

Multiple orifices may be necessary to meet the flow control requirements in **section 1.2.5**. Extremely low flow rates may result in the need for small orifices (i.e. < 1 inch) that are prone to clogging. Large projects may also result in high flow rates that necessitate excessively large orifice sizes that are impractical to construct. In such cases, several orifices may be located at the same elevation to reduce the size of each individual orifice, or a weir notch may be used.

Orifices must be protected within a vault or manhole structure with a trash rack or other structure designed to prevent floating debris from entering the structure.

Orifices may be constructed on a "tee" riser section.

Orifice diameter must be greater than or equal to the thickness of the orifice plate.

Orifices less than 3 inches shall not be made of concrete. A thin material (e.g., stainless steel, HDPE, or PVC) must be used to make the orifice plate; the plate must be attached to the concrete or structure.

Orifice Sizing Equation:

$$Q = \mathrm{C}\,\mathrm{A}\sqrt{2gh}$$

where:
Q = Orifice discharge rate, cfs
C = Coefficient of discharge, feet (suggested value = 0.60 for plate orifices)
A = Area of orifice, square feet
g = 32.2 ft/sec2
h = hydraulic head, feet

The diameter of plate orifices is typically calculated from the given flow. The orifice equation is often useful when expressed as an equivalent orifice diameter in inches.

$$d = \sqrt{((36.88\,Q)/\sqrt{h})}$$

where:
d = orifice diameter, inches
Q = flow, cfs
h = hydraulic head, feet

Rectangular Notched Sharp Crested Weir:

$$Q = C\,(L - 0.2H) * H\text{^}1.5$$

where:
Q = Weir discharge, cfs
C = 3.27 + 0.40*H/P, feet
H = Height from weir bottom to crest, feet
P = Height of weir bottom above downstream water surface, feet
L = Length of weir, feet*
* For weirs notched out of circular risers, length is the portion of the riser circumference not to exceed 50 percent of the circumference.

V-Notched Sharp Crested Weir:

$$Q = C\_d\,(\tan \,〚\theta/2〛)\,H\text{^}(5/2)$$

where:
Q = Weir discharge, cfs

C_d = Contraction coefficient, feet (suggested value = 2.5 for 90-degree weir)
Θ = Internal angle of notch, degrees
H = Height from weir bottom to crest, feet

Inlet(s): Any piped inlet shall have adequate energy dissipation to minimize erosion at the outfall. The outfall protection guidance in the *Public Works Standards* section 4.05.05 is considered to be adequately protective.

Outlet/overflow: For public ponds, ditch inlet structures shall be used as an outlet or overflow in accordance with Public Works Standards detail 403A. Outlet structure shall consist of a lower primary outlet and a secondary inlet that ties into the flow control/outlet structure higher than the primary inlet, but below the maximum pond elevation to minimize risk of failure if the lower structure becomes thatched by debris. Ditch inlet style structures must be channeled and not have any sump when used as a pond outlet, and the trash racks must be hinged at the top to allow for opening and cleaning.

All ponds must have an emergency overflow spillway or structure designed to convey the 100-year, 24-hour design storm for post-development site conditions, assuming the pond is full to the overflow spillway. The emergency overflow elevation must be set at or above the ~~100~~25-year elevation, while also being at least one foot below the top of the pond berm. The overflow must be designed to convey these extreme event peak flows safely over or around the berm structure for discharge into the downstream conveyance system. The emergency overflow spillway must be designed using the following formula:

$$L = \frac{Q_{100}}{3.21H^{1.5}} - 2.4H$$

where:
L = Length of the bottom of the weir (ft);
Q_{100} = 100-year post-development flow rate (ft3/s); and
H = Height of emergency overflow water surface (ft)

The emergency overflow spillway must be armored with riprap or other flow-resistant material that will protect the embankment and minimize erosion. Riprap must extend past the toe of the outside face of the pond embankment where the overflow is being directed. No vehicular access can be planned on the emergency overflow spillway, unless it is designed in accordance with the access road standard in the *Public Works Standards*; in cases where structures are placed in the emergency spillway, concrete may be used. If the emergency spillway is designed to overflow to a roadway, the sidewalk shall be designed to ensure flow is not impeded.

If an emergency overflow cannot be routed over a berm or to an adjacent roadway without impacting adjacent private property, an additional outlet from the pond connecting to the downstream storm system or other alternative may be approved by the city.

