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Water Environment Services Stormwater Standards

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CLACKAMAS
WATER
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SERVICES

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SECTION 0. DEFINITIONS

Commented [A1]: Need to review definitions for consistency among the 1) Rules, 2) Sanitary Standards, 3) Storm Standards, 4) Buffer Standards

Section 0 provides the definitions and abbreviations used in these Stormwater Standards.

0.1 Words and Terms

Unless the context specifically indicates otherwise, the following words and terms, as used in this document, shall have the meanings hereinafter designated:

Term	Definition
Applicant	Is any person who applies for an approval and/or permit from the District.
Approved Point of Discharge	A location down slope from a development that the District has deemed adequate to accept stormwater flows from all or a portion of the development area.
Bankfull Stage	The stage or elevation at which water overflows the natural banks of streams or other waters of the state and begins to inundate the upland. The bankfull stage may be approximated using either the 2-year recurrence interval flood elevation or one foot measured vertically above the ordinary mean high-water line.
Best Management Practice (BMP)	Schedules of activities, controls, prohibitions of practices, maintenance procedures, and other management practices designed to prevent or reduce pollution in stormwater and sanitary systems. BMPs include facilities, treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw materials storage. BMPs also include facilities, treatment requirements, operating procedures, and practices to control stormwater runoff.
BMP Sizing Tool	A computer program, approved by the District, for use in calculating the required size of stormwater management facilities. This tool is limited to a set list of pre-defined Stormwater Management Facilities.
Building Sewer	The private piping system that conveys roof runoff, stormwater runoff, and/or groundwater intercept to the Service Connection.
Contractor	A person duly licensed or approved by the State of Oregon to perform the type of work to be done under a permit or contract.
Debris	Discarded human made objects that would not exist in an undeveloped stream corridor or wetland. Debris includes, but is not limited to, tires, vehicles, litter, scrap metal, construction waste, lumber, plastic, or Styrofoam. Debris does not include objects necessary to a use allowed by Section 709, or ornamental and recreational structures. Debris does not include existing natural plant materials or natural plant materials that are left after flooding, downed, or standing dead trees, or trees that have fallen into protected water resources.
Design Storm	The distribution of rainfall intensity over time, identified to have a probability of recurrence, given in years (i.e., 5-year design storm).
Detention	The release of surface water runoff from a site at a slower rate than it is collected by the drainage system, the difference being held in temporary storage.
Development (developed, past tense)	Any anthropogenic change to improved or unimproved real estate, including but not limited to buildings or other structures, utility infrastructure, impervious surfaces, other structures or facilities, mining, dredging, paving, filling, or excavation or any surface type that changes or impedes the natural flow of

Term	Definition
	stormwater runoff. Development also includes partitions, subdivisions and land divisions redevelopment or modifications to the existing impervious surface footprint on a property. Development does not include the following: 1) Stream enhancement or restoration projects approved by the District. 2) Farm structures and private roads outside of the Urban Growth Boundary. 3) Lot Line adjustments. 4) Measures to replace within the existing footprint, a structure(s) lost due to a catastrophic event such as fire, provided that such measures are consistent with District/City/County regulations. 5) Linear utility projects that replace existing impervious surface with equivalent material. 6) Non-pollution generating, linear projects (ex. pathways) that shed runoff onto green space. 7) Modular/temporary structures.
Director	The Water Environment Services (WES) Director, or designated representative.
Discharge	Any addition of treated or untreated water, stormwater, wastewater, process water or any pollutant or combination of pollutants to waters of the State of Oregon, directly or indirectly, by actions of dumping, spilling, disposing, or physically connecting to the public storm system or natural drainage conveyance.
District	The administrative authority of WES, an ORS 190 intergovernmental entity, and a Department of Clackamas County with a service area encompassing Clackamas County Service District No. 1 (CCSD#1), Tri-City Service District (TCSD) and the Surface Water Management Agency of Clackamas County (SWMACC).
Disturbed Area	Areas of disturbance for activities defined under “Development”. Work area includes areas used for storage of equipment or materials that are used for these activities.
Drainageway	A natural or manmade channel formed by existing or manmade topography which directs and/or carries surface or stormwater runoff.
Drip Line	The outermost edge of a tree’s canopy; when delineating the drip line on the ground, it will appear as an irregularly shaped circle defining the canopy’s perimeter.
Drywell	An approved receptacle used to receive storm, surface and other water, the sides and bottom being porous, permitting the contents to seep into the ground. A drywell must conform to local agency standards and Oregon Department of Environmental Quality (ODEQ) Underground Injection Control standards.
Easement	The legal right to use a described piece of land for a particular purpose. It does not include fee ownership but may restrict the owner's use of the land. Easements granted must be legally recorded with the Recording Division of Clackamas County.
Emergency	Any anthropogenic or natural event or circumstance causing or threatening loss of life, injury to person or property, and includes, but is not limited to, fire, explosion, flood, severe weather, drought, earthquake, volcanic activity, spills or releases of oil or hazardous material, contamination, utility or transportation disruptions, and disease.

Term	Definition
Engineer	A registered professional engineer licensed to practice in the State of Oregon, who is responsible for the design and construction of the stormwater management plan. This person is also referred to as the project engineer or engineer of record.
Enhancement	The process of improving upon the natural functions and/or values of an area or resource that has been degraded by human activity. Enhancement activities may or may not return the site to a pre-disturbance condition but create/recreate beneficial processes and resources that occur naturally.
Erosion	The visual or measurable movement of soil particles resulting from the flow of, or pressure from, water, wind, or earth movement.
Fill	Placement of any soil, sand, gravel, clay, mud, debris, refuse, or any other material, organic or inorganic which as the effect of raising the level of the ground surface, whether such surface is above, at, or below the water table, or to replace surface waters with dry land.
Government Agency	Any municipal or quasi-municipal jurisdiction, corporation, county, state, or federal agency.
Green Infrastructure	A stormwater facility that mitigates stormwater runoff similar to the natural surface hydrological functions through infiltration and/or evapotranspiration, or that involves stormwater reuse.
Hazardous Materials	Materials described as hazardous under state and federal law, including but not limited to, any toxic chemicals listed as toxic under Section 307(a) of the Clean Water Act or Section 313 of Title III of the Superfund Amendments and Reauthorization Act (SARA).
Impervious Surface	Any manmade surface that changes, alters, prevents, or retards the existing surface or the natural hydrological cycle and/or prevents the entry of water into the soil and/or causes water to run off the surface in greater rate or quantity than natural conditions. Impervious surfaces may include, but are not limited to, rooftops, concrete or asphalt paving, sidewalk or paved walkways, patios, driveways, parking lots, oiled macadam, gravel, artificial turf, manmade impervious surfaces, or other surfaces which similarly resist infiltration or absorption of moisture or changes, alters, or retards the existing surface or the natural hydrological cycle. Standing water areas of stormwater management facilities and wetlands shall be considered as impervious surfaces. Permeable pavement stormwater management facilities, such as permeable pavement designed to mimic the natural hydrology of the site, are considered impervious surfaces for the purpose of determining project impervious surface area thresholds but may be used as a Stormwater BMP to mitigate the stormwater from the impervious surface area.
Infiltration Facility	A Stormwater Management Facility designed to use the hydrologic process of surface and stormwater runoff soaking/infiltrating into the ground to dispose of surface and stormwater runoff.
Inspector	A person designated by the District to inspect construction sites, construction activities, stormwater systems, activities that affect surface water, building sewers, service connections, and other installations to be connected to the District sewerage, stormwater and/or surface water systems.
Invasive Non-Native or Noxious Vegetation	Plant species that are listed in the Oregon Department of Agriculture's Noxious Weed Policy and Classification System.

Term	Definition
Landscape Architect	A registered Landscape Architect licensed to practice in the State of Oregon.
Low Impact Development (LID)	A stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of onsite natural features, site planning, and distributed stormwater management practices that are integrated into a project design.
Mitigation	The reduction of adverse effects of a proposed project by considering, in the following order: 1) Avoiding the impact altogether by not taking a certain action or parts of an action. 2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation. 3) Compensating for the impact by replacing or providing comparable substitute Water Quality Resource Areas. 4) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment.
Municipal Separate Storm Sewer System (MS4)	A storm drainage system(s) (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) as defined in 40 Code of Federal Regulations (CFR) 122.26(b)(8).
National Pollutant Discharge Elimination System (NPDES) Permit	A permit issued pursuant to Chapter 402 of the Clean Water Act (40 CFR 122, 123, 124, and 504).
Native Vegetation	Vegetation native to the Portland metropolitan area provided that it is not invasive non-native or noxious vegetation. See Portland Plant List.
Ordinary Mean High-Water Line	The line on the bank or shore to which water ordinarily rises in season.
Owner	The owner(s) of record title or the purchaser(s) under a recorded sale agreement and other persons having an interest of record in the described real property.
Parcel of Land	A lot, parcel, block, or other tract of land that is occupied or may be occupied by a structure or structures or other use and includes yards and other undeveloped areas required under the zoning, subdivision, or other development ordinances.
Permit	An official document, permit, or certificate issued by the District that authorizes performance of a specified activity.
Permittee	The person who applies for, and/or is issued a building permit, connection permit, development permit or any other permit described in these standards.
Person	Any individual, public or private corporation or company, political subdivision, governmental agency, municipality, industry, partnership, association, firm, trust, or any other legal entity.
Pollutant	Any of the following, including but not limited to: oil, grease, soil, mining waste, spoil, solid waste, incinerator residue, sewage, garbage, sewage biosolids, munitions, chemical wastes, pesticides, insecticides, fertilizer, biological materials, radioactive materials, heat, heavy metals, asbestos, wrecked or discharged equipment, rock, sand, cellar dirt and untreated industrial, municipal and agricultural waste discharged into water.

Term	Definition
Porous Pavement	Surface to walk, drive or park on that may reduce stormwater runoff by allowing water to soak/infiltrate into the ground. Examples are permeable pavers, pervious concrete, and porous asphalt.
Post-developed Conditions	Refers to the time period, or conditions that may reasonably be expected or anticipated to exist, after completion of the land development activity on a site.
Practicable	Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purpose.
Pre-developed Condition	Refers to a time period, or the condition of the land prior to the existing or proposed development. For the purpose of hydrologic evaluations, the pre-developed condition for redevelopment/replacement of impervious surface areas shall be modeled as grass/pasture for the purpose of performing flow control calculations.
Pretreatment Facility	Any structure or drainage way that is designed, constructed, and maintained to collect and filter, retain, or detain surface water runoff during and after a storm event for the purpose of water quality improvement.
Pretreatment or Treatment	The reduction of the amount of pollutants, the elimination of pollutants, or the alteration of the nature of pollutant properties in water to a less harmful state.
Private Stormwater	Private stormwater runoff is defined as flows that include stormwater runoff from private properties (i.e., homes, driveways, roads), that may include pipes and other natural drainageways, creeks, streams.
Private Stormwater Collection System	A privately-owned and maintained storm drainage system installed to serve non-single-family residential structures on a single ownership property, which cannot legally be further divided, such as apartments, mobile home parks and schools or privately-owned storm drainage systems installed in commercial or industrial subdivisions. A single-family residence with an unattached garage or shop with stormwater facilities is exempt from this definition.
Project	A project includes all infrastructure related items in both development and redevelopment conditions. Projects are the organized effort to construct a building or structure. In the fields of civil engineering and architecture, construction projects involve the process that consists of tangibly assembling infrastructure or buildings.
Proprietary Stormwater Treatment Device	A manufactured device, often proprietary, in which stormwater receives treatment before being discharged to the storm drainage system, to a Stormwater Management Facility, or to the receiving water. This is a broad category of stormwater management facilities with a variety of pollutant removal mechanisms and varying pollutant removal efficiencies. See **Appendix ~~C~~ J** for further information on proprietary stormwater treatment devices.
Public Right-of-Way	Any Right-of-Way dedicated to a public agency for ownership and maintenance such as a county or city owned highway, road, street, avenue, or alleyway. All land or interest therein which by deed, conveyance, agreement, easement, dedication, usage, or process of law is reserved for or dedicated to the use of the general public for roadway purposes, within which the District shall have the right to install and maintain a Public Stormwater System (ORS758.010).
Public Stormwater	Public stormwater runoff is defined as flows that include stormwater runoff from public streets that may include pipes, natural drainageways, creeks, streams & rivers.

Term	Definition
Public Stormwater Easement	Any easement in which the District or other public agency has the right to construct and maintain a Public Stormwater System.
Public Stormwater Mainline	The portion of the Public Stormwater System which conveys stormwater through a piping system flowing by gravity that is located in the public right-of-way, or an easement, and the piping system is owned, operated, and maintained by the District. Public Stormwater Mainlines shall be installed in a straight line and constant grade with no bends, or bellies in accordance with these Stormwater Standards, excluding Service Connections that are the responsibility of the property owner(s).
Public Stormwater System	In general, those portions of the stormwater drainage system that are within a dedicated right-of-way, or within a public stormwater easement. Public stormwater systems also include those stormwater drainage systems that are within dedicated right-of-way and permitted by another public agency such as the Oregon Department of Transportation, a City, etc., and any public entity that is owned or operated by the District.
Publicly Maintained Infrastructure	Public Stormwater Systems that are located within a right-of-way, or public easement granted to the District.
Redevelopment	Any proposed Development (see Definition of Development above) on a previously developed site, excluding ordinary maintenance activities, remodeling of existing buildings, resurfacing of paved areas, and exterior changes or improvements which do not materially increase or concentrate stormwater runoff, or cause additional nonpoint source pollution. New, existing, and modified connections to the public storm system are considered redevelopment if they increase the discharge of stormwater runoff from new or existing impervious surfaces that were previously not connected.
Replaced Impervious Surface	The removal of an impervious surface that exposes soil, or native subgrade, followed by the placement of an impervious surface is considered Redevelopment of an impervious surface area. Replacement does not include repair or maintenance activities on structures or facilities taken to prevent decline, lapse or cessation in the use of the existing facility or surface, provided the repair or maintenance activity does not expand the coverage of the existing impervious area. If a proposed development disturbs native subgrade of an existing impervious surface, then these stormwater standards apply.
Restoration	The process of returning a disturbed or altered area or water resource to a previously existing natural condition. Restoration activities reestablish the structure, function, or diversity to that which existed prior to impacts caused by human activity.
Retention	The process of collecting and holding surface water runoff with no surface outflow.
Riparian	Those areas associated with streams, lakes, and wetlands where vegetation communities are predominately influenced by their association with water.

Term	Definition
Seasonal High Groundwater	The maximum elevation to which the groundwater can be expected to rise due to a normal wet season.
Sensitive Areas	Sensitive Areas include: 1) **Existing or created wetlands, including all mitigated wetlands**. Limits defined by wetland reports approved by Oregon Division of State Lands (ODSL), the District, the Army Corps of Engineers, or the local jurisdiction. 2) **Rivers, streams, sloughs, swamps, creeks drainageways and open conveyances.** Limits defined by the top of the bank or first break in slope measured upland from the mean high-water line; 3) **Impoundments (lakes and ponds).** Limits defined by the top of the bank or first break in slope measured upland from the mean high-water line. Sensitive areas shall not include stormwater management facilities including constructed wetlands, rain gardens, detention ponds, vegetative buffers adjacent to sensitive areas, or water features, such as lakes, constructed during an earlier phase of a development for specific purposes such as recreation.
Service Connection	The part of the piping system within the public right of way, or public easement which extends from the Public Stormwater Mainline to serve a property and conveys discharge from the property into the mainline. Service Connections are maintained, repaired and/or replaced by the property owner benefitting from the service at their sole expense, up to and including the connection to the Public Sanitary Sewer Mainline.
Service Provider Letter	Applicants proposing to develop or redevelop property within the District service area shall obtain a Service Provider Letter from the District prior to submitting a Land Use or Design Review application to the Local Planning Authority. The applicant must submit adequate plans, reports, and studies for a preliminary evaluation by the District.
Soil	The upper layer of earth in which plants grow, a black or dark brown material typically consisting of a mixture of organic remains, clay, and rock particles.
Soil Disturbance	The excavation of soils for construction, landscaping, or other reasons.
Source Control	Stormwater management facilities and/or specific actions taken that attempt to control high risk pollutant loading from entering the stormwater runoff through site activities and site design.
Storm Drainage System/Storm Sewer	A pipe or drainageway or any method of storm drainage system that carries stormwater, surface runoff, or drainage.
Stormwater	Waters on the surface of the ground resulting from precipitation.
Stormwater Management	A program to provide surface water quality and quantity controls through structural and nonstructural methods. Examples of structural controls include the facilities included in Section 4 of this manual as well as structural source controls (covers and awnings, curbs for isolation, spill control manholes, and shut-off valves) described in Section 6. Nonstructural controls include maintenance of surface water facilities, public education, water quality monitoring, implementation of intergovernmental agreements to provide for regional coordination, and preparation of water quality control ordinances and regulations.
Stormwater Management Facility (SMF)	Any facility that is designed, constructed, and maintained to collect, treat, filter, retain, or detain surface water runoff during and after a storm event for the purpose of controlling flows and/or reducing pollutants in stormwater runoff.

Term	Definition
	SMFs include, but are not limited to constructed wetlands, rain gardens, water quality swales, stormwater planters, infiltration facilities, and ponds.
Stormwater Management Plan (for new and redevelopment projects)	A plan that is stamped by a professional engineer and contains specific information regarding plans to locate and construct stormwater management facilities and stormwater drainage systems to meet WES performance and design standards.
Stream	A body of running water moving over the earth's surface in a channel or bed, such as a creek, rivulet, or river. A stream flows at least part of the year, including perennial and intermittent streams. Streams are dynamic in nature and their structure is maintained through build-up and loss of sediment.
Stream, Intermittent	A stream that flows only part of the year, or seasonally, during years of normal precipitation.
Stream, Perennial	A stream that flows year-round during years of normal precipitation.
Structure	A building or other major improvement that is built, constructed, or installed, not including minor improvements—such as fences, utility poles, flagpoles, or irrigation system components—that are not customarily regulated through zoning codes.
Utility Facilities	Buildings, structures, or any constructed portion of a system that provides for the production, transmission, conveyance, delivery, or furnishing of services including, but not limited to, heat, light, water, power, natural gas, sanitary sewer, stormwater, telephone, and cable television. Utility facilities do not include stormwater pretreatment facilities.
Vegetated Buffer or Vegetated Corridor	A corridor adjacent to a sensitive area that is preserved and maintained to protect riparian area functions. Refer to District Rules and Regulations, Chapter 9 and WES Buffers Standards for dimensions and locations of regulated vegetated buffers.
Waters of the State	Those waters defined in Oregon Revised Statutes (ORS) Chapter 468B.005 or as amended which include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon, and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.
Wet Weather Season	The portion of the year when rainfall amounts and frequency tend to have the most significant effect on erosion prevention and sediment control (October 1 to May 31).
Wetland	Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are those areas identified and delineated by a qualified wetlands specialist as set forth in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, January 1987, or by an ODSL/USACE 404 permit. Wetlands may also consist of: 1) **Constructed Wetlands**. Wetlands developed as a water quality or quantity facility, subject to change and maintenance as such. These areas must be clearly defined and separated from naturally occurring or created wetlands.

Term	Definition
	2) **Created Wetlands**. Created wetlands are wetlands developed in an area previously identified as a non-wetland to replace, or mitigate, wetland destruction or displacement. A created wetland shall be regulated and managed the same as an existing wetland. 3) **Existing Wetlands**. Existing wetlands are those identified and delineated as set forth in the Federal Manual for Identifying the Delineating Jurisdictional Wetlands, January 1987, or as amended, by a qualified wetlands specialist.

0.2 Abbreviations

The following abbreviations shall have the designated meanings:

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
cfs	cubic feet per second
CLSM	Controlled Low Strength Material (CLSM)
CMP	corrugated metal
Ecology	Washington State Department of Ecology
EPSC	Erosion Prevention and Sediment Control
FEMA	Federal Emergency Management Agency
fps	feet per second
GULD	General Use Level Designation
h:v	horizontal to vertical
HDPE	high-density polyethylene pipe
HGL	hydraulic grade line
LID	low impact development
mm	millimeter
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
OAR	Oregon Administrative Rules
ODEQ	Oregon Department of Environmental Quality
ODSL	Oregon Division of State Lands
ORS	Oregon Revised Statutes
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
ROW	right-of-way
SBUH	Santa Barbara Urban Hydrograph
SDR	Standard Dimensional Ratio
SMF	Stormwater Management Facility

SWM	stormwater management
SWMM	stormwater management model
UIC	underground injection control
USACE	United States Army Corps of Engineers
WES	Water Environment Services
WPCF	water pollution control facility

SECTION 1. GENERAL INFORMATION

The stormwater standards in this document describe requirements and methods for minimizing the hydrologic and water quality impacts of development in areas managed by the District. Implementing these standards will help protect water resources which, in turn, will benefit human health, fish and wildlife habitat, recreational resources, and drinking water.

As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the changes in runoff and/or discharge patterns lead to reduced groundwater recharge and hydromodification of stream channels. The effects of hydromodification include increased erosion of streambanks, increased incision and/or aggradation of stream channels, reduction of high value riparian habitat, impacts to aquatic organisms, and degradation of water quality.

Runoff flowing from roadways, parking areas, rooftops, and other impervious surfaces also collects pollutants that are transported to streams, rivers, and groundwater. Stormwater pollutants are generally separated into the following categories: suspended solids (sediment), oxygen-demanding pollutants, bacteria, organic carbon, hydrocarbons, metals (cadmium, copper, lead, mercury, and zinc), nutrients (nitrogen and phosphorous) and pesticides/herbicides.

This section describes the purpose, applicability, jurisdictional and administrative requirements of these stormwater standards.