Low flow drain for wet ponds and subsurface gravel ponds: A gravity drain shall be installed to drain wet ponds for maintenance. The low flow drain pipe shall be a 6-inch perforated pipe within a 24-inch wide by 18-inch deep drain rock trench that is 10-feet in length, or up to one-third the pond length in larger facilities, along the pond bottom. A 3-inch choker course of smaller rock shall be used to provide separation between the stormwater facility topsoil and the drain rock surrounding the perf pipe. A shear gate shall be installed where this pipe enters the outlet structure. Operational access to the valve shall be located at finished ground surface and protected from damage and unauthorized operation. Valve shall be located within planned outlet structures; when that is infeasible, it may be located within a valve box that is less than 5' deep, otherwise an access manhole or vault is required. All metal parts shall be corrosion-resistant and not made of galvanized material.

Underdrain for dry ponds with swale~~/raingarden~~: Dry ponds being designed to provide water quality may need to install an underdrain system to allow filtration of the water quality event through the soil within 48 hours. If the water quality event cannot be retained within the pond without overflow and infiltrate within 48 hours, then a drain rock trench and perforated pipe following the requirements under "low flow drain for wet ponds" shall be installed.

Soil: Because pond grading generally requires the topsoil to be removed to form the basin shape of the pond, stormwater facility topsoil following the requirements in **Appendix F** shall be used within the top 12 inches of the facility, or the soil must be amended to support plant growth. Amended soil is not required in portions of wet ponds that will be submerged under permanent pool. Subgrade soil for dry ponds or facilities intended to achieve some infiltration should be fractured and loosened prior to placement or preparation of the 12 inches of growing medium. ~~Rock shall not be placed under the growing media to allow roots from vegetation to extend from the imported or amended topsoil into underlying existing subsoil.~~

Ponds/centralized facilities that are used during the construction phase as a temporary sedimentation basin (see Gresham Erosion Prevention and Sediment Control Manual best practice EPSC-18) shall not place stormwater facility topsoil (nor rock for subsurface gravel ponds) until after the facility is done being used for erosion control. Sediment removal, growing media replacement and/or vegetation replacement shall be required prior to city acceptance of any facility finished prior to the construction phase being complete if construction sediment is present.

Vegetation: Plantings shall be added to the bottom of ~~the~~ dry ponds and subsurface gravel ponds (zone A ~~-~~[TL1][KB2]~~for dry ponds surface and zone S for wet ponds~~ shown in **Figure G-1** in **Appendix G**). For all ponds, zone A is assumed to extend one vertical foot above the pond bottom, or for ponds with a permanent pool, one vertical foot above the permanent pool. Wet ponds with a permanent pool deeper than 18 inches do not need to plant zone S, but ~~not incorporating a vegetated shelf~~ shall add 1-gallon plants 15" on-center to the first 4~~8~~-feet of zone A~~S~~ above the permanent pool elevation.

The drier transitional portions of slopes (zone B) shall be planted with a seed mix of wildflowers, native grasses, and groundcovers (not turf or lawn mix). Follow the seed coverage rate specified on the label. City-maintained facilities must not require mowing more frequently than 1-2 times annually.

If trees or large shrubs are planted, they should generally be planted along the north side of a facility to minimize shading of the lower growing emergent vegetation.

See **Figure G-1** in **Appendix G** for zone references. Plants shall be selected from the **Gresham List of Stormwater Plants** following the requirements in **Appendix G**. **Table G-1** in **Appendix G** has plant spacing and size requirements for each zone of ~~dry and wet~~ ponds.

~~If trees or large shrubs are planted, they should generally be planted along the north side of a facility to minimize shading of the lower growing emergent vegetation.~~

~~The drier transitional portions of slopes (zone B) shall be planted with a seed mix of wildflowers, native grasses, and groundcovers (not turf or lawn mix). Follow the seed coverage rate specified on the label. City-maintained facilities must not require mowing more frequently than 1-2 times annually.~~

As ponds/centralized facilities require frequent and regular maintenance in perpetuity, no encumbrances or obligations may be placed on facility vegetation that might limit, conflict with, or otherwise impede the City's ability to routinely maintain, operate, modify, or reconfigure the facility, or any of its components, as deemed necessary by the City to respond to changing water quality regulations, standards, or best management practices. As such, required plantings within the functional area of the pond, berm, or tract that will be managed as part of the facility cannot be counted towards any mitigation requirements, such as tree planting required due to impacts to areas protected through the Natural Resource Overlay.