1.1 Purpose of the Stormwater Standards

The purposes of the Stormwater Standards include but are not limited to, the following:

- Meet federal and state National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permitting requirements.
- Minimize the discharge of pollutants and provide water quality treatment of stormwater runoff to preserve the beneficial uses of drainageways, lakes, ponds, wetlands, and other Sensitive Areas.
- Maintain water quality by protecting Sensitive Areas and the required vegetative buffers.
- Minimize stormwater runoff volumes and maximize groundwater recharge through the process of infiltration of runoff into vegetated stormwater facilities.
- Maintain the pre-development stormwater runoff characteristics to minimize effects on the drainageways, such as erosion and degradation, generally associated with urbanization.
- Protect the safety of persons and property by safely conveying all stormwater runoff from site development and preventing the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.
- Construct stormwater management facilities which are safe, effective, and economical to maintain and minimize future replacement costs.

- Provide for orderly development by preserving the drainageways and natural storm drainage systems shaped by the existing topography and creating man-made storm drainage systems with adequate capacity for future development upstream.
- Provide guidance to designers and engineers in meeting the requirements of stormwater regulations when developing land and constructing infrastructure within the District.
- Minimize the movement of soil during construction and the associated impacts to water quality through proper erosion prevention and sediment control practices.

1.2 Stormwater Management Requirements

The District restricts the uncontrolled and untreated discharge of pollutants into any stormwater system and/or natural drainageway area. The District's Stormwater Standards are intended to provide guidance for the reduction of pollutants in stormwater to the maximum extent practicable. These standards also address flow control, water quality, storm drainage system design, erosion prevention and sediment control, source control for pollutant activities, and operations and maintenance.

The following requirements apply to all public and private projects within the District.

1.2.1 General Design Requirements

General design requirements are as follows:

1. Design of surface water and stormwater systems must include provisions to control runoff from impervious and pervious areas within and upstream of the development without exceeding capacities of available facilities and downstream drainageways.
2. Development proposals shall maintain the natural drainage pathways for seasonal and intermittent drainages, or provide alternate manmade natural drainage pathways.
3. Pre-existing surface or subsurface drainage, caused or affected by development, shall not flow over adjacent public or private property in a volume, flow rate or location significantly different from that which existed prior to development, but shall be collected and conveyed to an acceptable point of discharge as approved by the District.
4. The District does not allow the diversion of stormwater runoff from one watershed to another watershed.
5. Surface drainage entering a development from offsite areas shall be intercepted at the naturally occurring locations. Offsite surface drainage shall be conveyed through the site in a separate stormwater drainage system and will not be mixed with the stormwater collected and treated within the onsite stormwater management facilities unless the onsite stormwater management facilities are designed to manage and treat the additional flows from the upstream drainage basin(s) assuming full development potential.
6. All public storm drainage systems shall be gravity systems without the use of pumps or other mechanical means to convey or transport stormwater.

7. The point of discharge for all stormwater may be a piped system, or open channel as approved by the District. All outfalls to an existing or proposed stormwater facility, storm drainage system, or drainageway shall be approved by the District.
8. When an approved point of discharge is located and/or conveyed on an adjacent private property, the applicant shall be responsible to acquire all applicable downstream private and/or public stormwater easements. An easement is not necessary if the point of discharge is considered an intermittent stream, perennial stream, river, wetland, or natural resource.
9. In compliance with Oregon Drainage Law, development shall not adversely impact downstream properties. Stormwater runoff from a development shall be safely conveyed to prevent the uncontrolled or irresponsible discharge of stormwater onto adjoining public or private property.
10. Development shall not cause or increase flooding of adjacent or downstream property. An upstream and downstream analysis of the drainage system shall be conducted according to the guidelines in Section 5. Open channel and closed conduit systems shall be designed to safely convey the design storms listed in Section 5.
11. All development, regardless of permit status, shall keep sediment laden water and any other forms of stormwater pollution from entering natural drainage systems, wetlands, natural resources, and the public stormwater system.
12. The point of discharge for surface water, stormwater and/or groundwater shall not be a sanitary sewerage system, except as provided in Section 6.
13. No project or development shall directly or indirectly discharge, to the public storm system, any quantity of stormwater, pollutant, substance, or wash water that will violate the discharger's permit (if one is issued), the District's NPDES MS4 permit, or other environmental laws or regulations.

1.2.2 Applicability of Stormwater Standards

These standards are intended for use by property owners, developers, and design professionals for all publicly and privately-owned and publicly maintained stormwater systems within the District.

All development that exceeds the thresholds as listed below is subject to stormwater review including, but not limited to developments that are subject to land use, design review and/or the building permitting processes. These processes generally include all land use proposals, site development and permit approvals within, or proposed to be within, the District boundaries.

All private storm drains outside the building envelope shall be designed using these standards, along with the Oregon Structural Code, Oregon Plumbing Specialty Code (OPSC), and/or other applicable codes as appropriate.

1.2.3 Minimum Requirements

The general stormwater management thresholds are as follows:

- All development that disturbs in excess of 800 square feet (SF) of soil shall be subject to the erosion prevention and sediment control requirements. The permittee shall be required to obtain an erosion control permit, unless otherwise excluded by the District.
- All new Development and Re-development activities that result in in excess of 5,000 SF of new or replaced impervious surface area, cumulative over the last 3 years, are subject to site planning, stormwater management, and erosion control requirements for all newly proposed and replaced impervious surface areas within the overall project boundary.
- Stormwater runoff from all of the Developed and Re-developed impervious surface areas shall be treated in accordance with the Standards. Water quality facilities shall be designed to capture and treat the first 1-inch of stormwater runoff from a 24-hour storm event. The water quality facility shall use either an approved vegetated BMP treatment facility or an approved proprietary device.
- All projects that discharge into an offsite storm drainage system are subject to storm drainage system and downstream analysis requirements.
- All existing site developments that desire to change the existing point of discharge and the stormwater runoff from impervious areas exceeds the 5,000 SF impervious threshold shall comply with these Standards, and for design criteria purposes the impervious area will be considered as redevelopment.
- All site developments that result in any new or replaced impervious surfaces that are categorized as high risk for increased pollutant loading in stormwater runoff are required to comply with the Source Control requirements (See Section 6).

Table 1-1 lists the stormwater minimum requirements and the applicable design standards within this manual.

Table 1-1. Stormwater Minimum Requirements

Category	Threshold	Minimum Requirements
Site Planning	Development or redevelopment proposing < 5000 SF of impervious surface areas, including the cumulative impervious surface area that was developed/redeveloped over the last 3 years.	Verify impervious areas through submission of a site plan that shows the exact square footage (< 5,000 SF) of all new or replaced impervious surfaces.
	Development or redevelopment proposing ≥5,000 SF of impervious surface areas, including the cumulative impervious surface area that was developed/redeveloped over the last 3 years.	Conduct a site assessment (Section 2) and submit a Preliminary Site Plan in accordance with Section 3.
Stormwater Management Plan (flow control & water quality)	Development or redevelopment proposing ≥ 5,000 SF of impervious surface areas, including the cumulative impervious surface area that was developed/redeveloped over the last 3 years.	Design and construct a Stormwater Management Facility/Facilities to meet the flow control, and water quality performance standards in Section 4.

Table 1-1. Stormwater Minimum Requirements		
Category	**Threshold**	**Minimum Requirements**
Storm drainage system	Development or redevelopment proposing ≥ 5,000 SF of impervious surface areas, including the cumulative impervious surface area that was developed/redeveloped over the last 3 years that discharges stormwater runoff to a natural or manmade storm drainage system.	Submit a Downstream Analysis in accordance with Section 2.3. Design Storm Drainage Systems in accordance with Section 5.
Source Control	Development or redevelopment that is categorized as high risk for increased stormwater pollutant loading (See Section 6 for list of high-risk site uses).	Design and implement applicable source controls in accordance **with Section 6.**
Erosion Prevention and Sediment Control (EPSC)	Development or redevelopment that is proposed to disturb ≥ 800 SF of soil.	Develop EPSC Plans and obtain EPSC permit in accordance with Section 7.

1.2.4 Exemptions

Projects in the following categories are exempt from the stormwater minimum requirements:

A. Residential structures being re-built following fire damage, flooding, earthquake, or other natural disasters, as long as the structure is re-built at the same scale and discharging to the same disposal point. Expansions to the original footprint, such as an addition or alteration to the original structure, may trigger stormwater management requirements for the expanded impervious area.

B. Interior remodeling projects and tenant improvements.

C. Stream enhancement or restoration projects as approved by the District.

D. Farming practices as defined by Oregon Revised Statutes (ORS) 30.930 and farm use as defined in ORS 214.200 and including farm roads, including farm structures and farm access roads outside the UGB where stormwater is managed through dispersion with no direct connection to the public drainage system. Buildings associated with farm practices and farm access roads are subject to the requirements of these standards if there is a direct discharge to a Storm Drainage System. Residential homes proposed to be built on farmland are not exempt from these Standards.

E. Forest practices as defined by ORS 527.610.

F. Modular/temporary structures that will be removed at the completion of the project and do not have a direct connection to the Storm Drainage System.

G. Actions by a public utility or any other government agency to remove or alleviate an emergency condition.

H. Road and parking area preservation/maintenance projects such as pothole and square cut patching, surface sealing, replacing or overlaying of existing asphalt or concrete pavement, provided the preservation/maintenance activity does not disturb the native subgrade or expand the existing area of impervious coverage above the thresholds listed in this section.

I. Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics.

J. Non-pollution generating, linear projects (e.g., pedestrian and bicycle pathways, sidewalks, trails, and ramps not included in a larger project) that disperse stormwater runoff into vegetated areas, as long as the pathways do not include inlets connected to the Storm Drainage System.

K. Storm Drainage Systems shall be designed to meet the requirements of Section 5, except when the Development/Redevelopment is not above the impervious thresholds listed in this section, and the storm drainage system is located entirely on a privately-owned parcel, is privately maintained, and receives no stormwater from outside the parcel's property limits. Those systems exempted from the stormwater storm drainage system requirements will remain subject to the requirements of the Oregon Plumbing Specialty Code (OPSC) and shall be reviewed by the building official.

1.2.5 Additional Requirements

The requirements presented in these standards do not exclude or replace the requirements of other applicable codes or regulations, such as the Willamette or Tualatin River Basin Total Maximum Daily Load Program, the industrial NPDES permitting program, or any other applicable federal or state regulations or permit requirements.

All development within Federal Emergency Management Agency (FEMA) regulated streams and floodplain overlay zones may be required to meet the FEMA floodplain requirements and the requirements through the local planning and building authority.

If it is determined by the District that stormwater management or storm drainage system facilities, in addition to the onsite facilities required by these standards, are necessary to manage and protect natural resources, Storm Drainage Systems, and/or private property effectively, the District may require additional facilities or modifications at the sole discretion of the District.

1.2.6 Stormwater Tracts and Easements

District maintained Stormwater Management Facilities shall be fully located within a tract of land with an easement granted to the District. Both tracts of land and easements with rights granted to the District shall include the minimum access requirements in accordance with Appendix L to accommodate perpetual maintenance of the infrastructure. The Owner shall provide the District with all necessary documentation granting such easements and dedications. Upon approval of the easement document, the District will either process the easement or require the applicant, at their own expense to process and record the document as a land record with the Recording Division of Clackamas County. The District will not approve the final construction plans until all public and private easement documents have been completed and recorded to the satisfaction of the District.

A public drainage easement is required on existing open drainages that conveys Public Stormwater.

1.2.7 Operations and Maintenance Requirements

Owners of all stormwater management facilities are required to comply with operations and maintenance (O&M) requirements described in Section 8. Developments subject to these standards are required to submit an O&M plan, and shall include an agreement that allows District personnel access to the stormwater facilities for inspections or abatement of a public nuisance or to correct a violation of District standards.

All publicly maintained Stormwater Management Facilities shall be fully located within a tract of land that has adequate maintenance access and rights dedicated to the District, and the Storm Drainage System(s) shall be located within an easement or tract of land that has rights dedicated to the District.

1.2.8 Access Requirements

All Stormwater Management Facilities and Storm Drainage Systems shall provide access to maintain, repair and/or replace the infrastructure. Access to private and publicly maintained infrastructure shall be designed and constructed as specified in these Standards.

1.3 Administration and Jurisdiction

The District, through its Director or other authorized designee or representative, shall have the authority to administer the provisions of these standards.

The District may promulgate new or amended standards in accordance with the process outlined in the Water Environment Services (WES) Rules and Regulations.

Conformance with these standards shall not be a substitute for, or eliminate the necessity of, conforming with any and all federal, state, and local laws, ordinances, rules and regulations which are now, or may in the future, be in effect.

Any provisions or limitations of these standards are suspended and supplemented by any applicable federal, state, or local requirements existing or adopted subsequent hereto which are more stringent than the provisions and limitations contained herein. In the event of a conflict, the most stringent local, state, or federal regulations generally apply.

1.4 ~~Design Exceptions~~Variance

Alternative materials and methods ~~for stormwater management~~ will only be accepted ~~only~~ if the applicant can demonstrate that the existing standards are not appropriate for a given site and the proposed alternative provides the same or greater level of performance ~~stormwater management mitigation~~s as defined in these standards. Alternate materials or methods not explicitly approved herein will be considered for approval through the ~~design exception~~variance process outlined below.

Commented [A2]: The Variance sections in the sanitary and storm now read the exact same.

1.4.1 Variance Request

A variance request to the Standards shall be submitted in writing to the District. The written request for a variance should be submitted to the District prior to land use approval if a land use action is required. Land use conditions of approval are commonly written so there is little, if any, flexibility after land use approval is issued.

If land use approval has already been issued or is not required, then the variance request ~~shall~~ should be submitted in writing along with the first plan review submittal.

Once the District ~~completes the first review~~approves the plans, a variance request will only be accepted at the discretion of the District, and if the request is the only feasible solution without regards to delays or cost. Only minor variance requests will be considered during the construction phase of the project to address a specific design or construction problem. It is the responsibility of the applicant to obtain all approvals from any Local, County, State or Federal authority having any jurisdiction or permitting of the activities before proceeding with an approved variance.

This written request shall include the following:

- The desired variances(s);
- The reason(s) for the request(s);
- A comparison between the specification(s) and standard(s) and the variance(s) for performance, function, maintainability, safety, etc.;
- References to regionally and/or nationally accepted standards, records of successful use by other agencies or other supportive information.

1.4.2 Criteria for ~~Design Exceptions~~Variance

The District may grant a variance when the request does not compromise the following: public safety, environmental protection, maintenance/repair/replacement, and when any one of the following conditions are met:

- Topography or other geographic conditions impose an environmental or safety concern and the request is considered an equivalent alternative, which can accomplish the intent and criteria that is provided in these standards.
- A minor change to the standard is required to address a specific design or construction problem which, if not enacted, will result in an unreasonable or disproportionate burden or obstacle to development. The financial viability of meeting the requirements of these design standards is not in itself a justification for a design exception.
- The variance request is in the public interest and requirements for safety, function, appearance, and maintainability are based upon sound engineering and functionality of the proposed system is a feasible alternative.

All requests will be evaluated on a case-by-case basis, and approval of alternative materials and methods for one development proposal will not imply an approval under similar circumstances in another proposal. Approval of a variance, or denial of a site-specific request shall not constitute a precedent for use at other locations with potentially similar circumstances.

1.4.3 Review Process

The request for variance shall be reviewed by the District. The District shall make one of the following decisions:

1. Approve as proposed, or
2. Approve with changes, or
3. Deny with an explanation.

~~A decision will be issued in writing to the applicant within 30 calendar days. The written decision can be appealed as outlined in the WES Rules and Regulations.~~

It is the responsibility of the applicant to obtain all approvals from any Local, County, State or Federal authority having any jurisdiction or permitting of the activities before proceeding with an approved variance.

1.4.4 Appealing Variance Request Decision

The applicant may make a written request to the District to appeal the variance request decision as outlined in the appeals process contained in Section 3.9 of the District Rules and Regulations.

1.5 Design Professional

Much of the information covered in this document is addressed to professional engineers. In order to assist the professional engineer in fulfilling their responsibilities related to a development project, the following comments address the District's expectations regarding the responsibilities of the project engineer and other design professionals.

1.5.1 Project Engineer's Responsibility

All engineering plans, reports, or documents must be stamped and signed by a professional civil engineer registered in the State of Oregon. The project engineer is responsible for reviewing the proposed improvements to assure the proposed design was completed in accordance with these Standards, Rules and Regulations.

When specifically indicated in this document, some submittals do not require the approval or stamp of a professional engineer. These include, but are not limited to, the site assessment and planning checklist, the use of the BMP Sizing Tool to size stormwater facilities, and the design of planting plans.

The engineer's responsibilities include:

- The project engineer shall prepare construction plans for site development in accordance with District Standards. The engineer shall remain responsible for the accuracy, completeness, and scope of all work submitted to the District. The engineer shall be responsible for correcting all deficiencies, when necessary, should errors, omissions, or inaccurate data due to the engineer's work come to the District's attention in the future. The engineer shall be responsible for any damages resulting from the incorrect work.
- The engineer shall oversee the required infiltration testing to properly size and locate stormwater management facilities.
- The engineer shall incorporate recommendations from geotechnical engineering reports and any other engineering recommendations into the construction plans for site development.
- The engineer shall be responsible for full-time inspection during the construction of the infrastructure that will be publicly maintained. This responsibility shall include, but need not be limited to, construction observation of the Stormwater Management Facility (SMF), and Storm Drainage System in accordance with the approved plans. In conjunction with the execution of this responsibility, copies of

any onsite inspection reports shall be submitted by the engineer to the District, when so requested. Inspection under this paragraph means the full-time visual observation and documentation during the construction of the SMF, and Storm Drainage System.

- The engineer shall act as the coordinating agent in the event the need arises for liaison between the owner, other professionals, contractors, the District, and other agencies.
- The engineer shall be responsible for the preparation of revised plans and the submittal of as-built plans or record drawings, as applicable upon completion of work.
- The engineer shall be responsible for verification of excavation and embankment quantities, detention pond volumes, slope steepness, and compliance with approved construction plans.
- Approval of plans and issuance of permits by the District does not in any way relieve the engineer of their responsibility to meet all requirements of the District or other affected jurisdictions, or the obligation to protect the life, health, and property of the public. The design for any project must be revised or supplemented at any time it is determined or suspected by the District, or the engineer, that the full requirements of the District were not met.
- The engineer shall be responsible for any damages resulting from incorrect work.

1.5.2 Geotechnical Engineer's Responsibility

When a geotechnical investigation report is required, the minimum responsibilities of the geotechnical engineer shall be as follows:

- The preparation of any required geotechnical investigation report.
- All reports, field data, test data, and recommendations shall be submitted to the project engineer.
- If applicable, the geotechnical engineer shall provide infiltration testing when required per **Appendix B**.
- The geotechnical engineer shall provide, when required by the project engineer or the District, professional inspection and approval concerning the preparation of ground to receive fills and testing for required compaction. The geotechnical engineer shall also provide oversight on stability of all finished slopes and the design of embankment fills.
- The geotechnical engineer shall prepare, when required by the project engineer or the District, a final soils report that includes locations and elevations of field density tests. The final geotechnical investigation report shall also include summaries of field and laboratory tests and other substantiating data and comments on any changes made during site development.
- The geotechnical engineer shall be responsible for any damages resulting from incorrect work.

1.5.3 Landscape Architect's Responsibility

"Landscape architecture" or the "practice of landscape architecture" means the performance of, or offer to perform, professional services that have the dominant purpose of landscape preservation, development and enhancement, including but

not limited to reconnaissance, research, planning, landscape and site design, the preparation of related drawings, construction documents and specifications and responsible construction observation. “Landscape architecture” or the “practice of landscape architecture” includes the location, arrangement and design of tangible objects and features that are incidental and necessary for landscape preservation, development, and enhancement.

When plans for a proposed SMF are prepared by a professional landscape architect registered in the State of Oregon, the landscape architect shall prepare construction plans for site development meeting the standards and requirements of this document. The landscape architect shall be responsible for correcting all deficiencies, when necessary, should errors, omissions, or inaccurate data due to the landscape architect's work come to the District's attention in the future. The landscape architect shall be responsible for any damages resulting from the incorrect work.

SECTION 2. PRELIMINARY PLANNING OVERVIEW

The District's Stormwater Standards guide the design of stormwater management plans for new development and redevelopment projects. Site-specific stormwater management plans are most effective when developed early in the site planning process. Strategies for meeting the requirements in these standards depend on several site factors, including soil infiltration capacity, available infrastructure, proposed development plans, and downstream conveyance.

This section outlines the requirements for conducting a site assessment and other preliminary evaluations, including infiltration testing and downstream analysis.

2.1 Stormwater Design Process

There are three major stages during the stormwater design process: the preliminary planning stage, the land use approval stage, and the plan review and permitting stage**. Figure 2-1** outlines the design activities and submittals expected at each stage of the design process. **Materials developed and submitted at one stage of the design process should also be included in submittals at subsequent stages of design.**

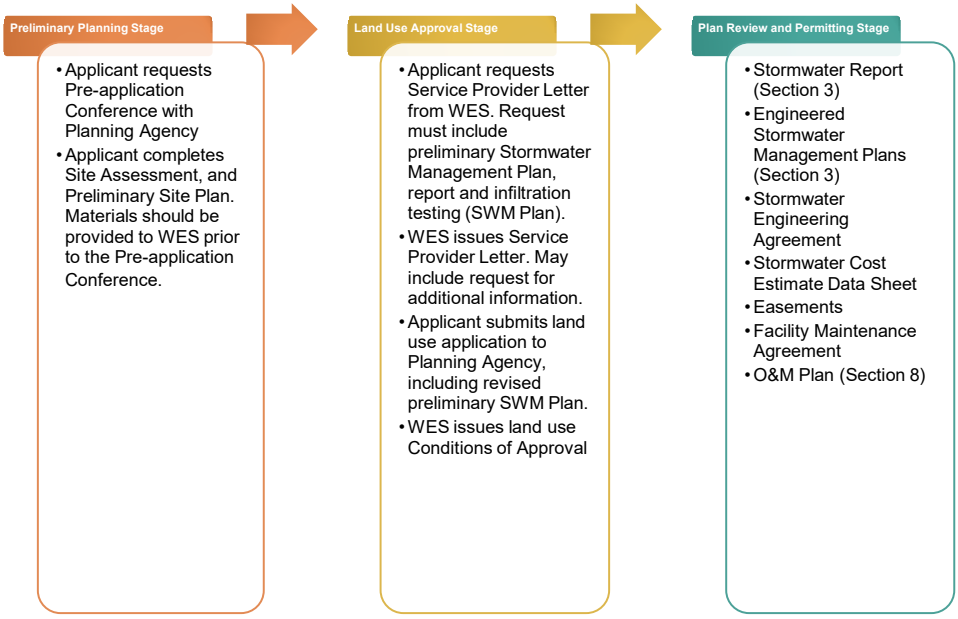

Figure 2-0-1. Stormwater Design Process

The plan review and approval requirements are specific to each jurisdiction and may vary from one application, submittal, and building permit to another. To obtain further information on a specific plan review or permit process, contact the District.