Irrigation: Permanent irrigation systems are allowed for public stormwater facilities when approved by the City. Irrigation systems will be required to install a stand-alone water meter and backflow device. Meters, backflow device, and in-ground irrigation plumbing will be installed according to irrigation system specifications in the City of Gresham *Public Works Standards*.

Fencing: Fences are required for all City-maintained ponds ~~with a permanent pool greater than 18 inches deep, or when~~ where the parcel containing the pond has any slopes steeper than 3H: 1V, or where any walls/bulkheads are greater than 24 inches high. A 3-foot chain link fence with coated wire (typically green or black) shall be placed around the ~~extent of any property containing a pond that meets any of those criteria~~portion of the pond where those conditions exist. ~~An alternative fencing option (e.g. split rail cedar fence) may be proposed, if approved by the City.~~ For facilities adjoining private properties adjacent to commercial, industrial, multi-family, or school uses, ~~where access is discouraged,~~ a 6-foot chain link fence shall be used around that portion of the pond parcel perimeter. Facilities with a wall greater than ~~24~~ 48 inches require a 6-foot fence to be placed at the top of the wall, and the fence must extend 5-feet past the wall end, or until another fence is reached or the slope is less than 2:1.

~~Fencing for privately owned facilities is at the discretion of the owner. The owner may use the criteria for City-maintained facilities.~~

Access: Access shall be provided to 1) any structures and 2) any area of the facility that will require equipment for maintenance.

Access to structures: Public facilities shall have vehicle access to manholes (e.g. sedimentation, flow control), vaults, and other structures with sumped areas designed for sedimentation located at ground level that meet City of Gresham *Public Works Standards* section 3.05.01, as well as the design criteria listed below.

- Maximum grade shall be 15% for asphalt paving and 12% for gravel or modular grid paving;
- Outside turning radius shall be 40 feet, minimum;
- When fencing is installed, the fence must include at least one vehicle access gate. For public facilities, the vehicle access gates must be 12 feet wide, consisting of two swinging sections each six feet wide, be lockable, and be oriented for ease of access. Fence gates shall be located only on straight sections of road;

- Access roads shall be 15 feet in width on curves and 12 feet on straight sections;
- Access shall extend all the way to the structure, or as close as possible when infeasible (maximum distance of 6 feet for straight-in and 12 feet for side access for vacuum truck access);
- A paved apron shall be provided where access roads connect to paved public roadways. The apron shall be consistent with driveway details in the *Public Works Standards*.

Access into facilities: Access to forebays, or other areas designed for sedimentation, shall be provided by leaving an area of non-woody vegetation with access perpendicular to a side slope that is ~~more gradual~~ not steeper than 3H:1V.~~Facilities where a sedimentation manhole cannot be appropriately sized as pretreatment are required to install an access road all the way into the facility forebay. All other f~~Facilities must delineate a clear route on the plans for how equipment needed for sediment excavation would access the facility forebay(s). If a gate and road for access to structures is being provided, the plans must show that there is adequate turning radius onto a suitable slope into facility to enter and exit the portion of the facility where sediment is expected to accumulate (i.e. forebay). A separate gate and access road from the one designed to access structures shall be required if the facility forebay cannot be accessed without impacting pond bottom vegetation outside the forebay (i.e. only side slope vegetation should be impacted during equipment access).

3.3 Subsurface Infiltration Facilities

Drywells, soakage trenches, and infiltration vaults/chambers are considered to be Underground Injection Control (UIC) devices, which are regulated by DEQ. Owners or operators of new and existing public or private UICs are required to register and provide site inventory data to DEQ. UICs collecting runoff only from single detached dwelling unit -roofs and footing drains are excluded from UIC registration and only require a silt basin as pre-treatment.

All other public and private UICs receiving runoff from larger roofs (duplexes, multiple single dwelling units on the same lot, attached dwelling units, commercial, industrial, etc.) or surface areas (driveways, parking lots, streets, etc.) need to be registered with DEQ and meet rule authorization standards as described on the DEQ website. Meeting rule authorization standards typically means 1) having at least 5 feet vertical separation from seasonal high groundwater, 2) being located more than 500 feet away from or outside the 2-year time of travel of a well, and 3) having adequate water quality treatment prior to discharge.