2.1.1 Preliminary Planning Stage

The Preliminary Planning stage provides the opportunity to conduct preliminary assessments and identify a potential stormwater management approach to best fit the proposed development and site conditions. The Preliminary Planning Stage may help the applicant in developing a site plan that takes advantage of low impact development (LID) strategies and maximizes the use of green infrastructure where it is smart and feasible.

The planning stage generally includes a pre-application meeting hosted by the local Planning authority, which provides an opportunity for the applicant to review a potential site development plan with WES and discuss potential challenges or special site conditions. No specific stormwater details are required during the pre-application meeting; however, it is beneficial to complete the Site Assessment Map and Preliminary Site Plan (Section 2) prior to the pre-application meeting (see **Figure 2-2**).

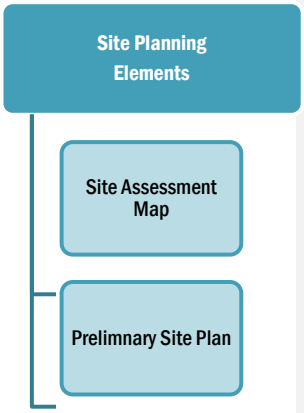

Figure 2-0-2. Site Planning Elements

2.1.2 Land Use Approval Stage

As part of the land-use application, the District will require: 1) Preliminary Stormwater Management Plans, 2) Preliminary Stormwater Report, 3) Infiltration Testing, and 4) a Geotechnical Report (if applicable).

The land use approval stage includes WES issuance of 1) a Service Provider Letter, prior to land use application submittal, and 2) land use conditions of approval, following receipt of a complete land use application from the local Planning Agency.

Local planning agencies generally require the applicant to include a service provider letter from WES with the land use application submittal. Before WES will provide this letter, the applicant shall provide the above-noted plans, reports, and infiltration testing results to WES. The preliminary plans and reports shall include an adequate level of detail to determine whether it is feasible to locate and construct stormwater management facilities that will likely meet WES stormwater performance standards. The Service Provider Letter may list any additional information that the applicant must include with the land use application that will allow WES to adequately draft conditions of approval. WES will issue land use conditions of approval based on the applicant's complete land use application. The land-use application shall include the revised preliminary plans, reports, infiltration testing results and sufficient supporting information to demonstrate that the proposed stormwater management design meets all the provisions within these standards.

2.1.3 Plan Review and Permitting Stage

Plan Review and Permitting includes the development of the proposed construction plans for the project. This includes the final Engineered Stormwater Report (Section 3.4), Engineered Stormwater Management Plans (Section 2.3), Infiltration Testing (Section 2.4), Erosion Control Plans (Section 7.4), Stormwater Engineering

Agreement, Stormwater Cost Estimate Data Sheet, Easements, Facility Maintenance Agreement, and O&M Plan (Section 8) as described in detail in **Appendix A**.

2.2 Site Planning

Site planning is recommended to review the physical attributes of the development site before placing man-made impervious surfaces such as streets, parking lots, and buildings. These planning requirements are intended to optimize site design of stormwater management techniques, habitat protection, and to reduce or eliminate potential conflicts between site development elements and required stormwater management systems. In addition, a site layout that integrates the site attributes to manage stormwater and protect habitat may reduce the number, size, and cost of stormwater facilities required for the site.

Figure 2-3 lists the primary advantages of LID strategies.

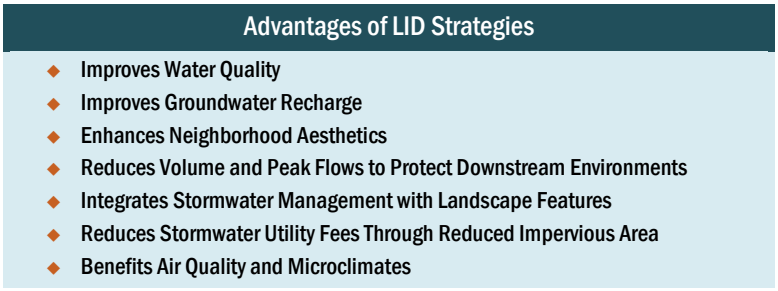

Figure 2-0-3. LID Strategy Advantages

To obtain the Service Provider Letter from the District during the Land Use Approval Stage, the applicant must provide sufficient plans, reports, studies, and agency approvals needed for preliminary review by the District. Site Planning is intended to help the applicant in developing and conducting the site assessment (Section 2.2.1) and preparing a preliminary site plan (Section 2.2.2) that takes advantage of LID strategies and maximizes the use of green infrastructure where it is appropriate and feasible.

Low impact development is a stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration by emphasizing conservation, use of onsite natural features, efficient site planning, and distributed stormwater management practices that are integrated into a project design. The applicant is highly encouraged to incorporate LID strategies during the site planning phase of any project. These strategies have numerous advantages and benefits, including the potential to reduce the impervious area requiring mitigation through stormwater management facilities.

Common LID strategies include:

- Preserving vegetation
- Clustering development
- Amending soils
- Using porous pavement
- Incorporating vegetated or green roofs

- Using green infrastructure approaches to stormwater management

Green infrastructure describes an approach to stormwater management that uses vegetated facilities (planters, rain gardens, swales, etc.) with an emphasis on infiltration. While many LID strategies can be used on any development site for water quality treatment, regardless of site conditions, green infrastructure approaches to stormwater management will have more flow control benefits when site conditions support infiltration.

Table 2-1 outlines site conditions that are more likely to support green infrastructure approaches to stormwater management, especially for flow control.

Table 2-1. Green Infrastructure Conditions and Limitations

Site conditions more likely to support green infrastructure	Site conditions that may limit the use of green infrastructure
• Well-draining soils with infiltration rates greater than 2 inches per hour (in/hr) • Seasonal high groundwater levels that provide adequate separation distance of at least 1 foot from the bottom of a non-infiltrating facility, and 3 feet from the bottom of an infiltrating facility • Flat or moderate slopes in areas of proposed stormwater facilities • Site uses that do not include material storage or other activities that could result in spills	• Poorly draining soils, with infiltration rates less than 1/2 in/hr • High groundwater levels • Steep slopes in areas of proposed stormwater facilities • Site uses with high potential for pollutant spills (e.g., gas stations, material storage areas, high traffic roadways, etc.) • Sites with known, or suspected, contamination • Sites requiring significant fill or structural measures to establish level building footprints • Underground utility vaults in proposed infiltration areas

2.2.1 Site Assessment Map

The first step in the process of determining the optimal approach for stormwater management is a thorough site assessment and information mapping. The goal is to learn how stormwater moves through the site and how natural hydrologic functions may be protected and preserved. The applicant must inventory conditions on and adjacent to the site, including topography, soils, hydrology, vegetation, and infrastructure.

Information collected by the applicant may be presented on a **Site Assessment Map** (**Figure 2-4** below) at a standard engineering scale appropriate for analyzing the information. In order to effectively use these standards, the applicant should also demonstrate an understanding of the development site conditions and of the upstream and downstream impacts resulting from the proposed development and the required stormwater management improvements. The applicant should outline how the use of LID strategies could reduce proposed impervious surfaces. The applicant should consider the use of green infrastructure approaches to stormwater management where site conditions allow.

The **Site Assessment Map** should generally include the following elements:

- **Topography:** Steep slopes greater than 25 percent and setback areas around those steep slopes, as well as landslide zones, are subject to additional requirements and restrictions. Infiltration is not allowed on steep slopes and slide-prone areas. Infiltrating stormwater on moderate slopes (10 percent or greater) requires a geologist or geotechnical engineering analysis to determine the appropriate strategies.
- **Soils and Groundwater:** Use soil maps, which are available from the Natural Resources Conservation Service Soil Survey to determine the site hydrologic soil type (an indication of soil infiltration capacity). An assessment of the seasonal high groundwater table may be required to ensure proposed infiltration facilities meet minimum separation distances.
- **Infiltration Assessment:** Stormwater management facilities that use infiltration shall be based on field tested infiltration rates. See Section 2.4 for Infiltration assessment guidelines. See **Appendix B** for specific infiltration testing requirements and methods.
- **Hydrology:** Show natural drainage features including channels, creeks, streams, and rivers. Identify jurisdictional wetland(s) (per Oregon Department of State Lands and U.S. Army Corps of Engineers) or 100-year floodplain (per FEMA mapping) present on the site.
- **Existing Drainage:** Show constructed drainage features on and adjacent to the site, including pipes, ditches, and outfalls.
- **Existing Vegetation:** Using aerial photos or survey, map all trees and vegetation. Show all existing trees on the site assessment map and mark areas of other vegetation types (e.g., shrubs, pasture). Native trees and vegetation should be protected whenever possible.
- **Pre-developed Conditions:** Describe the current vegetation cover of the site. If the site is currently developed, describe the conditions of the site prior to urban development. Note that hydrologic modeling for replaced impervious surfaces requires the pre-developed condition to be modeled as “grass” for flow control performance standards (See Section 4 for additional information).

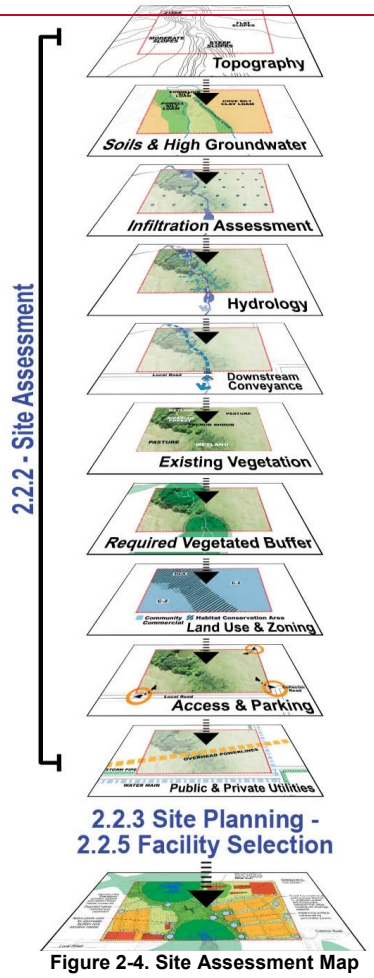

Figure 2-4. Site Assessment Map

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Commented [A4R3]: Site Assessment – Section 2.2.1
Site Planning – Section 2.2
Facility Selection – Appendix C? Need to refer to the native file for this.

- **Downstream storm drainage system:** Document the existing and proposed points of discharge for stormwater runoff leaving the site. See Section 2.3 for downstream analysis requirements.

2.2.2 Preliminary Stormwater Management Plan

The applicant is required to prepare a Preliminary Stormwater Management Plan (SWM Plan) at an engineering scale appropriate to review the information that includes proposed grading, clearing areas, stormwater facilities, natural resource areas and required setbacks, buildings, parking areas, streets, and other proposed impervious areas. The Preliminary SWM Plan must address the objectives listed below to reduce the impact of stormwater runoff from development. See **Appendix A** for additional details for preparing the Preliminary SWM Plan.

- **Preserve Existing Resources.** On the Preliminary SWM Plan, show sensitive areas and required buffers and setbacks. Show areas that require enhancement. If encroachment into any vegetated buffer area is proposed, show the area of encroachment on the site map, and show related proposed mitigation areas. Refer to Section 4.4 to identify any other buffer, conservation, or setback requirements.
- **Minimize Impervious Surface through Low Impact Development.** Site layout should consider the use of low impact development strategies and strive to reduce the impervious areas proposed for the site. These strategies reduce the volume of stormwater runoff and slow the rate of runoff from built surfaces. Examples include: flexible lot size developments; reduced building set-backs; shared parking areas; planned unit developments, attached housing and clustered buildings that require fewer driveways and pathways; reduced parking stalls (number or size), especially in transit-served areas; adding floors to buildings or parking garages; and, reduced street width if allowed by local planning codes. Applicants should evaluate which options are available through local planning and zoning codes.
- **Manage Impervious Surface through Reduction Methods.** Document the proposed impervious areas for the site. Consider the use of impervious area reduction strategies, such as porous pavement and/or green roofs, to reduce the net impervious area proposed for the site. Impervious area reduction strategies will reduce the impervious area requiring stormwater management facilities. Identify proposed impervious area reduction methods and show them on the Preliminary Site Plan. Note: SMFs such as porous pavement that are designed to mimic the natural hydrology of the site are considered an impervious surface for the purposes of determining project impervious area thresholds.
- **Manage Stormwater Runoff through Green Infrastructure.** Given suitable site and soil conditions, the District encourages the use of green infrastructure facilities for stormwater management that use infiltration of stormwater runoff to recharge groundwater and mimic pre-development hydrologic conditions. Green infrastructure approaches include rain gardens, stormwater planters, vegetated swales, filter strips, infiltration ponds, or other approaches that could be approved through a modification or variance process. A geotechnical investigation report is required to document onsite soil conditions to determine the appropriate green infrastructure strategy. Stormwater management facilities shall be designed to meet the water quality and flow control standards in Section 4.

- **Minimize Site Disturbance During Construction.** Protecting undisturbed, vegetated areas from construction activities provides more rainfall interception, evapotranspiration and runoff rate attenuation than clearing and replanting, even with soil amendments. On the Preliminary Site Plan, identify areas that will not be cleared during construction.
- **Minimize Soil Compaction During Construction.** Avoid any construction activity that could cause soil compaction in areas designated for SMFs to preserve filtration and infiltration characteristics of the soil. Also avoid soil compaction in vegetated buffers, in the dripline of tree canopies, and in mitigation and/or re-vegetation areas. Delineate these areas on the Preliminary Site Plan and protect them during construction with orange construction fencing.

2.3 Downstream Analysis

The downstream analysis (**Figure 2-5**) is a field investigation of the existing downstream storm drainage system to determine the capacity of the storm drainage system that will be utilized to safely convey stormwater runoff. Downstream analysis is a mechanism to assure the existing or proposed storm drainage system has adequate capacity to safely convey the stormwater runoff discharged from the development. The analysis will also provide the District with a better understanding of the storm drainage system, so that the District can add problem areas to maintenance work orders or to potential capital project needs.

A downstream analysis is required for all projects that exceed the impervious threshold that requires the applicant to submit a stormwater management plan designed by a registered professional engineer. The applicant shall complete the Qualitative Analysis (Section 2.3.1). Depending on the results, the District may require the analysis to extend further downstream, mitigation measures, a Quantitative Analysis (Section 2.3.2), offsite mitigation measures (Section 2.3.3), or additional flow control .

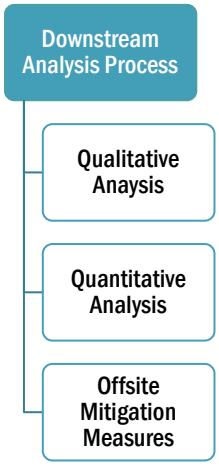

Figure 2-5. Downstream Analysis Process

If the proposed stormwater management system for a development or redevelopment project is designed to fully infiltrate the design storm as specified in Section 5, then the applicant is exempt from the downstream analysis requirements, but must still address the 100-year Emergency Overflow Pathway requirement in Section 4.

When required, the downstream analysis shall evaluate the offsite storm drainage system to the location where the project site contributes less than 15 percent of the upstream drainage area contributing to a public storm drainage system line or drainage channel, or a location 1,500 feet (approximately ¼ mile) downstream of the discharge point from the project site, whichever is greater. The downstream analysis may be stopped shorter than the required distance if the analysis reaches a stream, or river, or a point that is determined at the sole discretion of the District.

2.3.1 Qualitative Analysis

The Qualitative Analysis shall consist of a drainage system map, existing storm drainage systems, drainageways, outfall inspection results, storm drainage system description, and potential problem identification. Depending upon the presence of existing or predicted flooding, erosion or water quality problems, and the proposed design of the onsite drainage facilities, the District may require a Qualitative Analysis further downstream, mitigation measures, or a quantitative analysis.

- **Drainage System Map.** A drainage area map delineating the onsite and offsite contributing drainage areas upstream and downstream for the site shall be provided. The drainage system map shall be to a defined scale and must show the extent of the drainage system in the downstream analysis area. The drainage system map should also show general land use, topography, and other features impacting the onsite and downstream drainage system. Maps printed from GIS websites may be used as a base for the drainage system map.
- **Storm Drainage System and Outfall Inspection.** The engineer shall physically inspect the existing onsite and offsite drainage systems of the study area for each discharge location for existing or potential problems and drainage features. An inspection and investigation shall include the following:
  - Collect information on pipe sizes and slopes, channel characteristics, and drainage structures.
  - Note date and weather at time of inspection.
  - Take photographs of the existing condition of onsite and downstream drainage features.
  - Identify existing and potential problem areas.
- **Storm Drainage System Description.** For each drainage system component (e.g., pipe, culvert, outfall, ditch, open channel, tributary, stream), a written description shall be provided of the location, physical description, size, material, flow direction, and field observations. The description shall document points of inflow from adjacent drainage systems. The description shall also identify and describe points where water enters the downstream storm drainage system and the approximate tributary area at each contributing location. The tributary area shall account for upstream, onsite, and downstream contributions and land use conditions.
- **Existing and Potential Problem Areas.** All existing or potential problems identified during the storm drainage system and outfall inspection shall be documented and described. Problem areas include constrictions or capacity deficiencies in the drainage system, existing or potential flooding problems, erosion, scouring, or bank sloughing in open channels, and erosion or scouring at outfalls.

The following information shall be provided for each existing or potential problem area:

- Magnitude of, or damage caused by the problem.
- Assumed frequency and duration.
- Return frequency of storm or flow when the problem occurs.

- The pre and post construction water elevation when the problem occurs.
- Possible cause of the problem.
- Current mitigation of the problem.
- Whether the proposed development or redevelopment activity is likely to aggravate or mitigate the problem.

The descriptions shall be used to determine whether adequate mitigation can be identified or whether more detailed quantitative analysis is necessary.

2.3.2 Quantitative Analysis

Upon review of the qualitative analysis, the District may require a quantitative analysis, depending on the presence of existing or predicted flooding, erosion, or water quality problems and on the proposed design of the onsite drainage facilities. The quantitative analysis includes a hydrologic and hydraulic analysis of each component of the downstream storm drainage system. The analysis may be performed through spreadsheet and backwater calculations or by preparing a hydraulic model of the downstream system.

As-built drawings may be used to obtain structure information for the quantitative analysis. If as-built drawings are used, the engineer is responsible for verifying that all elevations are in the same datum. The District may require a field survey of the existing storm drainage system in the downstream analysis area to inform the quantitative analysis.

The quantitative analysis of the downstream storm drainage system shall assume the following:

- Project site is developed as proposed with the land use application.
- The surrounding drainage area is developed at future build out conditions, using the best zoning information available, or a conservative assumption of future build out conditions.
- Full functionality of the proposed onsite stormwater management facilities.
- The design storm for analysis shall be consistent with the storm drainage system design storms listed in Section 5.

The following shall be included as part of the quantitative downstream analysis:

- Upstream and downstream drainage area maps showing the flow route for both onsite and offsite stormwater.
- Description of hydrologic calculation parameters and design flows used in the analysis.
- Capacity and percent full during the design storm in each storm drainage system element.
- Velocity in each storm drainage system element during the applicable design storm.
- Headwater and tailwater assumptions.
- The hydraulic gradeline elevation for the design flow in each storm drainage system component.
- All calculation assumptions, equations, and outputs used in the analysis. If calculation assumptions are different than typical standards of practice,

justification of the parameters is required. When the downstream system includes older or deteriorated pipes, the Manning's n roughness coefficient should be adjusted to account for increased pipe roughness.

If the applicant is proposing mitigation measures to change the capacity of the downstream storm drainage system, the quantitative analysis shall include calculations for both the existing and proposed storm drainage system.

2.3.3 Offsite Mitigation Measures

Depending on the results of the offsite analysis, the applicant may be required to provide offsite mitigation measures. Where required, the mitigation will be of a type to be determined by the District. If the downstream analysis identifies outfall or streambank erosion or scour problems, the applicant shall correct the identified problem areas as a condition of the development activity.

If the downstream storm drainage system does not have the capacity to convey runoff according to the design standards outlined in Section 5, the applicant shall be required to mitigate for the undersized system (see **Appendix K** – Areas with Limited Downstream Conveyance Capacity). The applicant may elect to mitigate the storm drainage system problem by either correcting the deficiencies in the downstream storm drainage system (piped and open channel systems) or by providing additional onsite flow control beyond what is required in the performance standards in Section 4. The additional flow control may be in the form of additional onsite stormwater infiltration, retention, and/or storage, such that the 100-year, 24-hour post-developed peak discharge rate from the site matches the pre-developed peak discharge rate for the same storm event. The additional flow control requirements will take into account the downstream deficiencies and will be determined at the sole discretion of the District.

2.4 Infiltration Assessment

The best way to control the rate and duration of runoff is through the use of infiltration, including green infrastructure facilities. To properly size and locate stormwater management facilities, it is necessary to characterize the soil infiltration conditions at the location and depth of the proposed facility **(Figure 2-6)**.

All projects that require a Stormwater Management Facility (SMF) must evaluate existing site conditions to determine if the soils will support infiltration and to establish the design infiltration rate for stormwater management facilities.

The infiltration assessment starts with a site characterization. The applicant shall conduct infiltration testing and establish a design infiltration rate as described in this section~~Section 2.4~~. Please note: Infiltration testing is required as part of obtaining the Service Provider Letter.

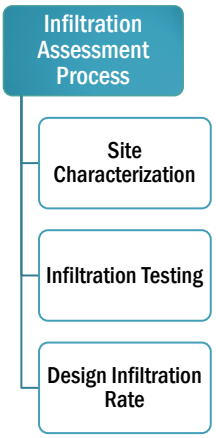

Figure 2-6. Infiltration Assessment Process

2.4.1 Site Characterization

Prior to testing, the applicant shall conduct a site characterization, using maps and available reports, to identify site conditions related to infiltration. Applicants should identify hydrologic soil groups, topographic constraints, groundwater levels, structural fill areas, and areas of contaminated soils.

- Infiltration is not a preferred strategy on sites where one or more of the following limiting conditions is present:
- Sites that include steep slopes (>25 percent) and/or geologic hazard zone designation (Subsection 1002.01, Hillsides of the Clackamas County Zoning and Development Ordinance). A geotechnical engineering or geologist report and District approval is required for infiltration facilities located on moderate slopes of 10 to 25 percent.
- Sites in areas of seasonal high groundwater table. Sites with jurisdictional wetlands or FEMA floodplains may be required to perform a seasonal high groundwater table assessment to determine that the seasonal groundwater table is at least 12 inches below the bottom of proposed non-infiltrating stormwater facilities.
- Sites within the 2-year time of travel to irrigation or drinking water wells or within the 500-foot horizontal setback from irrigation or drinking water wells are not suitable for underground injection control facilities, such as drywells or infiltration trenches or galleries. However, green infrastructure facilities that provide water quality treatment in conjunction with infiltration, such as rain gardens, planters, and bioinfiltration swales, may still be used within water pollution control facility (WPCF) permit setback distances.
- Sites where stormwater management facilities would be located on new or existing structural fill material.
- Sites with contaminated soils. Sites that have contaminated soils must be evaluated by the ODEQ and/or the U.S. EPA to determine if areas on the property are suitable for infiltration without the risk of mobilizing contaminants in the soil or groundwater. Documentation showing contamination assessment and determination must be submitted to the District at the time of application.
- There is a conflict with required source controls for high-risk sites.

For sites with limiting conditions, applicants should document the infiltration limitations and design SMFs that do not use infiltration. Infiltration testing may still be required to document select limitations.

Sites without limiting conditions have the potential to use infiltration as part of the stormwater management strategy. Applicants shall conduct infiltration testing and establish a design infiltration rate for potential SMFs. Infiltration, even at slow rates, has the potential to retain stormwater at the source, recharge groundwater, and reduce offsite flows. Incorporating infiltration into SMF design can also reduce the footprint of required SMFs.

Regardless of the tested infiltration rate of the soils on the site, applicants must demonstrate that SMFs will meet the performance standards for water quality treatment and flow control detailed in Section 4.

2.4.2 Infiltration Testing

Infiltration testing is required to establish the site characteristic to retain stormwater runoff, and to determine the most suitable placement to locate the SMFs. The infiltration testing results will be used to plan and design the SMF(s) that are required to mitigate the stormwater runoff.

2.4.3 Required Number of Infiltration Tests

Infiltration testing is required to determine the suitability to retain the stormwater runoff. No more than five infiltration tests are required per development application when site conditions and soil strata are verified to be consistent across the site by a geotechnical engineer.

2.4.3.1 Infiltration Testing to Establish Site Characteristics

For partitions, subdivisions, larger land divisions, commercial/industrial projects, parks projects, school projects, roadway projects, or similar, conduct at least two tests per one half acre of area proposed for development or redevelopment.

For single lot residential projects, conduct one infiltration test per lot, unless the development shares a common SMF.

2.4.3.2 Infiltration Testing Stormwater Facility

The engineer shall submit at least one infiltration testing result at the location and depth for each proposed SMF(s).

Methodology:

Infiltration testing shall be conducted according to the specifications in **Appendix B**, or using an equivalent method approved by the District. When a confining layer, or soil with a greater percentage of fines is observed during the subsurface investigation to be within 4 feet of the bottom of the planned SMF, the testing should be conducted within the confining layer.

2.4.4 Design Infiltration Rate

When feasible, infiltration is the preferred strategy to satisfy the flow control performance standard. The design infiltration rate shall be determined by the engineer conducting the infiltration test. A minimum correction factor of 2 shall be applied to the field-tested infiltration rates to determine the design infiltration rate for SMF design.

The design infiltration rate after applying the safety factor shall not exceed 100 in/hr for non-vegetative facilities, such as drywells or infiltration chambers. Vegetated facilities with growing media shall be designed at a maximum infiltration rate of 6.0 in/hr through the growing media.

SMFs shall be designed with an infiltration component, unless otherwise stipulated by the design professional. If the SMF cannot be designed to fully infiltrate the 10-year storm event, then an underdrain and outflow will be required to safely convey the discharge from the SMF to an approved discharge point. If the proposed facility does not have an approved discharge point, then it must be designed to fully infiltrate the 25-year storm event as required by the District.

2.5 Sensitive Area and Natural Resource Assessment

The District requires Water Quality Resource Area (WQRA) vegetated buffers to protect the water quality of water resources, which include perennial and intermittent streams and wetlands as outlined in the Rules and Regulations and the Buffer Standards. The purpose of the Buffer Standards is to assist applicants, developers, and property owners to plan and design their projects in compliance with District Water Quality Resource Area (WQRA) requirements. The WQRA requirements shall be incorporated into the preliminary site plan.

SECTION 3. PLAN REVIEW AND DEVELOPMENT APPROVAL PROCESS

This section outlines the submittals required by the District for development activities and provides an outline of what is required to obtain a Service Provider Letter, which is required prior to submitting the land-use application to the planning authority. This section also contains general guidelines, formats, and requirements regarding the District's development approval processes.

All applicants proposing development activities governed by these standards shall submit the plans, reports, studies, and information as required herein. The submittals shall be reviewed and approved by the District. Submittals must be complete with minimum fees paid before they will be accepted by the District for review.

3.1 General Processes

The following is a generalized overview of the District development review and permitting process. This process may vary from one application, submittal and/or building permit to another and is only shown as a general outline of procedures and processes involved in the review and approval of projects located within the District. To obtain further information on a specific plan review or permit process contact a Development Review staff member.

3.1.1 General Plan Review and Approval Process

This subsection outlines the most common elements of the general development review process for a typical partition, subdivision, multi-family, commercial or industrial project as described in detail in **Appendix A**. It is important to discuss your project with the District and Local Planning Authority early to understand the review and approval process required for your specific project.

1. Pre-Application Conference
2. Service Provider Letter
3. Sensitive Area Authorization
4. Conditions of Approval
5. Jurisdictional Authority
6. Pre-Design Meeting
7. Plan Submittal
8. Other approvals
9. Approved Plan(s)
10. Construction
11. Construction Completed
12. Final Inspection
13. Final As-built Drawings
14. Warranty Surety
15. Letter of Completion and Acceptance
16. Warranty Surety Inspection

3.2 Service Provider Letter

The intent of the Service Provider Letter is that, prior to applying for Land Use/Design Review to the local planning authority, the applicant must demonstrate the proposed development is viable in accordance with District Rules, Regulations, and Standards. The Service Provider Letter will only be issued once the applicant has provided sufficient plans, reports, and studies needed for preliminary review by the District. Based on the preliminary review, the District may request additional information prior to issuance of the letter or as part of the forthcoming land use application. Receipt of the Service Provider Letter does not imply that all District requirements have been met or guarantee that land use approval for the development will be granted. For additional details regarding the Service Provider Letter see **Appendix A**, Section A-2.

3.3 Stormwater Management Plan

Stormwater Management Plans and reports must be stamped by a registered licensed Professional Engineer within the State of Oregon. **Appendix A** contains specific information and drawing specifications for submittals of engineered Stormwater Management Plans made to the District. This section is intended to standardize the submittals and clearly outline the minimum requirements. The requirement for a complete submittal package is intended to reduce the overall plan approval processing time. Plans will not be reviewed until a complete plan has been submitted. A complete plan shall include, at a minimum, all requirements detailed in **Appendix A** and outlined below:

- Title Sheet, Title Block, Drawing Scale Requirements, North Arrow Requirement, Lettering/Text Requirements
- Composite Utility Plan
- Composite Plan Cover Sheet (sanitary and storm)
- Plan and Profile Views
- Grading Plan
- Geotechnical Report
- Erosion and Sedimentation Control Plan
- Vegetated Buffer Planting Plan
- Stormwater Management Facility Planting Plan
- Standard Drawings/Detail Sheets
- General Stormwater Construction Notes

3.4 Stormwater Report

The stormwater report shall accompany the engineered stormwater plans to complete documentation of the design and design intent. The stormwater report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon. The Professional Engineer shall ensure that the stormwater report matches the design displayed on the engineered drainage plans.

The stormwater report shall contain the following information (see **Appendix A** for more details):

A. Cover sheet
B. Table of contents
C. Vicinity map
D. Drainage area maps
E. Project description
F. Required permits
G. References to relevant reports
H. Existing conditions
I. Receiving waters
J. Developed site drainage conditions
K. Infiltration Testing Results
L. Pervious and Impervious area tables
M. Pre and Post Development flow rate tables
N. Soils Map
O. Contributing areas
P. Hydrologic and Hydraulic design computations
Q. Emergency overflow pathway
R. Downstream storm drainage system analysis
S. Erosion prevention and sediment control
T. Operation and Maintenance Plan
U. Landscape plan
V. Geotechnical report

3.5 Standard Detail Drawings

The District's standard drawings shall be used for public and private development projects and cannot be modified by designers, unless approved by the District on a project-by-project basis. It is the responsibility of the engineer to incorporate the standard detail drawings as originally intended. See **Appendix D** for the District's typical stormwater standard detail drawings.

3.6 Pre-Construction Meeting/Post Construction Considerations

If required, the engineer, contractor, applicant, District, and/or other related agency representatives will hold a pre-construction meeting to share information and requirements as specified in the stormwater report and/or engineered stormwater management plans. Upon final completion of the construction, the Engineer will certify that the post construction as-built drawings are complete in all respects and the Stormwater Management Facility and Storm Drainage System were built per the approved construction documents.

At a minimum, the following shall be done prior to requesting the final inspection of the stormwater facilities:

- Clean all stormwater management facilities of sediment and debris.
- Submit a Certification of Completion to certify that the project was constructed in accordance with the approved plans and District standards.

- Submit a Vegetated Planting Certification to certify that water quality plantings were constructed in accordance with the approved plans and these standards.
- Submit as-built drawings according to Section 3.9.
- Submit storm video testing and reports for all public storm systems that were constructed.
- Submit engineer inspection reports.
- Submit final construction cost data for the public storm systems that were constructed.

3.7 Performance / Warranty Surety

The District may require the Applicant to submit a surety bond or cash security to guarantee performance or warranty in completion of the public improvements required by these standards. Upon default, the District may draw upon the surety or available funds to remedy violations or required corrections. The different types of acceptable surety are provided in **Appendix A**.

3.8 General Building Permit, Partition/Subdivision Approval Processes

The District's processes for approving building permit applications, partitions, and subdivision plats can be found in **Appendix A**. This process includes:

- Building Permit Review and Approval
- Partition/Subdivision Plat Review and Approval
- General Conditions for Performance and Warranty Surety

3.9 As-Built Submittals

The District requires the stormwater plans shall be as-built prior to the acceptance of the project. As-built drawings are necessary to assure the project was constructed per the approved plans and/or meet the requirements of these Standards. The Engineer is responsible for record keeping, inspection, and preparation of the as-built drawings. Final as-builts drawings will be submitted in the following manner, CAD files and PDF files as detailed in **Appendix A**.

SECTION 4. STORMWATER MANAGEMENT FACILITY DESIGN

Stormwater Management Facilities (SMFs) include a variety of methods to mitigate stormwater runoff and remove pollutants from stormwater, including detention, infiltration/retention, sedimentation, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Infiltration is the preferred method to address stormwater runoff for water quality and flow control requirements. In some cases, using a combination of stormwater management facilities may be the most effective strategy for removal of specific pollutants of concern in designated high-risk areas.

In selecting a stormwater management approach, the designer must consider site characteristics, anticipated land uses, runoff characteristics, treatment objectives and maintenance needs. Once the site analysis is complete, the designer may incorporate the most effective stormwater management facilities into the site design for the proposed development. See Section 2 for additional details on site assessment and planning.

This section describes the methods and criteria for designing stormwater management facilities to meet water quality and flow control performance standards. Additional structural source controls may be required for certain types of development categorized as high risk for pollutants as described in Section 6.

4.1 Stormwater Management Performance Standards

Applicants of projects subject to stormwater review must demonstrate that the proposed project will include stormwater management facilities that meet water quality and flow control performance standards.

4.1.1 Infiltration

When site conditions allow, infiltration is the preferred strategy to achieve the stormwater management performance standards. When a SMF is designed to fully infiltrate the 10-year, 24-hour design storm, the facility is assumed to meet the flow control performance standard, without further analysis. Such facilities provide onsite stormwater retention for most rainfall conditions and should only result in partial downstream discharge during events larger than a 10-year storm. When site conditions do not allow infiltration of the full 10-year, 24-hour design storm, infiltration can still be incorporated into the flow control facility design to reduce the volume of discharge released from the site. Flow control facilities designed with partial infiltration should include an underdrain, control structure, and overflow system to manage the release rates from the facility. Whether or not infiltration is incorporated into the design, release rates from the facility must meet the flow control performance standard in Section 4.1.3.

When a rain garden, planter, swale, or pond is designed to fully infiltrate the 10-year, 24-hour design storm, the facility is also assumed to meet the water quality performance standard, without further analysis. Underground injection control (UIC) facilities, such as drywells, infiltration trenches, and infiltration chambers may require upstream water quality treatment to meet the water quality performance standards.

Refer to the individual facility design requirements in Section 4.5 to determine which infiltration facilities can be used to provide upstream water quality treatment for UICs. When a UIC facility is designed to infiltrate the 10-year 24-hour design storm, the applicant is responsible for demonstrating the proposed UICs will be rule authorized under Oregon Administrative Rules (OAR) 340-44-008 or will obtain an ODEQ-issued UIC Permit.

4.1.2 Water Quality Performance Standard

Stormwater management facilities shall be designed to capture and treat 80 percent of the average annual runoff volume, to the maximum extent practicable with the goal of 80 percent total suspended solids removal. In this context, "maximum extent practicable" means less-effective treatment may not be substituted when it is practicable to provide more effective treatment. Based on local rainfall frequency and intensity, the required treatment volume equates to a **water quality design storm of 1.0 inch over 24-hours**[1]. Stormwater management facilities for water quality shall be designed in conformance with the design guidelines in this section.

Hydrodynamic separators, when used as a sole method of stormwater treatment, do not meet the "maximum extent practicable" requirement for stormwater treatment effectiveness with regard to these stormwater standards.

In general, water quality facilities should be vegetated facilities; however, the District does allow the use of water quality mechanical devices. See **Appendix C** for acceptable water quality devices approved by the District for use.

4.1.3 Flow Control Performance Standard

Flow control facilities shall be designed so that the duration of peak flow rates from post-development conditions shall be less than or equal to the duration of peak flow rates from pre-development conditions for all peak flows between **42 percent of the 2-year peak flow rate[2] up to the 10-year peak flow rate**. A hydrologic/hydraulic analytical model capable of performing a continuous simulation of peak flow rates from local long-term rainfall data must be used to determine the peak flow rates, recurrence intervals, and durations. SMFs for flow control shall be designed in conformance with the design guidelines in Section 4.5.

Flow control is not required for projects that discharge directly to the Willamette River, the Tualatin River, or the Clackamas River, provided that all of the following conditions are met:

- The project site is drained by a storm drainage system that is composed entirely of man-made conveyance elements (e.g., pipes, culverts, ditches, outfall

[1] The water quality design storm rainfall depth is documented in a technical memorandum: *Selection of Representative Rainfall Volume and Rainfall Intensities to result in Capture and Treatment of 80% of the Average Annual Runoff Volume*, Brown and Caldwell, May 11, 2010.

[2] The lower threshold of 42 percent of the 2-year peak flow rate for flow-duration matching is based on a 2008 study by the Oregon Department of Transportation (ODOT) titled, "Water Quantity (Flow Control) Design Storm Performance Standard." ODOT's study found that bed movement in sand-bedded streams occurs at approximately two-thirds of the bank full flow, which is assumed to be roughly equivalent to the 1.2-year discharge. ODOT's flow frequency analysis established that two thirds of the 1.2-year discharge is approximately equivalent to 42 percent of the 2-year discharge.

protection, etc.) and the storm drainage system extends to the ordinary high-water line of the exempt water body.

- The entire length of the storm drainage system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharge from the proposed development of the site and the existing development condition from the remaining drainage area contributing to the storm drainage system for the 25-year storm event, based on the conveyance of the design storm as outlined in Section 5.3.
- Any erodible elements of the man-made storm drainage system must be adequately stabilized to prevent erosion under the conditions noted above.
- The constructed storm drainage system does not result in an inter-basin transfer of runoff, as determined by the District.

Projects that are exempt from flow control are still subject to the other requirements outlined in these standards, including requirements to provide erosion and sediment control, water quality treatment, storm drainage systems, downstream storm drainage system analysis and applicable source controls.

4.1.4 Emergency Safe Overflow Pathway

For all projects with stormwater management facilities, an overland emergency safe overflow pathway must be identified and/or designed that allows runoff from large storm events to discharge without risk of injury or property damage. The emergency safe overflow pathway must be incorporated into the design to show how flow will escape from the site during rainfall events larger than the design storm and/or from failure of the primary stormwater storm drainage system. If a Storm Drainage System is used as a component to convey the emergency safe overflow pathway, then the structure(s) and system shall be designed to convey the 100-year design storm.

The applicant shall identify the proposed 100-year emergency safe overflow pathway. If downstream properties are impacted by the 100-year storm event, then the applicant shall provide additional flow control or secondary stormwater management facilities to mitigate the potential impact.

4.1.5 Fee in Lieu

When a proposed development is unable to meet the flow control or water quality performance standards, the District may allow applicants to pay a fee in lieu of stormwater management improvements. In such a case, the fee shall be based on a proportional cost for the District to construct an equivalent SMF including costs for land acquisition, design, construction, maintenance, and administration.

The financial viability of designing and constructing onsite or offsite stormwater management facilities is not a justification to use the fee in lieu program. Applicants must demonstrate that the proposed development site has one or more physical limitations that prevent the installation of onsite stormwater management facilities, and that offsite or regional facilities are not a feasible alternative. All projects should meet the downstream storm drainage system capacity requirements, and provide a safe emergency safe overflow pathway, as needed.

4.2 Facility Sizing Methods

This section explains the methods accepted by the District for determining the appropriate size and configuration of stormwater management facilities to achieve the performance standards. A BMP Sizing Tool is available from the District to assist in facility sizing.

4.2.1 Infiltration

See Section 4.1.1 for a discussion of the use of infiltration in stormwater facility sizing. When sizing stormwater management facilities that incorporate infiltration, the design infiltration rate shall be determined as outlined in Section 4.1.1. See **Appendix E** for SBUH calculation parameters and **Appendix I** for rainfall isopluvial maps that should be used for 10-year, 24-hour design storm calculations and infiltration facility design.

4.2.2 Water Quality Facility Sizing

Water quality stormwater management facilities shall be sized to capture and treat 80 percent of the average annual stormwater runoff with the goal of 80 percent total suspended solids removal. This is equivalent to treating runoff from the first 1.0 inch of an individual 24-hour storm event.

The water quality design volume or flow rate shall be determined through one of the following methods[3] (see **Appendix C** for approved water quality devices):

- The water quality design volume for volume-based stormwater management facilities (constructed wetlands, ponds, planters, rain gardens, and bioinfiltration swales) shall be calculated as the total runoff volume from a storm with 1.0 inch of precipitation. Volume analysis may be performed using a hydrograph analysis program or spreadsheet tools. (Refer to Section 5.3.4 and **Appendix E** for design limitations and calculation references when using the Santa Barbara Urban Hydrograph [SBUH], Technical Release 55 (TR-55), or SWMM method for sizing water quality treatment.)
- The design flow rate for flow-based stormwater management facilities (filter strips and most manufactured treatment systems) shall be calculated as the peak discharge from design storm with the following peak rainfall intensities[4]:
  - Design storm intensity for online facilities of 0.18 inches per hour (in/hr)
  - Design storm intensity for offline facilities of 0.10 in/hr
- Use the BMP Sizing Tool to size the facility using either the treatment or treatment and flow control methods, depending on the application. Note: Facilities sized using the BMP Sizing Tool must follow the design details for ponding depth, overflow height, depth of growing media, depth of drain rock, and sizing of orifice controls (where relevant). Those dimensions are shown in the typical facility drawings in **Appendix D**.

[3] The District does not allow the use of the PAC Tool.

[4] The water quality design storm rainfall intensity as documented in a technical memorandum: *Selection of Representative Rainfall Volume and Rainfall Intensities to result in Capture and Treatment of 80% of the Average Annual Runoff Volume*, Brown and Caldwell, May 11, 2010.