3.3.1 Drywells

Facility Description

The typical drywell is a precast concrete ring (28” or 48” in diameter) in 5-foot-tall sections perforated to allow for infiltration. These facilities are vertical in nature and typically range from 5 to 25 feet in depth. There are also manufactured plastic “mini-drywells” which can be used for residential applications where <500 sf of roof area drains to each mini-drywell.

Applicability

For the purpose of meeting the requirements of volume reduction in this Stormwater Management Manual, drywells are only allowed in the City's designated UIC area. Drywells are typically installed in well-draining soils, although they can be installed with an overflow in areas infiltrating less than 2 inches per hour. Drainage from private properties is not allowed to flow into public drywells located within the right-of-way. All public and private drywells need to meet DEQ's rule authorization standards, which requires a minimum of 5 feet of vertical separation between the bottom of the drywell and seasonal high groundwater, as well as pre-treatment. Drywells are UICs and require DEQ registration, unless they are used exclusively for -single detached dwelling unit roofs or footing drains.

Design Requirements

Pre-Treatment: A silt trap is required for UICs receiving runoff from residential roofs and footing drains, unless a mini drywell is being installed. The silt basin should be installed between the dwelling and the UIC. In soils draining less than 2 inches per hour, an overflow shall be installed at least 4 inches higher than the pipe leading to the UIC and flow to an approved discharge point. Depending on the depth of the UIC and the site slope, the overflow can either be from the silt trap or from the UIC.

With DEQ concurrence, a silt trap is considered adequate pre-treatment for most roof runoff and pedestrian-only plaza areas. Commercial or industrial sites with mechanical structures or emissions that might result in elevated levels of pollutants of concern in their roof runoff should consult the City and DEQ to determine if additional pre-treatment may be required.

Pre-treatment of ground-level impervious surfaces that are not pedestrian-only plazas requires installation of one of the vegetated facilities listed in **section 3.2**; a proprietary device may be proposed if infeasibility has been demonstrated per **section 1.2.2**. For public drywells within the right-of-way where space would not allow for installation of a vegetated facility, the Stormwater Manager may deem a sedimentation manhole to provide adequate pre-treatment.

Soil suitability: Drywells typically function best in soils that infiltrate at least 2 inches per hour. Drywells may be installed in areas with lower infiltration rates, but must have an overflow to an approved discharge point. Installation of drywells in fill material is not permitted. All drywells must be installed in native soils. Supporting geotechnical evidenceA Geotechnical Engineer must supply supporting documentation before drywells will be allowed to be placed in fill material or before drywells will be allowed on is required for all slopes of 20 percent or greater or when requested. An infiltration test or bore-log feasibility test must be performed for any site trying to demonstrate full on-site retention.

Setbacks: Drywells should be located 10 feet on-center from all foundations and 5 feet from property lines. The top of the perforated drywell sections must be located downgrade from foundations and at a lower elevation than local basements and meet Oregon Building Code requirements.

Sizing: For development using the Simple Method, Figure 3-1 may be used to size the drywell(s) based on the amount of impervious area that each drywell is designed to manage. Gray boxes indicate acceptable sizes in soils with infiltration rates >2" per hour. Soils with infiltration rates <2" per hour may use these sizes to meet water quality, but must install an overflow and then address remaining flow control requirements in a centralized facility.

Table 3-4. Drywell Sizing Chart

	Maximum Catchment Area Managed by a Single Drywell (sq ft)		
Drywell Depth (ft)	**24" Plastic Mini-drywell**	**28" Diameter Concrete**	**48" Diameter Concrete**
2'	500 sf	NA	NA
5'	NA	1,000 sf	2,500 sf
10'	NA	2,500 sf	4,500 sf
15'	NA	3,500 sf	5,000 sf

Drainage Layer: A layer of open graded washed ¾- to 2½-inch round or crushed rock must be installed on all sides of the drywell (12" minimum for private and 16" minimum for public). Plastic "mini-drywells" must also have a one-foot gravel lens below.

Post installation testing: UICs installed outside the designated UIC area that are designed to infiltrate the 100-year storm event must conduct post-installation infiltration testing following the method in **Appendix E**.