- Use a continuous simulation hydrologic/hydraulic model analysis that addresses the design equivalent of capturing and treating 80 percent of the average annual stormwater runoff.
- Volume calculations using the 1.0-inch design storm and the following equation:

$$V_{imp} \text{ or } V_{perv} = 3{,}630 * A * \frac{\left(P_{design} - 0.2 * \left[\frac{1{,}000}{CN} - 10 \right] \right)^2}{\left(P_{design} + 0.8 \left[\frac{1{,}000}{CN} - 10 \right] \right)}$$

where:

V = runoff volume (impervious or pervious), cubic feet
A = drainage area, acres
P = design precipitation depth, inches (assumed to be 1.0 for water quality sizing)
CN = NRCS curve number, unitless (see **Appendix E**)

4.2.3 Flow Control Facility Sizing

To design for flow duration matching, a hydrologic/hydraulic analytical model capable of performing a continuous simulation of peak flow rates from local long-term rainfall data must be used to determine the peak flow rates, recurrence intervals, and durations.

A BMP Sizing Tool is available from the District to assist with the sizing of stormwater management facilities that meet these performance standards. The BMP Sizing Tool can be used during the initial site planning, preliminary design, and final design. The BMP Sizing Tool was developed based on specific design requirements for each facility type. Facilities sized using the BMP Sizing Tool must follow the design details for ponding depth, overflow height, depth of growing media, depth of drain rock, and sizing of orifice controls (where relevant). Those dimensions are shown in the typical facility drawings in **Appendix D**.

As an alternative to the BMP Sizing Tool, the engineer may use other stormwater modeling and calculation tools to determine the size and configuration of stormwater management facilities to meet the flow control performance standard. The engineer may use any analytical model capable of performing a continuous simulation of peak flows from long-term local rainfall records. Regardless of how the stormwater calculations are performed, the report submitted to the District must show how the proposed stormwater management facilities meet the flow control performance standards. Creation of a continuous simulation hydrologic model for a specific development site requires specialized expertise and usually takes additional time and expense to develop and review. The applicant may be required to pay additional fees to the District to review the stormwater management plan developed using other modeling methods. These fees will be used to pay for a third-party peer review of the stormwater report, hydrologic model, and facility design.

4.2.4 Pre-developed Hydrology

For the purposes of hydrologic modeling to size and configure flow control facilities, the pre-developed condition of the site will be modeled as follows:

- For new development, the pre-developed condition shall be defined as the condition of land prior to the proposed development, excluding any pre-developed impervious areas.
- For redevelopment projects, the pre-developed condition shall be defined as the condition of the land before urban development. For the purpose of hydrological evaluations, grass should be used as the pre-developed condition for modeling replaced impervious surface areas.

4.2.5 Unmitigated Flow

Due to topographic constraints, runoff from portions of a development site may be permitted to be released at post-development rates (without flow control), on a case by case basis at the sole discretion of the District provided that all of the following are met:

- Runoff from the unmitigated area rejoins the downstream pre-development drainage course.
- The project engineer has demonstrated in the downstream analysis (see Section 2.3) that the downstream drainage course will not be adversely impacted by the runoff from the unmitigated area. Improvements to the downstream storm drainage system may be required to provide adequate storm drainage system capacity for flows from unmitigated areas.
- Easements (as required) shall be obtained by the applicant from all downstream property owners, through whose property the unmitigated runoff flows, prior to rejoining other public stormwater that is conveyed in a Storm Drainage System.
- The cumulative release rate from all areas of the project site, including the unmitigated area, shall not exceed the cumulative pre-developed rates from the site (in accordance with the flow control performance standards in Section 4). This may be achieved by providing additional storage and flow control of an equal off site area in the SMF to compensate for unmitigated on site areas.

4.2.6 Equivalent Stormwater Management

If it is infeasible to manage stormwater runoff at the location of the new or replaced impervious surface area, then it is acceptable to mitigate an equal amount of existing impervious surface area in accordance with these Standards within the same drainage basin. Equivalent stormwater management solutions shall be reviewed and approved by at the discretion of the District.

4.3 Stormwater Management Facilities Selection

Low impact development strategies, such as retaining vegetation and open space, clustering buildings, disconnecting residential downspouts, and constructing pervious pavement and green roofs, may be used as techniques to help mitigate stormwater runoff and reduce the size of the required stormwater management facilities. These strategies should be identified during the site planning and preliminary design processes (see Section 2).

When a SMF is required, green infrastructure approaches, such as planters, swales, rain gardens, ponds, and other vegetated facilities are the preferred strategy to meet the stormwater management requirements for water quality treatment and flow control. The best

way to control the rate and duration of runoff is through the incorporation of infiltration using green infrastructure facilities.

4.3.1 Allowable Facilities

While the District provides design guidance for numerous public and privately maintained SMF types, not all facilities are acceptable for use in every jurisdictional area. **Appendix C** provides lists of facilities that are approved for use in different parts of the District. The lists cover areas managed by WES, the City of Happy Valley, and the Clackamas County Department of Transportation and Development.

Applicants should consult with District and local agency staff to understand the types of stormwater management facilities that could be approved for use on the project.

If a proposed facility meets the ODEQ criteria for a UIC, the applicant shall comply with UIC requirements and prepare appropriate registration information for ODEQ.

4.3.2 Alternative Facilities

Applicants may propose stormwater management facilities that are not listed in **Appendix C**. Such a proposal will require the applicant to submit a request for a variance per Section 1.4. Alternate facilities must be designed to meet the performance standards outlined in Section 4.1.

Design guidance is provided below for the following facility types:

- **Stormwater Planter**
- **Rain Garden**
- **Vegetated Swale (biofiltration)**
- **Filter Strip**
- **Drywell**
- **Infiltration Trench**
- **Constructed Wetland**
- **Detention or Infiltration Pond**
- **Structural Detention System**
- **Manufactured Treatment**
- **Sheet Flow Dispersion**
- **Pervious Pavement**
- **Green Roof**

4.4 General Facility Design Requirements

The following design requirements apply to all stormwater management facilities. Additional facility specific design criteria are included in Section 4.5.

4.4.1 Location and Setbacks

Applicants must review local zoning, building and plumbing code requirements to understand setback requirements for stormwater management facilities. The minimum setback for a stormwater facility is 5-feet from a property line, unless more distance is specified by the design engineer, geotechnical engineer, and/or by local and state minimum setback requirements~~S~~. See District Buffer Standards for further information on the design requirements for vegetated facilities and buffer areas.

In addition, stormwater facilities that incorporate an infiltration component are subject to all local and state minimum setback requirements. A geotechnical report is required to determine setbacks from slopes for infiltration facilities installed near slopes ≥15 percent or within 200 feet of a steep slope hazard area or landslide hazard area.

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4.4.2 Outlet Structures

Stormwater management facilities designed as flow through systems shall have a perforated pipe underdrain system to convey water from the facility to a flow control structure and/or downstream storm drainage system.

Orifice sizes for stormwater management facilities will be specified by the BMP Sizing Tool results. Orifices shall be located to prevent clogging and blockages. Outlet structures (orifices, weirs, overflow risers, etc.) shall be configured to operate as passive systems and shall not require adjustments during normal operation.

Flow control structures shall be located in an enclosed structure, outside the open water storage area, in a location that provides sufficient maintenance access for a minimum of 20 feet. Flow control manholes shall have solid locking covers, however open grates may be permitted.

Outlet structures and overflow configurations must address the 100-year safe overflow pathway requirements in Section 4.1.4.

Additional outlet requirements for specific facility types are addressed in Section 4.5.

4.4.3 Stormwater Facility Signage

All vegetated and porous stormwater management facilities, including permeable surfaces such as porous pavement shall have at least one informational sign that is clearly visible and legible to the public.

- The permittee shall install the applicable sign(s) before the District deems the project is completed, and/or prior to the issuance of the Certificate of Occupancy Permit.
- Signs for publicly maintained stormwater management facilities require the following:
  - The permittee shall be responsible for obtaining and installing the stormwater facility sign at their own expense.
  - The material shall be aluminum with green reflective sheeting and silk screen lettering or equal as approved by the District.
  - The minimum sign size shall be 12 by 18 inches. The maximum sign size shall be 24 by 30 inches.
  - The sign shall be affixed to metal signpost, or facility fencing.
  - The sign shall be installed near the stormwater facility in a location highly visible to the public.
  - The sign shall be created and installed in accordance with the Standard Detail Drawing D.26 SWM ST-3.0 Storm – Surface Water Facility Signs.
  - An electronic file format of the sign is available upon request from the District.
  - Signs may be available for purchase from the District.
- Signs for privately maintained vegetated stormwater management facilities shall be provided by the permittee and will include text stating the following:

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Protect Our Streams and Groundwater

This facility filters stormwater runoff to protect public health and the environment.

- **Requires routine inspection and maintenance.**
- **For more information or to report a problem, contact: XXXX**

- Signs for privately maintained permeable surfaces, such as porous pavement shall be provided by the permittee and will include text stating:

Porous Pavement

This pavement is specially designed and constructed to allow stormwater to infiltrate through it into the ground. Please follow these rules to allow the pavement to function as designed including:

- **Avoid tracking or piling dirt, mud, or sediment on the driveway.**
- **If debris is tracked onto the driveway surface, clean by using a vacuum-type street cleaner during dry weather.**
- **Maintain vegetation along the sides of the driveway to help keep erosion and sediment laden water from clogging the surface.**
- **Do not place any sealants on the driveway.**
- **Contact a qualified pervious pavement contractor for repair and/or repaving**
- **For more information or to report a problem, contact: XXXX**

4.4.4 Soil Mixes for Stormwater Management Facilities

Vegetated facilities require a soil/landscape system that simultaneously supports plant growth, soil microbes, water infiltration, nutrient and pollutant adsorption, sediment and pollutant filtration, and pollutant decomposition. Therefore, the soil mix selected for a facility is critical to its success. See **Appendix G** for soil mix requirements.

4.4.5 Planting and Irrigation

SMF planting guidelines are included in **Appendix F**. Planting plans must meet the following requirements:

- Establish and implement procedures such as control of the following: invasive weeds, animal and vandal damage, mulching, re-staking, and watering to the extent needed (as determined by the District) to ensure plant survival. Plastic and mesh tubes are prohibited and shall not be used within a publicly maintained facility.
- Stormwater facilities located in the public street right-of-way (ROW) are not permitted to include trees.
- Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions (see **Appendix F**).

- For facilities located in riparian corridors, all plants within the facility area shall be appropriate native species from the **Buffer Standards Appendix A** plant list.
- No nuisance, invasive, or prohibited plants shall be used in any stormwater facilities.
- The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.
- Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation once established.
- Side slopes of planted areas shall not exceed 3 feet horizontal to 1 foot vertical.

The engineer or landscape architect shall determine the appropriate irrigation strategy to maintain the plant survivability. Temporary irrigation systems must be fully removed by the developer before the District releases the storm warranty bond.

4.4.6 Pond Embankment, Retaining Walls, Fencing, Gates and Handrails

Pond embankments and retaining walls are allowed to impound water to enhance the functionality of the stormwater management facility.

4.4.6.1 Pond Embankments

Pond embankments must be constructed with a maximum slope of 3H: 1V on the upstream and downstream face. Side slopes within the pond must be sloped no steeper than 3H: 1V below the maximum water surface elevation, unless otherwise approved by the District.

Retaining Walls

Retaining walls greater than 4 feet in height shall have a professional structural or geotechnical engineer registered in Oregon provide stamped design calculations and detail drawings required for the retaining wall construction, per local building code requirements. Stormwater ponds that require retaining walls will be limited to the height of 10 feet above the vegetated surface elevation for 50 percent of the circumference of the facility, and 6 feet for the remaining portion of the circumference, unless otherwise approved by the District.

4.4.6.2 Retaining Wall Ownership

The District shall not have any maintenance or ownership responsibility for retaining walls. The Owner of the property (HOA) shall be responsible for the maintenance, repair and/or replacement of the retaining wall(s) within the public easement(s) or tract(s). The ownership and maintenance responsibility for the retaining wall shall be clearly specified in the CCRs and/or within the stormwater maintenance plan.

4.4.6.3 Fencing, Gate and Handrails

A minimum 6' high fence is required to be constructed around the parameter of all publicly maintained stormwater facilities with a designed water depth greater than 3-feet. Publicly maintained stormwater facility must provide a maintenance access gate with a minimum opening width of 12-feet wide that consists of two 6-foot sections. Fencing or handrails may be required along the top of the retaining wall in accordance with local zoning and building codes.

1. ~~Retaining walls greater than 4 feet in height shall have a professional structural or geotechnical engineer registered in Oregon provide stamped design calculations and detail drawings required for the retaining wall construction, per local building code requirements. SMFs that require retaining walls will be limited to the height of 10 feet for 50 percent of the circumference of the facility, and 6 feet for the remaining portion of the circumference.~~

~~Fences are required for all publicly maintained stormwater management facilities.~~

~~Fencing for privately maintained facilities must conform to local and state zoning and building codes.~~

~~The local building department may require handrails for stormwater management facilities with vertical sides that exceed 30 inches in depth, measured from the top of the curb to the top of the soil.~~

~~4.4.6~~4.4.7 Public Maintenance Access

Publicly maintained stormwater facilities and structures must provide an access road designed and constructed for the intended use and purpose for accessing and maintaining the proposed stormwater management facilities. District maintained facilities should be located adjacent to the public ROW. Public maintenance access roads shall be designed and constructed to the minimum standard as specified below and in accordance with **Appendix L**.

In addition, the following is required for publicly maintained facilities:

- Maintenance road access for District-maintained facilities shall be shown on the recorded plat and be situated in a separate tract and identified with the specific and intended use for maintenance access.
- The District may require additional protection for access roads, including fencing, signs and/or bollards to restrict public access. Minimum maintenance access of 20 feet to structures is required.

~~4.4.7~~4.4.8 Private Maintenance Access

Privately maintained facilities shall be located in a manner so that the facility can be safely and efficiently maintained. Egress and ingress access routes shall be clear of any obstacles and constructed of a sufficient surface to safely convey the size and weight of vehicles, and equipment necessary to maintain, repair and replace the SW facility. Minimum maintenance access of 20 feet from the access point to structures is required. The access surface shall be maintained to accommodate scheduled maintenance in accordance with the Standards.

~~4.4.8~~4.4.9 UIC Registration

Infiltrators and infiltration trenches are generally classified as UICs by ODEQ. The District will evaluate each case and may accept ownership and/or maintenance responsibility for UICs. For UICs on private property, with the exception of single-family residential roof and footing drains, there is a requirement to register the UICs and provide site inventory data to ODEQ.

Any proposed UIC facility shall be rule authorized pursuant to OAR 340-44-008, have an ODEQ-issued UIC permit associated with the facility, or have a notice of intent to issue a UIC permit.

4.5 Stormwater Facility Design Requirements

The following section includes SMF design guidelines for facilities approved for use in the District. Refer to **Appendix C** for a list of facilities that are approved for use in different jurisdictions within Clackamas County, including WES, the City of Happy Valley, and unincorporated areas of Clackamas County regulated by the Clackamas County Department of Transportation and Development. Typical facility drawings are included in **Appendix D.**

4.5.1 Stormwater Planter

Stormwater planters are walled basins that capture and treat runoff through a combination of vegetation and an engineered soil mix called biofiltration soil medium. Planters may also be used for flow control when designed with infiltration or with an underdrain with controlled outlet.

Planters treat stormwater through sedimentation of particles in ponded water; filtration and phytoremediation through contact with vegetation; and biodegradation and adsorption of pollutants through contact with soil organisms and chemical soil processes. Planters and rain gardens provide similar treatment and flow control performance, though planters require less space than rain gardens to treat the same contributing area.

General Stormwater Facility Requirements

- Water quality pretreatment is generally not required.
- Stormwater facilities shall be designed to treat the entire inflow.
- An infiltration test shall be conducted at the location and depth of the facility.
- Stormwater Management Facilities shall have a minimum separation of 3 feet from the bottom of the facility to the seasonal high groundwater elevation or other layer that limits infiltration (e.g., bedrock, clay lens).
- If infiltration is used as a design component to determine retention, then the maximum draw down time is 24 hours.
- Native soil infiltration rate shall be at least 0.25 in/hr for an infiltration planter. If the infiltration rate is less than 0.25 in/hr, an underdrain is required. For native soil infiltration rates between 0.25 and 2.0 in/hr, the engineer shall determine the need for an underdrain based on design performance calculations.
- Water quality planters shall be located prior to the flow control facility, and not be located downstream of detention.
- Planters are designed with vertical walls and may require a structural engineer to design (because of their structural walls).
- Planters receiving stormwater from downspouts need energy dissipation at the downspout outlet and planters receiving water from the street need a sediment forebay to facilitate maintenance.
- Lined flow-through planters may not have setback requirements from building foundations. Check with local building code division to confirm the setback of these facilities from building, structures, and property lines.

- Planters shall be designed to consider safety issues (including pedestrian safety). Curbing, fencing, railings, or placing planters above grade may be necessary. Planters located within the ROW shall be approved by the local roadway authority.

Dimensions

- Drain rock depth is 18 inches.
- Minimum bottom width: 2.0 feet.
- Minimum orifice size: filtration facilities 0.5 inches, all other 1.0 inches.
- Minimum freeboard: 2.0 inches, if contributing area is less than 5,000 SF; 6.0 inches for larger contributing areas.
- Maximum ponding depth: 12.0 inches.
- Depth of biofiltration mix: 18 inches minimum.

Materials

- When required, waterproof liners shall be 30 mil polyvinyl chloride (PVC) membrane or equivalent.
- Planter walls and bottom (when needed) shall be made of concrete. Chemically treated wood that can leach out toxic chemicals and contaminate stormwater shall not be used.
- Drain rock is required below the biofiltration soil mix. For infiltration planters, use 0.75 inch to 1.5 inches of washed drain rock. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.
- When used, underdrains shall be a minimum of 4 inches diameter for private facilities and a minimum of 6 inches for publicly maintained facilities. Underdrains shall be slotted or perforated PVC that conforms to American Society for Testing and Materials (ASTM) D 3034, with a pipe stiffness of 46 pounds per square inch (psi) or a minimum standard dimensional ratio (SDR) of 35 or approved equal. Installation and testing requirements shall conform to the current Oregon Plumbing Specialty Code (OPSC) and ODOT Standard Specification 02415.50 for PVC pipe. Slotted perforations (0.064-inch-wide x 1.00-inch-long, spaced 0.3 inch on center) are preferred and less susceptible to clogging.
- Drain rock and biofiltration soil mix shall be separated by a 2-inch to 3-inch choker course layer. Choker course shall conform to ODOT Standard Specifications 00430.11.
- Biofiltration soil mix must support long-term plant and soil health and provide treatment for water as it moves through the soil column. See **Appendix G** for soil mix requirements.
- Plant selection shall follow the Planting Guide in **Appendix F**. Plant selection shall be based on water level tolerances during the rainy season, as well as the ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the proposed planter. Planters shall be designed so that they do not require mowing.

4.5.2 Rain Garden

Rain gardens are vegetated depressions that capture and treat runoff with a combination of vegetation and biofiltration soil medium. Rain gardens may also be used for flow control when designed to infiltrate or with an underdrain with controlled outlet.

Rain gardens treat stormwater through sedimentation of particles in ponded water, filtration, and phytoremediation through contact with vegetation, and biodegradation and adsorption of pollutants through contact with soil organisms and chemical soil processes. Rain gardens are ideal for residential and small commercial sites, within parking lots, and along roadways. They can help fulfill landscaping requirements.

Rain gardens may take a variety of shapes to fit the site layout. Rain gardens may be round, linear, or irregular shape and can have multiple distinct depressions, called cells, which can be linked hydraulically via overflow structures or berms.

Site Requirements

- Pretreatment is not required.
- An infiltration test shall be conducted at the location and depth of the facility.
- Rain gardens shall have a minimum separation of 3 feet from the bottom of the facility to the seasonal high groundwater elevation or other layer that limits infiltration (e.g., bedrock, clay lens).
- If infiltration is used as a design component to determine retention, then the maximum draw down time is 24 hours.
- The native soil infiltration rate shall be at least 0.25 in/hr for an infiltration rain garden. If the infiltration rate is less than 0.25 in/hr, an underdrain is required. For native soil infiltration rates between 0.25 and 2.0 in/hr, the engineer shall determine the need for an underdrain based on design performance calculations.
- Water quality raingardens shall not be located downstream of detention.

Dimensions

- Minimum drain rock depth is 18 inches.
- Minimum bottom width: 2.0 feet
- Planted side slopes: no steeper than three horizontal to one vertical (3H:1V). Rock or concrete walls may be used for areas that require steeper side slopes.
- Minimum orifice size: filtration facilities 0.5 inches, all other 1.0 inch.
- Minimum freeboard: 2.0 inches, if contributing area is less than 5,000 SF; 6.0 inches for larger contributing areas.
- Maximum ponding depth: 12.0 inches.
- Depth of biofiltration mix: 18 inches minimum.

Materials

- When required, waterproof liners shall be 30 mil PVC membrane or equivalent.
- Drain rock is required below the biofiltration soil mix. For infiltration rain gardens, use 0.75 inch to 1.5 inches of washed drain rock. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.
- When used, underdrains shall be a minimum of 4 inches diameter for private facilities and a minimum of 6 inches for public facilities. Underdrains shall be slotted or perforated PVC that conforms to ASTM D 3034, with a pipe stiffness of 46 psi or a minimum SDR of 35 or approved equal. Installation and testing requirements shall conform to the current UPC and ODOT Standard Specification 02415.50 for PVC pipe. Slotted perforations (0.064-inch-wide x 1.00-inch-long, spaced 0.3 inch on center) are preferred and less susceptible to clogging.
- Drain rock and biofiltration soil mix shall be separated by a 2- to 3-inch choker course layer. Choker course shall conform to ODOT Standard Specifications 00430.11.
- Biofiltration soil mix must support long-term plant and soil health and provide treatment for water as it moves through the soil column. See **Appendix G** for soil mix requirements.
- Plant selection shall follow the Planting Guide in **Appendix F**. Plant selection shall be based on water level tolerances during the rainy season, as well as ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the proposed rain garden. Rain gardens shall be designed so that they do not require mowing.

4.5.3 Vegetated Swale

Vegetated swales are gently sloping, landscaped depressions that collect, convey, and treat stormwater runoff with a combination of vegetation and a biofiltration soil medium. Swales may also be used for flow control when designed with infiltration or with an underdrain with controlled outlet. Vegetated swales are designed much like rain gardens, but with a sloping bottom.

Vegetated swales reduce stormwater flow rates, volume, and temperature and improve water quality. Pollutants are removed as runoff passes through the vegetation and soil media and is collected in an underlying layer of gravel or drain rock. Swales are ideal for residential and small commercial sites, within parking lots, and along roadways. They can help fulfill landscaping requirements.

Site Requirements

- Pretreatment is not required.
- An infiltration test shall be conducted at the location and depth of the facility.
- Stormwater Management Facilities shall have a minimum separation of 3 feet from the bottom of the facility to the seasonal high groundwater elevation or other layer that limits infiltration (e.g., bedrock, clay lens).
- If infiltration is used as a design component to determine retention, then the maximum draw down time is 24 hours.
- The native soil infiltration rate shall be at least 0.25 in/hr for an infiltration swale. If the infiltration rate is less than 0.25 in/hr, an underdrain is required. For native soil infiltration rates between 0.25 and 2.0 in/hr, the engineer shall determine the need for an underdrain based on design performance calculations.
- Water quality swales shall not be located downstream of detention.

Dimensions

- Longitudinal Slope: range is from 0.5 to 6 percent (for steeper sites, use check dams or similar features to slow flow velocity and create step pools to promote infiltration.) See also Section 5.4 and Typical Facility Drawings and associated notes in **Appendix D**.
- Minimum drain rock depth is 18 inches.
- Minimum bottom width: 2.0 feet.
- Planted side slopes: no steeper than three horizontal to one vertical (3H:1V). Rock or concrete walls may be used for areas that require steeper side slopes.
- Minimum orifice size: 0.5 inches.
- Minimum freeboard: 2.0 inches, if contributing area is less than 3,000 SF; 6.0 inches for larger contributing areas.
- Maximum ponding depth: 12.0 inches.
- Depth of biofiltration mix: 18 inches minimum.

Materials

- When required, waterproof liners shall be 30 mil PVC membrane or equivalent.
- Drain rock is required below the biofiltration soil mix. For infiltration swales, use 0.75 inch to 1.5 inches of washed drain rock. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.
- When used, underdrains shall be a minimum of 4 inches diameter for private facilities and a minimum of 6 inches for public facilities. Underdrains shall be slotted or perforated PVC that conforms to ASTM D 3034, with a pipe stiffness of 46 psi or a minimum SDR of 35 or approved equal. Installation and testing requirements shall conform to the current UPC and ODOT Standard Specification 02415.50 for PVC pipe. Slotted perforations (0.064-inch-wide x 1.00-inch-long, spaced 0.3 inch on center) are preferred and less susceptible to clogging.
- Drain rock and biofiltration soil mix shall be separated by a 2-inch to 3-inch choker course layer. Choker course shall conform to ODOT Standard Specifications 00430.11.
- Biofiltration soil mix must support long-term plant and soil health and provide treatment for water as it moves through the soil column. See **Appendix G** for soil mix requirements.
- Plant selection shall follow the Planting Guide in **Appendix F**. Plant selection shall be based on water level tolerances during the rainy season, as well as ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the proposed swale. Swales shall be designed so that they do not require mowing.

4.5.4 Filter Strip

Filter strips are gently sloped areas intended to remove pollutants using sheet flow that runs off adjacent impervious surfaces. Filter strips are vegetated with grasses and densely spaced groundcovers that filter pollutants and reduce the velocity of stormwater.

Filter strips are a good choice for use adjacent to uncurbed roads where a gravel shoulder or shallow gravel strip helps to uniformly distribute flow. They can also be good choices for small projects; for example, to provide water quality treatment for roof or driveway runoff before it is discharged into a drywell, infiltration trench, or other facility.

Site Requirements

- Pretreatment not required.
- Filter strips are appropriate for all soil types.
- Flow shall be distributed evenly along the length of the strip. This may require additional structures or design features to fully spread point discharges along the length of the strip.
- Filter strips shall be a minimum of 50 feet from wetlands, rivers, streams, and creeks.
- The maximum flow path distance of the contributing impervious surface shall be 100 feet to prevent concentrated flow.

Dimensions

- Slope (measured in the direction of flow): 0.5 to 10 percent
- Minimum width: 5 feet, measured in the direction of flow
- Maximum slope of contributing impervious area (measured in the direction of flow): 6 percent. Steeper slopes may be allowed with an appropriate energy dissipation structure between the impervious area and filter strip.
- Maximum design flow depth: 1.0 inch for water quality flow.
- Maximum design velocity: 0.5 feet per second for water quality flow.
- The filter strip width and slope shall be determined through iterative calculations, using the following two equations:

$$y = \left(\frac{Q_{design} * n}{1.49 * T * \sqrt{S}}\right)^{0.6} \quad \text{and} \quad V = \frac{Q}{T * y}$$

where:

Q = water quality flow rate, cubic feet per second
T = filter strip width (measured in the direction of flow), feet
S = filter strip slope (measured in the direction of flow), feet per feet
y = flow depth, feet (maximum 0.083)
n = Manning's roughness coefficient, unitless
V = flow velocity, feet per second (maximum 0.5)

Materials

- Plant selection shall follow the Planting Guide in **Appendix F**. Establish dense plant growth of groundcovers, herbaceous plants, and shrubs, with a goal of 95 percent coverage. Filter strips often experience moist soil conditions during the wet, rainy season and dry soil conditions during warm summers. Plant selection should respond to specific site conditions for each facility.

4.5.5 Drywell

A drywell is an underground perforated pipe or chamber that collects stormwater runoff and gradually discharges it into underlying soils.

Drywells are “Class V Injection Wells” under the federal Underground Injection Control Program (OAR Division 44). UICs are either classified as exempt (no registration required), authorized by rule, or authorized by permit. Designers are urged to review current regulations and UIC registration materials from ODEQ.

Drywells do not provide water quality treatment, so water quality treatment is required before stormwater discharges into drywells. Drywells utilized exclusively to infiltrate the roof runoff from one single-family residential roof are exempt, and a silt trap is the only pretreatment necessary. An approved water quality pretreatment device is required for multiple single-family residential roofs to discharge into a common drywell. Where space is available, rain gardens are preferred to manage residential runoff because they provide both treatment and flow control (and are not regulated UICs). The intent of this section is to support compliance with the water quality treatment requirements as specified by the State of Oregon UIC regulations.

Site Requirements

- Native soil design infiltration rate shall be at least 2.0 in/hr. Apply a factor of 2 to the tested infiltration rate to determine the design rate.
- Bottom of drywells and other types of stormwater injection devices shall be at least 3 feet above seasonal high groundwater or impermeable layer.
- The edge of excavation for the drywell shall be at least 10 feet from building foundations, unless otherwise specified by the local building code division.
- Drywells are not allowed on slopes of 15 percent or more.
- Drywells are not allowed in areas with existing soil or groundwater contamination
- Drywells may be allowed to be located under the travel surface within the public ROW. The minimum setback from the edge of the travel lane is 5 feet. Check with the local roadway authority,
- Soil surrounding the drain rock, surrounding the drywells shall be native, uncompacted soil.
- Drywells are not allowed within 500 feet of drinking water or irrigation wells or within the 2-year time of travel setback to drinking water or irrigation wells.
- Infiltration rates shall be tested after construction and testing shall be overseen by the engineer to confirm that the dry well provides adequate infiltration capacity for the relevant design storm.
- A water quality pretreatment device is required, unless the drywell is receiving runoff from only one single-family residential roof,
- The following facilities are approved for pretreatment:
  - Facilities identified for water quality treatment in **Appendix C**.
  - Catch basins with a 36-inch sump and trapped outlet (snout).
- If the facility is designed to infiltrate the 100-year storm event, then an emergency safe overflow pathway is not required.

Dimensions

- Private: Diameter: 2 feet minimum
- Publicly Maintained: 4 feet minimum
- The required storage capacity within the drywell structure and surrounding drain rock is determined by subtracting the volume of water that can infiltrate out of the facility within a 24-hour period from the runoff volume generated by the contributing drainage area during a 25-year, 24-hour storm event.

Materials

- Place 12-inch minimum layer of 1.50-inch to 0.75-inch round rock that conforms to ODOT Standard Specifications 00430.11 or AASHTO No. 4 between drywell structure and earth wall. The drain rock should extend from one foot below the drywell structure up to the lid.

4.5.6 Infiltration Trench or Gallery

An infiltration trench is a linear, gravel-filled trench that distributes stormwater to underlying soils. An infiltration gallery includes underground chambers to increase subsurface storage.

Infiltration trenches that receive only surface runoff (no underdrains or subsurface pipe) are not classified as UICs. Infiltration trenches with underdrains and infiltration galleries are "Class V Injection Wells" under the federal UIC program (OAR Division 44). UICs are classified either as: exempt (no registration required), authorized by rule, or authorized by permit. Infiltration trenches and galleries do not provide water quality treatment, so water quality treatment is required before stormwater discharges into the facility.

Water quality treatment is required before stormwater discharges into infiltration galleries, though galleries used exclusively for single-family residential roof runoff are exempt and a silt trap is the only pretreatment necessary. Where space is available, rain gardens are preferred to manage residential runoff because they provide both treatment and flow control (and are not considered UICs).

An infiltration test shall be conducted at the location and depth of the facility. Designers are encouraged to review current regulations and UIC registration materials from ODEQ.

Site Requirements

- Trenches or galleries are not approved for slopes greater than 15 percent, unless approved by a geotechnical engineer.
- Trenches or galleries within 200 feet of a steep slope or a mapped landslide hazard area require the review and approval of a geotechnical engineer.
- Infiltration trenches or galleries are not allowed in the public ROW.
- Trenches shall not be located where they will be subject to vehicular traffic.
- Soil surrounding trenches or galleries shall be native, uncompacted soil.
- Bottom of trench or gallery shall be at least 3 feet above seasonal high groundwater elevation.
- Native soil design infiltration testing rate shall be at least 1.00 in/hr which includes the applicable safety factor of two, therefore the minimum infiltration design rate is 0.50 in/hr.
- Trenches or galleries are not allowed within 500 feet of drinking water or irrigation wells or within the 2-year time of travel setback to drinking water or irrigation wells.
- Infiltration trenches or galleries shall be located outside of tree protection zones or at least 10 feet from the base of newly planted trees and large shrubs.
- Water quality treatment is required unless the infiltration trench or gallery is receiving only single-family residential roof runoff, then an approved pretreatment device will suffice. The following facilities are approved for pretreatment:
  - Facilities identified for water quality treatment in **Appendix C**.
  - Private catch basins with a 36-inch sump and trapped outlet (snout).

Dimensions

- The required storage capacity within the structural chambers and surrounding drain rock is determined by subtracting the volume of water that can infiltrate out of the facility within a 24-hour period from the runoff volume generated by the contributing drainage area during a 25-year, 24-hour storm event.
- The maximum draw down time is 24 hours.
- Minimum infiltration trench dimensions shall be 12 inches deep and 2 feet wide, filled with drain rock.
- An observation well is required for all infiltration galleries and for infiltration trenches that exceed 50 feet in length.

Materials

- Drain rock shall be 0.75 inch to 1.50 inch of granular drain backfill material. Drain rock shall conform to ODOT Standard Specifications 00430.11 or AASHTO No. 4.
- If applicable, the distribution pipe in an infiltration trench shall be perforated, 6-inch-diameter PVC pipe that conforms to ODOT Standard Specification 02410.70. The invert elevation shall be at least 12 inches below finished grade.

4.5.7 Constructed Wetland

Constructed wetlands are stormwater management facilities that are designed to emulate natural wetlands, with shallow water that varies in depth, and varied side slopes. They are saturated or have standing water for part of the year, rather than draining over a short period of time as rain gardens are designed to do. Wetlands are inundated or saturated at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation.

Constructed wetlands present an opportunity to integrate wildlife habitat and a public amenity into the landscape of a large residential, institutional, or commercial development. Constructed wetlands with healthy, thriving plants provide excellent water quality treatment. They require a large surface area and a large contributing area to ensure that wetland conditions are maintained.

Site Requirements

- Site shall have adequate space for maintenance access that allows equipment access within 20 feet of the flow control, water quality devices and other structures as specified by the District.
- Constructed wetlands are best for Type C and D soils or in areas with a high groundwater table. Soils shall be saturated for a long enough time to maintain wetland vegetation. The soil profile should be investigated to determine whether appropriate site soils exist and if any soil amendments need to be added to assist with initial plant establishment.
- Waterproof liners may be used to maintain saturated conditions.
- Constructed wetlands may be irregularly shaped, with a sinuous flow path and a variety of side slopes and benches incorporated to maximize plant establishment and diversity.
- Vector (mosquito) control is an important design consideration for any facility that has standing water for extended periods of time. Bat boxes, diverse planting, and other design strategies to encourage biological controls can help to keep mosquito populations in balance.

Dimensions

- Constructed wetlands can be sized for water quality treatment or a combination of treatment and flow control, similar to ponds. However, constructed wetlands will have a larger surface area, varied side slopes, and shallower ponding areas to maximize water quality treatment.
- Two cells are required, with the first cell, the sediment forebay, containing 10 percent of the design volume, unless pretreatment is provided in a different facility. A sediment forebay provides a clear visual indicator of when maintenance is needed.
- Water depth in a constructed wetland may vary in the different cells. Determine the average, maximum, and minimum depths for permanent pool in each cell of the wetland.
- Design varied side slopes, water depths, and planting zones to provide a variety of habitat and maximize treatment.
- Bottom width: minimum 3.0 feet
- Maximum ponding depth: 4.0 feet

- Average ponding depth: ≤ 2.5 feet
- Side slopes: no greater than 5 horizontal: 1 vertical below maximum ponding depth
- Side slopes: no greater than 3 horizontal: 1 vertical above maximum ponding depth

Materials

- When required, waterproof liners shall be 30 mil PVC membrane or equivalent.
- Investigate the soil profile and determine whether appropriate site soils exist and if any soil amendments need to be added.
- Plant selection shall follow the Planting Guide in **Appendix F**. Plant selection shall be based on water level tolerances during the rainy season, as well as the ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in each of the proposed wetland cells.
- Woody vegetation shall be used to provide shade over standing water and to provide structural diversity within the constructed wetland. Shrubs and trees shall be sited to promote long-term health and survival, minimize maintenance, and protect lines of sight. Shrubs and trees shall be located to allow for maintenance access to the treatment area.
- Woody vegetation shall not be planted within 20 feet of inlet and outlet structures.

Overflow Spillway

- All constructed wetlands shall have an emergency overflow spillway or other overland flow location that will safely pass runoff from the 100-year storm event over the embankment in the event of control structure failure or for storm events that exceed the design of the control structure.
- Locate the spillway to direct overflows safely toward the 100-year emergency safe overflow pathway.
- Protect the spillway with riprap or an approved material that extends to and is an appropriate distance beyond the bottom of the berm embankment. Fill the voids of the riprap with soil and vegetate the spillway with grass or ground cover. The selection of the vegetation on the spillway shall consider the required design capacity.
- The invert elevation of the spillway shall be a minimum of 6 inches above the 10-year water surface elevation.
- Provide a minimum of 12 inches of freeboard through the spillway between the 100-year water surface elevation and the top of the berm.
- Alternate methods to accomplish the design intent of the emergency spillway will be acceptable, as long as they accomplish the same level of protection.

4.5.8 Pond

Stormwater ponds can provide water quality treatment, infiltration, and flow control to mitigate post-construction stormwater runoff. Ponds are a good choice where there is a large contributing area draining to a single facility, where there is adequate space to design a pond that can be integrated into the landscaping, and where it is accessible for maintenance. Stormwater ponds can be used to meet both water quality treatment and flow control performance standards. When site conditions allow, ponds should be designed as infiltration facilities or with an infiltration component in addition to a detention component to meet the flow control performance standard. An infiltration test shall be conducted at the location and depth of the facility.

The stormwater report and engineered drainage plans, in addition to documentation of existing and proposed conditions, shall include, at a minimum, the flow control structure rim elevation, the pond grading plan, the outlet pipe invert elevation, the elevation of the top of the berm, the elevation of the top of the overflow structure, all pipe diameters, and any deviation in shear gate/lift assembly from the District's Standard Details.

Site Requirements

- Pond type selection shall be appropriate for soil characteristics (e.g., if soils have adequate infiltration capacity, design an infiltration pond rather than a facility with a controlled downstream outlet)
- The minimum setback of a pond from the edge of the top of bank, wall, or toe of an embankment to the nearest property line must be horizontal for a minimum of 5-feet, or greater if recommended by a civil or geotechnical engineer.
- ~~Edge of water surface shall be at least 20 feet from property lines and structures.~~
- A geotechnical report is required to determine setbacks of ponds near slopes ≥15 percent or within 200 feet of a steep slope hazard area or landslide hazard area.~~Edge of water surface shall be at least 200 feet from tops of slopes greater than 15 percent~~
- Vector (mosquito) control is an important design consideration for any facility that has standing water for extended periods of time. Bat boxes, diverse planting, and other design strategies to encourage biological controls can help to keep mosquito populations in balance.

Dimensions

- May include two cells, with the first cell (forebay) containing approximately 10 percent of the design surface area. Forebays simplify maintenance and are strongly encouraged. Maintenance access shall be provided to the forebay.
- Maximum side slopes: 3H:1V
- Length to width ratio: ≥ 3:1

Materials

- When required, waterproof liners shall be 30 mil PVC membrane or equivalent.
- Soil amendments shall meet the requirements of **Appendix G**.
- Plant selection shall follow the Planting Guide in **Appendix F**. Plant selection shall be based on water level tolerances during the rainy season, as well as the

ability of plants to withstand dry summer conditions. Species should be selected that are suitable for the hydrologic, light, and soil conditions in the pond.

- Woody vegetation shall be used to provide shade over standing water and to provide structural diversity within the pond. Shrubs and trees shall be sited to promote long-term health and survival, minimize maintenance, and protect lines of sight. Shrubs and trees shall be located to allow for maintenance access to the treatment area.
- Woody vegetation shall not be planted within 20 feet of inlet and outlet structures.

Outlet Structures

- Flow Control Structure: Flow control structures for ponds shall be located in an enclosed manhole, outside the open water storage area, in a location that allows equipment maintenance access and access during high flow events. Access to a flow control structure, not located in a public roadway, shall be provided within 12 feet of the edge of a vehicular access, measured from center of flow control structure, when designed to be accessed perpendicularly by the maintenance vehicle and within 6 feet when designed to be accessed from the front of the maintenance vehicle. The flow control structure may be farther from the edge of the roadway if a public access road is provided that allows for maintenance trucks to get within the appropriate distances.
- Secondary Outlet. Detention ponds shall have a secondary pond outlet structure, such as a catch basin with grated lid located along an interior side slope. This secondary pond outlet will serve as a backup to convey stormwater to the flow control manhole should the primary pond outlet become clogged. The lip elevation of the secondary pond outlet should be set at approximately the 10-year design water surface. See **Appendix D** for a graphical depiction showing a secondary pond outlet.
- Flow control manholes shall comply with District Standard drawings SWM FC 1.0 through 6.0.
- Orifices less than 2.0 inches shall be made of material (e.g., stainless steel, high-density polyethylene pipe [HDPE], or PVC) shall be used to make the orifice plate. The plate shall be attached to the concrete or structure.

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Overflow Spillway

In addition to primary and secondary outlets, ponds shall have an emergency overflow spillway that will safely pass runoff from a post-developed 100-year design storm to the downstream emergency safe overflow pathway. The design intent is to protect the integrity of the pond, as well as associated embankments and downstream properties, during large storm events and/or failure of the flow control structure. Secondary spillway shall meet the following criteria:

- Locate the spillway to direct overflows safely toward the 100-year overflow pathway.
- Locate the spillway in existing soil wherever possible. Protect the spillway with riprap or an approved material that extends to, and is an appropriate distance beyond, the bottom of a berm embankment.
- The invert elevation of the spillway shall be a minimum of 6 inches above the 25-year water surface elevation.

- Provide a minimum of 12 inches of freeboard through the spillway between the 100-year water surface elevation and the top of the berm.

Alternate methods to accomplish the design intent of the emergency spillway will be acceptable, as long as they accomplish the same level of protection.

Pond Interior Maintenance Access

- Design ponds with access suitable for maintenance equipment (backhoe, etc.) to safely access the bottom of the interior of the pond. The purpose of this requirement is to provide an access suitable for sediment removal by District equipment.
- The interior pond access will begin at the edge of the required pavement and end at the lowest elevation of the pond. The minimum access requirement is at least 15-feet wide with slopes no steeper than 4:1.
- The pond interior access shall be constructed of 8 inches of gravel, pervious pavers, or native vegetation (no trees or shrubs). The access can be constructed of compacted native material suitable for the intended seasonal use. Other materials will be reviewed and approved on a case-by-case basis.

4.5.9 Structural Detention

Structural detention facilities include underground tanks and vaults that temporarily store water must be designed in accordance with the custom pond sizing feature that is part of the BMP Sizing Tool program~~before releasing it~~. Structural detention facilities are appropriate for commercial sites, industrial locations, and multi-family sites. They can be designed to reduce the runoff rate and duration of flow to meet the flow control performance standards. Structural detention facilities alone do not provide water quality treatment, so a separate water quality treatment facility is necessary to meet the water quality performance standards.