3.3.2 Soakage Trench

Facility Description

A soakage or infiltration trench is a shallow trench in permeable soil that is backfilled with washed drain rock. A perforated pipe delivers stormwater from the surface area being drained to the rock trench where water will be stored before infiltration. Once installed, the trench will be covered with at least a foot of stone, sand, or soil that can then support grass or other plantings. Private soakage trenches can be used to provide stormwater discharge by collecting and recharging stormwater runoff into the ground.

Applicability

Soakage trenches are typically installed in well-draining soils, although they can be installed with an overflow in areas infiltrating less than 2 inches per hour. Soakage trenches need to meet DEQ's rule authorization standards, which requires a minimum of 5 feet of vertical separation between the bottom of the trench and seasonal high groundwater. Soakage trenches are not allowed in the right-of-way. Soakage trenches are UICs and require DEQ registration, unless they are used exclusively for single detached dwelling unit roofs or footing drains

Design Requirements

Pre-Treatment: A silt trap is required for UICs receiving runoff from residential roofs and footing drains. The silt trap should be installed between the dwelling and the UIC. In soils draining less than 2"/hour, an overflow shall be installed at least 4 inches higher than the pipe leading to the UIC and flow to an approved discharge point. Depending on the depth of the UIC and the site slope, the overflow can either be from the silt trap or from the UIC.

With DEQ concurrence, a silt trap is considered adequate pre-treatment for most roof runoff and pedestrian-only plaza areas. Commercial or industrial sites with mechanical structures or emissions that might result in elevated levels of pollutants of concern in their roof runoff should consult the City and DEQ to determine if additional pre-treatment may be required.

Pre-treatment of ground-level impervious surfaces that are not pedestrian-only plazas requires installation of one of the vegetated facilities listed in **section 3.2;** a proprietary device may be proposed if infeasibility has been demonstrated per **section 1.2.2**.

Soil suitability: Soakage trenches typically function best in soils that infiltrate at least 2 inches per hour. Soakage trenches may be installed in areas with lower infiltration rates but must have an overflow to an approved discharge point. A Geotechnical Engineer must supply sSupporting ~~geotechnical analysis is required for~~documentation before soakage trenches will be allowed to be placed in fill material or allowed on slopes of 20% or greater.~~, or when requested. An infiltration test or bore-log feasibility test must be performed for any site trying to demonstrate full on-site retention.~~

All trenches must be constructed in native soil and must not be subject to vehicular traffic or construction work that will compact the soil, thus reducing permeability.

Setbacks: Soakage trenches must be located 5 feet from property lines and 10 feet from building foundations, unless approved by City. One hundred-foot setbacks are typical for slopes 20 percent or greater. Trenches may not be constructed under current or future impervious surfaces.

Sizing: Sizing requirements vary by soil infiltration rate. The maximum impervious area to be served by a soakage trench is 10,000 square feet.

The excavated trench width shall be 30" wide and 30" deep. The drainage rock will be 18", with 12" of soil over the top of the completed soakage trench.

The trench length shall be 30' for every 1000 sq ft of impervious surface draining to it. Soakage trenches installed in soils draining <2"/hour shall also add an overflow.

Drainage Layer: A minimum of 18 inches of open graded washed ¾- to 2½-inch round or crushed rock separated from soil by one layer of geotextile fabric.

Geotextile fabric: Use appropriate filter fabric between the native soil and the drain rock, including the perforated pipe to prevent clogging.

Piping: The solid conveyance piping from a building or other source must be installed at a ¼-inch per linear foot slope prior to connection with perforated pipe.

A minimum 12-inch cover is required from the top of all piping to the finished grade. All piping within 10 feet of a building must be 3-inch sch. 40 ABS, sch. 40 PVC, or cast iron for rain drain piping serving 1,500 square feet or less of impervious area. For an area greater than 1,500 square feet, 4-inch pipe must be used.

The pipe within the trench must be either PVC D2729 or HDPE leach field pipe. Perforated pipe must be laid on top of gravel bed and covered with geotextile fabric.

Post installation testing: UICs installed outside the designated UIC area that are designed to infiltrate the 100-year storm event must conduct post-installation infiltration testing following the method in **Appendix E**.