Detention pipes and vaults are not allowed for use on developments that convey public waters, such as stormwater runoff from public roadways. Structural detention design shall demonstrate that the facilities have adequate maintenance access of 20 feet to the flow control and water quality structures, can withstand vehicular and other structural loadings, will be stable, have been designed to counteract buoyancy forces in areas of high groundwater, and that the materials can withstand chemical properties of soils on the site.

The stormwater report and design drawings, in addition to documentation of existing and proposed conditions, shall include, at a minimum, the flow control structure rim elevation, the storage pipe invert elevation, the outlet pipe invert elevation, the elevation of the top of the storage pipe, the elevation of the top of the overflow pipe, all pipe diameters, and any deviation in shear gate/lift assembly from the District's Standard Details.

Site Requirements

- Structural detention facilities shall be located to avoid conflicts with other underground utilities.
- Regular maintenance is essential to ensure continued function of underground detention facilities. Maintenance access shall be provided to allow sediment removal from the length of the facility and to maintain the outlet control structure. Facility location shall be chosen to maximize access for maintenance and replacement.
- Pipes and vaults shall be placed on stable, consolidated native soil with suitable bedding. Pipes and vaults are not allowed in fill slopes unless a geotechnical analysis is performed for stability and construction practices.

Dimensions

- Detention Pipe:
  - Minimum diameter: 36.0 inches
  - Pipe bottom shall be flat or gently sloped: ≤ 0.5 percent
  - Maximum distance between pipe bottom and finish grade: 20.0 feet
  - Sediment storage depth in upstream standard manhole: 6.0 inches minimum
  - Minimum freeboard: 6.0 inches, measured from the maximum design water surface elevation and the overflow elevation in the control structure.
- Detention Vault

  - Vault bottom shall be flat or gently sloped to the center, forming a "V": ≤0.5 percent
  - Minimum sediment storage depth: 6.0 inches
  - Minimum freeboard: 6.0 inches, measured from the maximum design water surface elevation and the overflow elevation in the control structure.
- Private facilities may use a 1.0-inch-diameter orifice if the structural detention facility is preceded by an approved water quality filtration device.

Materials

- **Private Maintained Detention Pipe**: Stormwater detention/conveyance pipes that are located solely on private property shall be constructed of a material in accordance with Oregon Plumbing Specialty Code (OPSC). A plumbing permit to construct the pipe shall be obtained by the local plumbing authority, and the project engineer shall certify the infrastructure was constructed in accordance with the approved plans. Galvanized metals leach zinc into the environment, especially in standing water situations. This can result in zinc concentrations that can be toxic to aquatic life. Therefore, galvanized materials shall not be used in stormwater facilities and storm drainage systems.
- **Publicly Maintained Detention Pipe**: For publicly maintained facilities, the detention pipe material shall be concrete. The joints shall conform to technical and manufacturer's specifications.
- Detention vaults shall be constructed of structural reinforced concrete (3,000 psi, ASTM 405). All construction joints shall be provided with water stops.
- A flow control manhole shall be provided to regulate outflow from the structural detention facility. Flow control manholes shall comply with District Standard drawings SWM FC 1.0 through 6.0.
- Orifices structure material shall be HDPE or PVC. A thin material (e.g., stainless steel, HDPE, or PVC) shall be used to make the orifice plate. The plate shall be attached to the structure.

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Access

- Detention pipes more than 50 feet long shall provide an access riser at each end for maintenance. Detention pipes over 200 feet long shall have an access riser at the upstream end and access risers at least every 100 feet.
- Access for detention vaults may be provided by use of removable panels, hatches, or ring and cover.
- 36-inch minimum diameter corrugated metal riser-type manholes of the same gauge as the detention pipe material may be used for access along the length of the detention pipe and at the upstream terminus of the detention pipe. The top slab is separated (1-inch minimum gap) from the top of the riser to allow for deflections from vehicle loadings without damaging the riser pipe.
- All detention pipe, vault access and control structure openings shall be readily accessible by maintenance vehicles.
- Detention pipes and vaults shall comply with the OSHA and Oregon OSHA confined space requirements, which include, but are not limited to, the preparation of ventilation plans and clearly marked entrances to confined space areas.

- Internal structural walls of large vaults shall be provided with openings sufficient for maintenance access between cells. The openings shall be sized and situated to allow access to the maintenance “V” in the vault floor.
- For detention vaults, the recommended minimum internal height is 7 feet from the highest point of the vault floor (not sump), and the recommended minimum width is 4 feet. However, concrete vaults may be a minimum 3 feet in height and width if there are access manholes at each end, and if the width is no greater than the height. Minimum internal height requirements do not apply for any areas covered by removable panels.

4.5.10 Proprietary Stormwater Treatment Devices

Proprietary Stormwater Treatment Devices are manufactured technologies used to address the stormwater quality impacts of land development, including removing pollutants through physical, chemical, or biological treatment processes. These stormwater systems rely upon a variety of mechanisms to remove pollutants.

Proprietary Stormwater Treatment Devices include hydrodynamic separators, cartridge filters, and other emerging treatment technologies that are designed to remove pollutants from stormwater. Proprietary devices are generally grouped by their use for pretreatment, oil removal, enhanced treatment, basic treatment, phosphorus removal and construction pollutant management. There are numerous manufacturers that build proprietary devices.

Stormwater treatment technologies are reviewed and certified by several agencies. The District follows the Technology Assessment Protocol - Ecology — better known as the TAPE program – administered by the Washington State Department of Ecology (Ecology). The District allows the use of proprietary stormwater treatment devices that have the General Use Level Designation (GULD) for basic, dissolved metals, or phosphorus treatment as water quality treatment facilities. Pilot Use Level Designation or Conditional Use Level Designation are not permitted. The District may require pretreatment facilities to improve the performance of proprietary stormwater treatment devices.

The proprietary stormwater treatment devices that have been tested and approved under Ecology's TAPE program are regularly updated on the TAPE program website.

Site Requirements

- Proprietary stormwater treatment devices for water quality treatment shall not be located downstream of flow control facilities.
- Proprietary stormwater treatment devices may be located on a range of site conditions. Site requirements vary by type of system. Review the manufacturer's restrictions and recommendations when selecting an appropriate treatment device and configuration for the development and site conditions.
- Proprietary stormwater treatment devices shall be a minimum of 5 feet from structures.
- Proprietary stormwater treatment devices that are publicly maintained, and require staff to enter, shall provide a minimum of 78-inches of head room.
- The device shall be designed to safely convey the storm event as specified in Section 5, and if applicable provide an emergency safe overflow pathway.
- Devices shall be readily accessible by maintenance vehicles and in accordance with manufacturer recommendations at a minimum distance of 20 feet.

Dimensions

- Proprietary stormwater treatment devices may be configured as inline systems or offline systems with high flow bypasses, in accordance with manufacturer specifications.
- To meet water quality standards, the proposed proprietary stormwater treatment device must have the Ecology approval under the GULD for basic, dissolved metals, or phosphorus treatment as water quality treatment facilities. Pilot Use

Level Designation or Conditional Use Level Designation are not approved to meet water quality treatment standards.

- Proprietary stormwater treatment devices shall be designed to treat the peak flow or total volume from the water quality storm event, as defined in Section 4.2.2.
- Calculations to determine the required size, number, or configuration of the proprietary stormwater treatment device must be based on the design guidelines specified in the GULD approval documents from Ecology. When sizing proprietary stormwater treatment devices for water quality treatment, applicants shall use the treatment flow rates identified in the TAPE approval documents.

4.5.11 Sheet Flow Dispersion

Sheet flow dispersion is one of the simplest methods of stormwater management. Sheet flow dispersion is the dispersion of concentrated flows from driveways, roadways, or other impervious surfaces through a vegetated pervious area. Because flows are already dispersed as they leave the surface (i.e., not concentrated), they need only traverse a narrow band of adjacent vegetation for effective flow attenuation and treatment.

Sheet flow dispersion is applicable for impervious surfaces with slopes less than 15 percent, such as driveways, sport courts, patios, roofs without gutters, recreational vehicle pads, or other situations where concentration of flows can be avoided.

Sheet flow dispersion is a preferred stormwater management strategy for impervious surfaces in rural areas, driveways, and agricultural buildings. The discharge shall not be directly connected to a Drainageway, Storm Drainage System, or other Public Storm System.

Site Requirements

- Dispersion is not permitted within potential landslide areas. The District may require a geotechnical report to verify the site soils are suitable for sheet flow dispersion.
- Dispersion is not permitted within 10 feet of the top of a slope greater than 25 percent.
- Dispersion is not permitted over contaminated sites or abandoned landfills.
- For sites with septic systems, the discharge point shall be downgradient of the drain field primary and reserve areas. This requirement may be waived if site topography clearly prohibits flows from intersecting the drain field.
- Area receiving flow shall be protected from compaction during construction, or substantial soil amendment may be required prior to final site stabilization.
- No erosion or flooding of downstream properties may result.

Dimensions

- A 2-foot-wide transition zone to discourage channeling shall be provided between the edge of the contributing impervious area and the downslope vegetation. This may be an extension of subgrade material (crushed rock), modular pavement, drain rock, or other material approved by the District. The transition zone may be narrowed for sidewalks and pathways, if approved by the District.
- A 10-foot wide vegetated buffer shall be provided for up to 20 feet of width of contributing impervious surface. An additional 5 feet of buffer width shall be added for each additional 20 feet of width of contributing area or fraction thereof.
- The flow path shall be covered with well-established lawn or landscape area (landscaping with well-established groundcover, or native vegetation with natural groundcover). The groundcover shall be dense enough to help disperse and infiltrate flows and to prevent erosion.

4.5.12 Pervious Pavement

Pervious pavement is a walking or driving surface designed to allow rainfall to percolate into the underlying soil or aggregate storage reservoir beneath the pavement. The wearing course (surface layer) of pervious pavement may be any of the following:

- **Porous asphalt** is open-graded asphalt that allows water to percolate or infiltrate into underlying soils.
- **Pervious concrete** omits fines in the aggregate to create stable air pockets that allow water to drain to the base below. There is an inverse relationship between porosity and strength. As porosity is increased, the structural strength is reduced.
- **Pavers** are generally suitable for pedestrian areas and low traffic parking areas. They are available in a variety of configurations such as rigid concrete or durable plastic grid filled with gravel or a mixture of gravel, sand, and topsoil suitable for vegetation.

Pervious pavement shall be designed only as an impervious area reduction technique to manage direct rainfall. It shall not be designed as a SMF that receives runoff from surrounding areas.

Site Requirements

- Surface slope no greater than 6 percent.
- Site does not receive high sediment loads. Areas with high volumes of leaf litter can cause clogging, so avoid pervious pavement under large trees.
- Adequate separation from underlying seasonal high groundwater table; bedrock or other impermeable layer shall be at least 3 feet below the bottom of the pervious pavement facility.
- Pervious pavement is not appropriate for areas at elevated risk of hazardous materials spills such as gas stations.
- Minimum infiltration rate of 0.25 in/hr.
- Not appropriate for construction over fill soils unless evaluated and approved by geotechnical engineer.
- No stormwater run-on allowed.
- Pavement design shall demonstrate that pavement structure has the structural strength for anticipated vehicle loadings.

Dimensions

- Pervious pavements designed with 6 inches of aggregate storage and a minimum design infiltration rate of 0.25 in/hr are assumed to meet the performance standard to fully infiltrate the 10-year, 24-hour design storm.
- Pervious concrete wearing course: 4-inch thickness for residential driveway, pedestrian only, private street, parking lot or fire lane; 7-inch thickness for public street. Public streets shall be designed in conformance with the local roadway authority.
- Porous asphalt wearing course: 2.5-inch thickness for residential driveway or pedestrian paths; 3 inches for private street, parking lot, or fire lane; 6 inches for public street. Public streets shall be designed in conformance with the local roadway authority.

- Pavers shall be designed according to manufacturer recommendations. State size of stone to be used between pavers—sand is not allowed if pavers are used for stormwater treatment or flow control.
- Where pervious pavement installations are proposed over fine sediments, provide a 1- to 3-inch-thick leveling course if the pervious pavement surface is open-celled paving grids, interlocking concrete pavers, or porous asphalt concrete.
- Minimum depth for aggregate storage reservoir shall be 6 inches for vehicular loading. In addition to structural design considerations, design depth is typically determined by storage depth needed to manage design storm.
- Pervious pavements designed with 6 inches minimum of 3/4-inch to 2-inch crushed/washed open graded base material and a minimum design infiltration rate of 0.25 in/hr are assumed to meet the performance standard to fully infiltrate the 10-year, 24-hour design storm.

Materials

- Leveling course: The leveling course shall consist of uniformly graded, washed aggregate that conforms to AASHTO No. 8 gradation.
- Aggregate storage reservoir: The aggregate storage reservoir shall conform to ODOT Standard Specifications 00430.11 granular drain backfill material, AASHTO No. 57, or approved equal.
- Porous asphalt: The surface wearing course for porous asphalt shall conform to open-graded, ½-inch or ¾-inch asphalt concrete pavement design from ODOT Standard Specification 00745 or approved equal.
- Content: 6.0 to 6.5 percent by weight of total (dry aggregate) mix. Performance Grade: 70-22. Do not use an asphalt cement performance grade less than 70-22 for open-graded, porous asphalt mixes.

4.5.13 Green Roofs

A green roof is a building roof that is partially or completely covered with vegetation and growing media, atop a waterproof membrane; a green roof is also called an eco-roof or vegetated roof. Green roofs include the following elements: a thin, layered system of waterproofing, drainage layers, growing media, and planting to cover impervious roof areas and allow water to be absorbed, detained, and evaporated back into the atmosphere. Proprietary systems are also available using various layers or even modular trays that fit easily on an existing roof.

Green roofs are primarily designed for stormwater management, with aesthetics as a secondary goal. Green roofs are not designed for foot traffic or recreation.

Site Requirements

Flat or slightly sloped roofs on large institutional, commercial, or residential projects. Green roofs work on sloped roofs up to a maximum of 4:12 roof pitch without additional engineering–and can be steeper with intermediate structural support of soils.

Structural Considerations

- Shall be able to carry additional loads as determined by a structural engineer (15 to 30 pounds per square foot is typical) to support fully saturated conditions.
- These load recommendations do not include snow load.
- Access to roof via crane, lift or other device is recommended to load heavy, and bulky materials up to rooftop surface.
- Safety line tie-off points, hand holds, or walking surfaces may be necessary to facilitate maintenance.
- Green roofs shall include outlets to an approved location from roof drains, scuppers, and other drainage devices.

Dimensions

- Green roofs may be designed to meet flow control and water quality performance standards:

  The design Engineer is required to provide adequate documentation showing how the planned green roof meets District performance standards for flow control and water quality treatment Materials.

  - **Root barrier/protection layer**. A synthetic, non-biodegradable layer shall be placed to protect waterproofing layers and to provide additional protection from roots. Do not use copper or copper hydroxide for a root inhibitor.
  - **Drainage layer/filter fabric**. A synthetic or mineral layer shall be placed over the protection layer to allow for water movement under the growing media. The drainage layer shall be 1/2-inch-deep with a void space of at least 50 percent, covered by a non-woven (needle-punched) filter fabric to separate the drainage layer from the growing media.
  - **Growing media**. An engineered growing media mix shall be placed over the filter fabric to a depth of at least 4 inches to meet requirements. It shall contain no fines, weed seeds, or other materials. Provide documentation of saturated weight (field moisture capacity) that has been tested and documented by a third party. The media mix shall consist of 80 to 90 percent pumice or

lightweight aggregate and 10 to 20 percent composted, plant-based organic matter.

- **Mineral mulch**. A mulch layer of washed gravel or non-decomposable material (no fines) that will not be moved by wind or water movement shall be placed on top of the growing media.
- **Planting**. Establish dense plant growth of low-maintenance, low-water use succulent vegetation supplemented with some hardy perennials, grasses, and other native, non-woody vegetation. A minimum of 10 species shall be included to promote microclimatic diversity and resilience to the roof, allowing for species to fill in if others are slow to perform. Use 10 percent deciduous species distributed throughout the roof to provide organic matter inputs through leaf litter. Plant selection shall follow the Planting Guide in **Appendix F**.
- Proprietary systems may not match these dimensions or materials.

SECTION 5. STORM DRAINAGE SYSTEM DESIGN

Storm drainage system design is an integral component of site planning. Acceptable storm drainage system design must strive to maintain compatibility and minimize interference with existing drainage patterns; control onsite and downstream flooding of property, structures, and roadways for design flood events; and minimize the potential environmental impacts of stormwater runoff. Three considerations largely shape the design of these systems: public safety, flooding, and water quality. Stormwater collection systems must be designed to provide adequate surface drainage while at the same time meeting other stormwater management goals such as water quality treatment, stream channel protection, wildlife habitat protection, and groundwater recharge.

Some sites may require two separate storm drainage systems: the localized onsite system and the regional bypass system. The onsite system is generally designed to convey stormwater runoff from the developed areas of the site to the stormwater management facilities. The stormwater management facilities discharge to the bypass system, which conveys upstream stormwater runoff around or through the developed site and conveys the stormwater to the natural point of discharge downstream. This section includes requirements for storm drainage system design.

5.1 General Conditions

This section presents design requirements for open channel and closed conduit storm drainage systems. It also describes requirements and methods used to plan, design and size storm drainage systems. Storm drainage systems are generally made up of four components; stormwater runoff entering the site from upstream drainage areas; stormwater runoff conveyed through the site; the acceptable point of discharge from the site; and stormwater runoff discharged downstream from the site.

Storm drainage systems shall be designed to meet the requirements of Section 5, except when the drainage system is located entirely on a privately-owned parcel, is privately maintained, and receives no stormwater from outside the parcel's property limits. Those systems exempted from the storm drainage system requirements will remain subject to the requirements of the Oregon Plumbing Specialty Code (OPSC) and shall be reviewed by the building official.

The following are the District storm drainage system requirements. It is understood that these are general guidelines and that every site will encounter specific issues regarding the overall drainage system design.

- All public storm drainage systems shall be gravity systems without the use of pumps or other mechanical means to convey or transport stormwater.
- The applicant is required to provide an acceptable point of discharge from the developed site. Generally, the point of discharge shall be deemed acceptable by the District prior to approving the Service Provider Letter.
- A point of service for upstream parcels shall be provided to facilitate an orderly extension of the Public Stormwater System. This shall include the extension of Public Stormwater System in right-of-way or easements across the property to serve the upstream properties in a location as approved by the District. Development projects that construct Public Stormwater System, which can directly serve adjacent properties may

qualify for the establishment of a Reimbursement District as defined in Section 6.6 of the Rules and Regulations.~~Any development will be required to extend the storm drainage systems to allow all adjacent uphill parcels to be served by the storm drainage systems as the natural drainage patterns and future planning concerns dictate.~~

- The District's construction and design specifications for storm drainage systems, including acceptable materials, workmanship, fittings, and installation, are described in these Stormwater Standards. Except as otherwise provided in this or other issued policy documents, the Standard Details shall be followed for all aspects of conveyance design.
- Storm drainage systems shall be designed and constructed in compliance with requirements of all applicable federal, state, and local agencies. Written authorization of approval from other jurisdictions may be required at the discretion of the District.
- A stormwater bypass drainage system will be required to accept and convey upstream offsite stormwater runoff through the site. The bypass drainage system shall not be designed to collect the onsite stormwater runoff until onsite stormwater runoff has passed through stormwater management facilities for treatment and flow control.
- All open and piped conveyance systems that convey Public Waters shall be contained with a public drainage easement.
- Storm drainage systems shall be designed and constructed such that the cumulative incremental effects of such work considered alone or together with existing or similar projects in the vicinity will not result in damage to existing waterways and surface waters by erosion, siltation or sedimentation, significant adverse effects to water quality, increased downstream water velocity, significant harmful deterioration of groundwater drainage, or significant deterioration of aquatic wildlife habitat as determined by the District.
- Storm drainage systems shall be designed and constructed in accordance with floodplain management policies and regulations and other National Flood Insurance Program requirements and as determined by the District.
- The owner is responsible for controlling the flows from springs and groundwater that surface during construction and within the warranty period of the drainage system.
- Any proposed modification to the approved storm drainage system plans shall be submitted to the District for review and approval prior to construction.

5.2 Storm Drainage System Requirements

Planning for the storm drainage system is an essential element in preparing a site plan. Several factors must be considered prior to developing the preliminary design and requesting District approval of the Service Provider Letter.

Storm drainage systems are to be designed to intercept and convey stormwater runoff efficiently enough to meet flood protection criteria. The storm drainage system should complement the ability of the site design and structural stormwater controls to mitigate the major impacts of urban development.

Listed in the subsections of Section 5 are some of the key issues that must be considered in ensuring that the storm drainage system design is compatible with the existing natural site conditions. They include District criteria that must be incorporated into the overall Stormwater Report.

5.2.1 Points of Discharge

All storm drainage system considerations and/or limitations in the following subsection will be evaluated prior to approving the point of discharge.

- The applicant will establish an acceptable point of discharge. The point of discharge shall be accepted by the District prior to approving the Service Provider Letter.
- Runoff from developed portions of the site drainage area should be discharged at the existing natural drainage outlet or outlets.
- Runoff must be discharged in a manner that will not increase flooding to downstream properties.
- The applicant will be responsible for acquiring approval from any other agency having jurisdiction or permitting authority related to the activity. The District may require a copy of other jurisdictional approval(s) prior to approving the plan.
- If the point of discharge is an open storm drainage system, then adequate velocity dissipation and/or additional channel protection shall be required to prevent erosion and/or alteration to the existing downstream drainageway.
- Any connection to a public or private piped downstream storm drainage system shall be approved by the District. The means and methods of connecting or extending a piped storm drainage system will be consistent with District standards and/or other standards required by agencies having the authority to regulate the connection.