3.3.3 Infiltration Vault

Facility Description

Infiltration vaults are typically a horizontal perforated pipe, or proprietary open-bottomed corrugated plastic stormwater chamber which provides a temporary subsurface storage area for stormwater before it infiltrates. Most of these devices are made of high-density polypropylene or polyethylene (HPDE) installed in a rock trench that is a hybrid between a drywell and a soakage trench.

Applicability

Infiltration vaults are typically installed in well-draining soils, although they can be installed with an overflow in areas infiltrating less than 2 inches per hour. Infiltration vaults need to meet DEQ's rule authorization standards, which requires a minimum of 5 feet of vertical separation between the bottom of the trench and seasonal high groundwater. Infiltration vaults are not allowed in the right-of-way. Infiltration vaults are UICs and require DEQ registration, unless they are used exclusively for single detached dwelling unit roofs or footing drains.

Design Requirements

Pre-Treatment: A silt trap is required for UICs receiving runoff from residential roofs and footing drains. The silt trap should be installed between the dwelling and the UIC. In soils draining less than 2"/hour, an overflow shall be installed at least 4 inches higher than the pipe leading to the UIC and flow to an approved discharge point. Depending on the depth of the UIC and the site slope, the overflow can either be from the silt trap or from the UIC.

With DEQ concurrence, a silt trap is considered adequate pre-treatment for most roof runoff and pedestrian-only plaza areas. Commercial or industrial sites with mechanical structures or emissions that might result in elevated levels of pollutants of concern in their roof runoff should consult the City and DEQ to determine if additional pre-treatment may be required.

Pre-treatment of ground-level impervious surfaces that are not pedestrian-only plazas requires installation of one of the vegetated facilities listed in **section 3.2;** a proprietary device may be proposed if infeasibility has been demonstrated per **section 1.2.2**.

Soil suitability: Infiltration vaults typically function best in soils that infiltrate at least 2 inches per hour. Infiltration vaults may be installed in areas with lower infiltration rates but must have an overflow to an approved discharge point. A Geotechnical Engineer must supply supporting documentation before soakage trenches will be allowed to be placed in fill material or allowed on ~~Supporting geotechnical analysis is required for~~ slopes of 20% or greater~~, or when requested. An infiltration test or bore-log feasibility test must be performed for any site trying to demonstrate full on-site retention.~~.

Sizing: Any manufactured chamber proposed must be installed according to the manufacturer's specifications based on the measured infiltration rate for the site. The City has also developed a sizing calculator for infiltration vaults consisting of horizontal pipes in a rock trench.

Setbacks: Infiltration vaults are typically 10 feet on center from all foundations and 5 feet from property lines. The bottom of the drain rock must be a minimum of 5 feet from permanent groundwater.

Drainage Layer: A minimum of six inches of open graded washed drain rock is required below the vault/chamber, as well as on all sides and over top of chamber. A minimum of a foot of topsoil must be placed over the top of the rock.

Geotextile fabric: Use appropriate filter fabric between the drainage rock and native soils to prevent clogging.

Post installation testing: UICs installed outside the designated UIC area that are designed to infiltrate the 100-year storm event must conduct post-installation infiltration testing following the method in **Appendix E**.

3.4 Other Facilities

3.4.1 Proprietary Devices

Proprietary treatment devices may be approved to meet stormwater quality treatment requirements only by exception.

Facility Description

The only proprietary water quality facility currently approved for public projects within the City of Gresham is the Contech Stormfilter (see approved list for specific size and model details). The City of Portland maintains a list of approved manufactured stormwater treatment technologies which Gresham will consider in meeting pollution reduction requirements for private facilities, only if the developer demonstrates that use of a vegetated stormwater facility cannot fit due to mandatory land use or grade constraints.

Note that the Stormfilter, and many of other proprietary devices, are only designed to treat water quality – so detention and flow control will need to be addressed using a separate facility.

If use is approved, the proprietary facility must be designed, constructed, and maintained in accordance with the manufacturer's specifications.

Each site plan must undergo manufacturer review before the City can approve the design for site installation. A letter that certifies that the project has been designed to manufacturer's specifications must be submitted to City prior to the appropriate design milestone. For public improvements, including Public Works Permits, the letter must be submitted to City prior to 60% plan review. For installation on private property, the letter must be submitted prior to building permit plan approval.

Submittal Requirements: The following must be submitted with each project proposing use of a proprietary facility:

- Flow-rate calculations to demonstrate that the proprietary facility will perform within the approved sizing standards.
- Identification of high flow bypass.
- Facility dimensions and setbacks from property lines and structures.
- Profile view of facility, including typical cross-sections with dimensions.
- All stormwater piping associated with the facility, including pipe materials, sizes, and slopes.
- High-flow or overflow bypass.
- Any necessary documentation to demonstrate compliance with the specific Conditions of Approval for that device.

3.4.2 Detention Pipes and Detention ~~/~~Vaults

Facility Description
Structural detention facilities such as tanks, vaults, and oversized pipes provide detention of stormwater, slowly releasing it at a rate determined by an orifice at the outlet. These structures must be designed not only for their function as runoff flow control facilities, but also to withstand an environment of periodic inundation, potentially corrosive chemical or electrochemical soil conditions, and heavy ground and surface loadings.

Tanks and vaults require a sedimentation manhole to capture sediment upstream of the tank or vault. The sedimentation manhole does not provide adequate water quality treatment, so a stormwater quality treatment facility is required to meet pollution reduction requirements. **Table 3-1** should be used to select a facility to provide stormwater quality treatment.

Applicability
Detention pipes and detention vaults provide detention, but do not meet the infiltration requirement listed in **Table 3-1**. They can however be used as a downstream detention facility to provide flow control, particularly for smaller developments ~~where complete on-site infiltration cannot be achieved and a pond/centralized facility would end up being smaller than 5,000 square feet~~of seven acres or less.

~~Since the City has minimum orifice size requirements (2 inches for public facilities, 1 inch for private facilities), a V-notch weir may need to be utilized if these facilities are proposed for smaller projects.~~

Design Requirements

Access: All areas of a tank or vault must be within 50 feet of a minimum 24-inch diameter access entry cover. All access openings must have round, solid locking lids.

Pipes and vaults designed to detain runoff from a single private property shall be privately owned and maintained and not be located within the public right-of-way. All privately owned and maintained facilities must be located to allow easy maintenance and access.

Publicly owned detention pipes are permitted within the public right-of-way and must be designed according to *Public Works Standards*. Detention pipes/vaults treating multiple properties shall be publicly owned and maintained. When publicly owned detention pipes cannot fit within the public right-of-way, they shall be placed in a separate open space tract with a public easement dedicated to the City of Gresham.

Sizing: The maximum diameter for public detention pipes is 96 inches outside of rights-of-way and 60 inches within rights-of-way. Detention pipes may be reduced to a minimum of 36 inches in diameter at connections to manholes, per PWS detail 406. Access for inspection and maintenance shall be provided for all detention pipes.

If the collection system piping is designed also to provide storage, the resulting maximum water surface elevation must maintain a minimum 1-foot of freeboard in any catch basin below the catch basin grate. Pipe capacity must be verified using an accepted methodology approved by the City. The minimum internal height of a vault or tank must be 3 feet, and the minimum width must be 3 feet. The maximum depth of the vault or tank invert is 20 feet.

Where the tank or vault is designed to provide sediment containment, a minimum of 0.5 foot of dead storage must be provided, and the tank or vault must be laid flat.

Materials and Structural Stability: For public facilities, pipe materials and joints must conform to the *Public Works Standards*. For private facilities, the pipe material must conform to the Oregon Plumbing Specialty Code.

All tanks, vaults, and pipes must meet structural requirements for overburden support and traffic loadings, if appropriate. H-20 live loads must be accommodated for tanks and vaults under roadways and parking areas. End caps must be designed for structural stability at maximum hydrostatic loading conditions.

Detention vaults must be constructed of structural reinforced concrete (3000 psi, ASTM 405). All construction joints must be provided with water stops.

In soils where groundwater may induce flotation and buoyancy, measures must be taken to counteract these forces. Ballasting with concrete or earth backfill, providing concrete anchors, or other counteractive measures must be required. Calculations must be required to demonstrate stability. Tanks and vaults must be placed on stable, consolidated native soil with suitable bedding. Tanks and vaults must not be allowed in fill slopes, unless a geotechnical analysis is performed for stability and construction practices.

Flow Control Structures for Detention Systems: To restrict flow rates, a flow control structure must be used. The outlet control structure and orifice sizing shall follow the requirements listed under **Section 3.2.~~5~~6**.