5.2.2 Onsite Storm Drainage System

The following onsite storm drainage system requirements shall be incorporated into the design of the stormwater utility plan:

- The site shall be planned and designed to generally conform to onsite natural drainage patterns and discharge to natural drainage paths within a drainage area. These natural drainage paths should be modified as necessary to contain and safely convey the peak flows generated by the development.
- Open channel storm drainage systems are preferred over closed conduits where feasible, especially where they might provide opportunities for water quality treatment, some infiltration, wildlife habitat improvement, or emergency overland flood relief routes.
- It shall be the responsibility of the owner to provide a storm drainage system for all stormwater runoff and/or or surface water entering the property from offsite. Surface water, springs, and groundwater shall be incorporated into the drainage design.
- An emergency safe overflow pathway must be identified and/or designed that allows large flow events to discharge without risk of injury or property damage. The safe overflow pathway must be incorporated into the design and show how flow will escape from the site during rainfall events larger than the design storm events and/or from failure of the primary storm drainage system. Any safe overflow pathway structures shall be designed for the 100-year design storm.
- It is important to ensure that the onsite storm drainage system is designed to reduce blockages and flows in excess of the design storm capacity to minimize the likelihood of nuisance flooding or damage to private properties. If failure of

these systems and/or drainage structures occurs during these periods, the risk to life and property could be significantly increased.

5.2.3 Upstream Drainage Areas

Developments are required to convey upstream drainage through or around the development in a system the District refers to as a "Bypass System". Listed below are the criteria for storm drainage bypass system components to be designed and constructed in accordance with the Stormwater Report.

- The upstream offsite stormwater or other nuisance surface water runoff will be conveyed through the development in a separate system referred to as the "Bypass System" and will not be mixed with the stormwater collected and treated with onsite stormwater management facilities unless the stormwater management facilities are designed to include all of the additional flows from the upstream drainage areas(s) assuming full development potential.
- Analysis of upstream drainage areas shall assume ultimate build out and/or maximum zoning density in determining the size of the storm drainage system required through the site as specified in Section 5.
- Land use zoning adopted by the local planning agency will be used to size the capacity of the bypass system. For areas within the upstream drainage area that currently have a rural zoning designation but have the potential to be incorporated into the Urban Growth Boundary or Reserve, the District will concur with the local planning agency to assign the appropriate zoning designation and/or allowable maximum density to use in the upstream drainage area analysis for ultimate development potential and storm drainage system sizing.
- It is important to ensure that the bypass storm drainage system is designed to reduce blockages and flows in excess of the design storm capacity to minimize the likelihood of nuisance flooding or damage to private properties.
- If failure of these systems and/or drainage structures occurs during rainfall events in excess of the design storm capacity, the risk to life and property could be significantly increased.
- In establishing the layout of stormwater networks, it is essential to ensure that upstream flows will not be redirected onto private property during rainfall events up to the storm drainage system design capacity.

5.2.4 Downstream Analysis

Downstream analysis requirements are outlined in Section 2.3. When a downstream analysis is required follow the calculations methodology in Section 5.3.

5.3 Storm Drainage System Design Methods

The following section describes accepted criteria and methods for analyzing and designing storm drainage systems. It is the responsibility of the engineer to determine the appropriate method of analysis in determining the capacity of the proposed storm drainage system.

5.3.1 Design Methodology

The following are general design considerations for storm drainage system sizing requirements:

- Storm drainage systems shall be designed and constructed to carry the design storm flowing full with no pressure flow. Flow conditions in existing pipe systems will be evaluated on a case-by-case basis for adequacy.
- Storm drainage systems in the public right-of-way (ROW) shall be designed as gravity systems, without the use of stormwater pumps. Privately-owned and maintained stormwater pumps will only be allowed if the land cannot be developed without pumping the stormwater because of the topology of the property. It shall be the owner/developer responsibility to acquire an easement in order to provide the required gravity system. Failure to obtain an easement to safely discharge the stormwater runoff, or provide an emergency safe overflow pathway is not a reason for the District to approve the pumping of stormwater runoff as described in Section 5.11.
- Generally, the SBUH method for computing peak discharge is preferred by the District. Other acceptable methods include TR-55, stormwater management model (SWMM), or other standard methods as approved by the District. For drainage areas 10 acres or less, the Rational Method is acceptable.
- Manning's equation shall generally be acceptable for determining pipe or open channel capacity only within a drainageway with an upstream drainage area of 50 acres or less. For larger drainage areas, backwater effects shall be included in determining capacity for a drainageway, typically using Hydrologic Engineering Centers-River Analysis System or equivalent computer modeling software.

5.3.2 Design Event

The design event for sizing each component of the storm drainage system is determined based on the size of the contributing drainage area and the type of storm drainage system being designed. The design events for storm drainage system sizing are listed in **Table 5-1** below**.** Design rainfall intensities and 24-hour storm events are included in Sections 5.3.3 and 5.3.4.

Table 5-1. Storm Drainage System Design Storms			
Contributing drainage area	**Design storm for storm drainage system sizing**		
	Storm sewer, culverts, and outfall pipes[a]	**Creek or stream channels**	**Bridges**
Less than 40 acres	10-year, 24-hour storm	10-year, 24-hour storm	100-year, 24-hour storm
40 to 640 acres	25-year, 24-hour storm	25-year, 24-hour storm	
640 acres or greater	50-year, 24-hour storm	50-year, 24-hour storm	
[a] *When a backwater condition exists, the storm drain system shall be designed in accordance with Section 5.3.6.*			

5.3.3 Rational Method

The Rational Method is most applicable for runoff estimates from small drainages with large amounts of impervious area. When using the Rational Method, refer to the current version of the ODOT Hydraulics Manual for calculation formulas and tables of coefficients. When using the Rational Method, the following limitations shall apply:

- Use the Rational Method only for predicting a conservative peak flow rate to be used in determining the required capacity for storm drainage system elements. The Rational Method shall not be used to size stormwater management facilities.
- The contributing drainage area cannot exceed 10 acres and the time of concentration shall not exceed 100 minutes for a single calculation.
- The rainfall intensity (I) should be based on the rainfall intensity, duration, and recurrence curves shown in **Appendix E**.
- In computing the Time of Concentration (Tc), for smaller drainage areas, the largest and most significant component in the total Tc is the portion of the time devoted to sheet flow. For this reason, extreme care should be given to determining the true travel time for the sheet flow component of the Tc. In calculating the total Tc, the following limitations will apply:
  - The flow segment used for the sheet flow component shall not extend for more than 300 feet. The use of a distance of less than 200 feet on a pre-developed land condition will require supporting documentation, such as photographs that show evidence of shallow concentrated flow at the point of transition.
  - For segments of the Tc route that flow through closed storm drainage system facilities, such as pipes and culverts, standard hydraulics formulas shall be used for establishing velocity and travel time.
  - For segments of the Tc route that flow through lakes or submerged wetlands, travel time is normally very short. The travel time can be determined using an appropriate storage routing technique, or it can be assumed to be zero.
  - The minimum total Tc used in the runoff calculations shall be 5 minutes.

5.3.4 Hydrograph Method

When storm drainage system design calculations are based on SBUH, TR-55 or the SWMM method, the calculations shall have the following limitations:

- The rainfall distribution to be used within the District is the design storm of 24-hour duration based on the standard NRCS Type 1A rainfall distribution using the 24-hour precipitation isopluvial maps in the National Oceanic and Atmospheric Administration Atlas 2, Volume 10, *Precipitation-Frequency Atlas of the Western United States*. The depth of rainfall for the 2 through 100-year 24-hour storm events are provided in **Appendix E**.
- Curve numbers shall be derived from the NRCS runoff curve numbers contained in TR-55 *Urban Hydrology for Small Watersheds* (see **Appendix E**).
- Soil types shall be derived from the NRCS Soil Survey for Clackamas County.
- A maximum overland distance for sheet flow used in calculations shall be 300 feet.
- The minimum time of concentration shall be 5 minutes.
- See **Appendix E** for additional guidance on performing hydrograph method calculations.

5.3.5 Capacity Analysis: Non-Pressure Flow

Storm drains that are designed to operate at full or partially full conditions during the design storm are called non-pressure flow. The capacity of pipe systems and open channels, for non-pressure flow conditions, can often be estimated using Manning's equation for steady uniform flow as follows:

Manning's Equation

$$Q = \left(\frac{1.486}{n}\right) AR^{2/3}S^{1/2}$$

or

$$V = \left(\frac{1.486}{n}\right) R^{2/3}S^{1/2}$$

where: Q = flow in cubic feet per second (cfs)

n = coefficient of roughness

A = cross-sectional area of flow in SF

V = Velocity, fps

R = hydraulic radius in feet = A/WP

(WP = wetted perimeter = length, in feet, of the wetted contact between a flow of water and its containing channel, measured at right angles to the direction of flow)

S = hydraulic slope (or hydraulic grade line) in feet per foot

The hydraulic slope or hydraulic grade line (HGL) is defined by the elevations to which water will rise in small vertical pipes, located at various locations along the flow. In a non-pressure flow condition, the hydraulic slope can be assumed to be parallel with the flow line slope. The HGL is separated from the energy line by the

velocity head. The energy grade line is the sum of the HGL, the velocity head, friction loss, and the incidental losses. Manning's equation does not take into account entrance, exit, bend, and junction losses within catch basins or manholes.

Typical values for the hydraulic roughness coefficient (Manning's n) for conduits and channels can be found in **Table 5-2** and **Table 5-3** below. Refer to the current version of the ODOT Hydraulics Manual for additional hydraulic roughness values.

This capacity estimate using the Manning's equation is acceptable for final design purposes if the storm drainage system does not have tailwater influence (such as discharge into a partially full detention basin) or abrupt changes in channel cross-section or slope that might cause non-uniform flow.

Table 5-2. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Conduits

Type of Pipe Material	Manning's n (normal)
Concrete	0.013
Ductile iron	0.012
Corrugated metal (CMP) - annular - 2-2/3" x 1/2"	0.024
CMP - annular – 3" x 1"	0.027
CMP - annular – 6" x 2"	0.032
CMP - helical- 2-2/3" x 1/2"	
12-inch diameter	0.013
18-inch diameter	0.015
24-inch diameter	0.017
36-inch diameter	0.021
48-inch diameter	0.023
60-inch diameter and larger	0.024
Corrugated high-density polyethylene: single wall	0.024
Corrugated high-density polyethylene: smooth wall	0.012
Spiral rib metal	0.011
PVC	0.011
High density polyethylene - butt fused	0.009

Note: These n values are the "normal" range hydraulic roughness coefficient values for use in the analysis of conduits. Refer to the most current version of the ODOT Hydraulics Manual for additional reference values.

Table 5-3. Normal Range Hydraulic Roughness Coefficient (Manning's n) for Channels

Type of channel	
Constructed	**Natural**
A. Earth, straight and uniform 1. Clean, recently completed ..... 0.018 2. Clean, after weathering ..... 0.022 3. Gravel, uniform section, clean ..... 0.025 4. With short grass, few weeds ..... 0.027 B. Earth, winding and sluggish 1. No vegetation ..... 0.025 2. Grass, some weeds ..... 0.030 3. Dense weeds or aquatic plants in deep channels ..... 0.035 4. Earth bottom and rubble sides ..... 0.030 5. Stony bottom and weedy banks ..... 0.035 6. Cobble bottom and clean sides ..... 0.040 C. Rock cuts 1. Smooth and uniform ..... 0.035 2. Jagged and irregular ..... 0.040 D. Channels not maintained, weeds and brush uncut 1. Dense weeds, high as flow depth ..... 0.080 2. Clean bottom, brush on sides ..... 0.050 3. Clean bottom, brush on sides, highest stage of flow ..... 0.070 4. Dense brush, high stage 0.100	A. Minor streams (top width at flood stage less than 100 feet) 1. Streams on plain a. Clean, straight, full stage, no rifts or deep pools ..... 0.030 b. Same as above, but more stones and weeds ..... 0.035 c. Clean, winding, some pools and shoals ..... 0.040 d. Same as above, but some weeds and stones ..... 0.045 e. Same as above, lower stages, irregular slopes and sections with more ineffective flow area ..... 0.048 f. Same as d, but more stones ..... 0.050 g. Sluggish reaches, weedy, deep pools ..... 0.070 h. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush ..... 0.100 2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages a. Bottom: gravels, cobbles, and few boulders ..... 0.040 b. Bottom: cobbles with large boulders ..... 0.050 B. Floodplains 1. Pasture, no brush a. Short grass ..... 0.030 b. High grass ..... 0.035 2. Cultivated areas a. No crop ..... 0.030 b. Mature row crops ..... 0.035 3. Brush a. Scattered brush, heavy weeds ..... 0.050 b. Light brush and trees ..... 0.050 c. Medium to dense brush ..... 0.070 4. Trees a. Dense willows, straight ..... 0.150 b. Cleared land with tree stumps, no sprouts ..... 0.040 c. Cleared land with tree stumps, heavy growth of sprouts ..... 0.060 d. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches ..... 0.100 e. Same as above, but with flood stage reaching branches 0.120

Note: The n values listed above are the "normal" range hydraulic coefficient values for use in the analysis of open channels. For conservative design of channel capacity, the "maximum" values listed in the current version of the ODOT Hydraulics Manual should be considered. For channel bank stability calculations, the "minimum" values listed in the current version of the ODOT Hydraulics Manual should be considered.

5.3.6 Capacity Analysis: Pressure Flow

A backwater analysis shall be included in the stormwater report for the following circumstances:

- Where uniform flow is not expected or where losses within the system may cause surcharging of water.
- A discharge into a tailwater condition, such as a partially full stormwater detention pond or into a partially full channel.
- Culvert entrances.
- Ditch inlet location where backwater effect could cross a property line.
- Other locations as determined by the District.

The backwater analysis shall be to a point where non-pressure flow at the design storm flow rate is re-established.

When a backwater condition exists, the storm drain system shall be designed to convey and contain at least the peak runoff from the 25-year design storm or the design storm identified in Section 5.3, whichever is larger.

Structures for proposed pipe systems must be designed to provide a minimum of 1 foot of freeboard between the HGL and the top of the stormwater structure and appurtenances or finish grade above the pipe during the design flow. Surcharge in pipe systems shall not be allowed if it will cause flooding in portions of a structure, including below-floor crawl spaces and basements.

5.3.7 Hydrologic and Hydraulic Calculation Reporting

Design hydrologic and hydraulic data for each reach of a proposed storm drain system shall be included in the stormwater report submittal. It is the responsibility of the engineer to determine the best way to document the design analysis for presentation in the Stormwater Report.

Storm Drainage System calculations shall include the following items:

- Description and sketch of the storm drainage system, including pipe size, slope, and material for each segment of the system.
- Description and sketch of the contributing area (curve number value or equivalent, as well as the size).
- Time of concentration calculations, including assumed coefficients, flow path lengths, and slope.
- Capacity analysis calculations as outlined in Sections 5.3.5 and 5.3.6.
- Design flow calculations, including assumed coefficients and design storm.
- Design flow rate for each pipe and open channel segment of the onsite storm drainage system.
- HGL and ground surface elevation at each structure and outlet location. It is preferable to show this information on a profile plot on an engineering scale, though spreadsheet tables are acceptable. When spreadsheet tables are used in place of a profile plot, include the distance between the ground surface and the HGL at each structure and outlet location.
- Flow velocity at outlet structures and in open channels.

5.4 Open Channels

The following section describes accepted criteria and methods for designing open channel storm drainage systems, such as swales and ditches.

5.4.1 Geometry

Open channel geometry shall meet the following criteria:

- Constructed open channels shall be sized to pass the design flows listed in **Table 5-4** without causing erosion.
- Channel side slopes shall be no steeper than two-horizontal to one-vertical (2h:1v) for undisturbed ground (cuts), as well as for disturbed ground (embankments).
- A low-flow channel, within the main channel, designed to carry 10 percent of the design storm, will be required for channels with a design flow of greater than 20 cubic feet per second (cfs). Side slopes for the low-flow channel shall not exceed 2h:1v and shall be stabilized to the satisfaction of the District. The minimum stabilization material shall be seeded matting or approved equivalent.
- Channel design along curves shall be curvilinear with a 100-foot minimum radius. Tighter curves may be used if the District determines that sufficient erosion control has been incorporated into the design to maintain stable bank conditions following development.
- Channels shall be designed to provide sufficient freeboard so as not to saturate any adjacent public road base with design storm peak flows. Channels shall have a minimum freeboard of 6 inches when the design discharge is 10 cfs or less and 1 foot when the design discharge is greater than 10 cfs. Extra freeboard may be required for curved segments of an open channel.

5.4.2 Channel Lining and Infiltration

Every opportunity should be taken to design open channels to provide infiltration throughout an entire storm drainage system. Engineers are also encouraged to consider innovative means of collecting and conveying runoff to incorporate infiltration into the storm drainage system design.

Protection for open channels shall meet the following criteria:

- Vegetation-lined channels shall be used whenever practicable. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion.
- If the channel has a flow line slope of 6 percent or greater or a peak design velocity that exceeds 4.0 feet per second (fps), the channel shall incorporate rock lining or riprap energy dissipation devices designed by a qualified Professional Engineer. Channel protection shall be based on the minimum level of protection listed in **Table 5-4.**
- Where riprap protection is specified, riprap shall be placed over a woven geo-textile fabric.
- No protruding pipes, culverts, or other structures, which reduce or hinder the flow characteristics of the channel, will be allowed. Channel connections shall be

designed to prevent scouring. All pipe connections shall match side slopes and incorporate a headwall.

- All channel sides and bottoms shall be seeded, sodded, or rock-lined immediately following excavation, regardless of mean flow velocity.

Table 5-4. Protection for New Channel Construction

Velocity at design flow, fps		Required protection	Thickness, feet	Minimum height above design water surface, feet
Greater than	Less than or equal to			
0	5	Vegetation lining	Not applicable	0.5
5	8	Bioengineered lining	Not applicable	1
		ODOT Class 50 riprap[a]	1.5	
8	12	ODOT Class 200 riprap	2.5	2
12	20	Slope mattress, etc.	Varies	2
20		Engineer-designed		

a. The District may require ODOT Class 100 Riprap on an as needed basis.

5.4.3 Open Channel Location

New open channels in residential areas shall be in easements and recorded on plat maps with the following restrictions:

- Property owner shall not alter the drainageway without approval of the District.
- Property owner shall not place any structure or fence within the normal high-water area of the open channel.
- Property owner shall not introduce foreign material such as grass clippings within the high-water area of the open channel.

5.4.4 Check Dams

Check dams are not recommended for use in storm drainage system channels due to the problems they pose for routine maintenance operations. However, check dams are recommended for use in temporary channels as an erosion and sedimentation control device (see Section 7) and for stepping down swales being used for infiltration. Where check dams are proposed, they shall be spaced at maximum 2-foot elevation intervals.

5.5 Culverts

Culverts, for the purposes of this manual, are single runs of pipe that are open at each end and do not have structures such as catch basins or manholes. Culverts designed for fish passage are governed by the Oregon Department of Fish and Wildlife and often require additional design considerations such as depth of flow and velocity that may differ considerably from the design requirements included herein. When conflicts exist, the applicant shall work with the District and the regulating agency to establish the appropriate design criteria.

Criteria for culverts designed for open channel flow in this section shall apply to culverts placed in drainageways and roadside ditches. Culverts which are part of a roadside ditch system or within the right-of-way shall be permitted by the local road authority.

Culverts within FEMA floodplains shall be reviewed and approved by the local FEMA-designated floodplain permitting authority.

Culverts placed in streams or drainageways determined to be "waters of the State" require approval from the Oregon Division of State Lands (ODSL) and the U.S. Army Corps of Engineers (USACE).

For culverts which convey flows from or through water quality sensitive areas; a local representative of the Oregon Department of Fish and Wildlife or other applicable state or federal agency shall be contacted to determine if fish passage is required and to identify site specific design criteria.

5.5.1 Culvert Design Criteria

Storm Drainage System culverts shall meet the following design criteria:

- Culverts located within the structural street section shall be placed in accordance with local agency standard details for utility placement location.
- For new culverts 18 inches in diameter or less, the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed two times the pipe diameter or three times the pipe diameter with a seepage collar unless an exception is approved by the District.
- For new culverts larger than 18 inches in diameter the maximum allowable design storm event headwater elevation (measured from the inlet invert) shall not exceed 1.5 times the pipe diameter unless an exception is approved by the District.
- The maximum headwater elevation of a design storm event for new culverts shall be at least 1 foot lower than the road or parking lot sub-grade.
- Minimum culvert diameters are as follows:
  - For cross-culverts under public and private roadways: minimum 18 inches.
  - For all other roadway culverts, including driveway culverts: minimum 12 inches.
- No bends shall be permitted in culvert pipes.
- Minimum cover, as measured from the top of pipe to finished grade:
  - Under roads classified as collectors or higher: 2 feet.
  - If Class 52 Ductile Iron Pipe is used, the cover may be reduced to 1 foot.
  - PVC and HDPE shall require a 2-foot minimum cover in any public roadway area.
  - Pipe covers of less than the above stated minimums may be permitted on a case-by-case basis. These may require a designed reinforced concrete cover that will distribute roadway use (traffic) forces to a foundation area to the sides of the pipe.
  - Reinforced concrete box culverts with no cover requirement may be permitted on a case-by-case basis. Signed and sealed structural design calculations shall be submitted for review (this requirement may be waived for pre-cast

reinforced concrete box culverts with covers greater than 2 feet). In culverts with no cover, the clearance from the roadway surface to the reinforcing steel shall be no less than three inches and the 30-day concrete strength shall be no less than 4,500 pounds per square inch.

- Maximum culvert length without access structures is 300 feet.
- Minimum separation from other utility pipes and conduits (as measured from the outside edge of pipe) is 6 inches vertical, 3 feet horizontal, unless otherwise specified by the purveyor of the utility in question.
- Controlled Density Fill or Controlled Low Strength Material (CLSM) shall be used for any pipes with less than 12-inch separation.
- Pipe bedding and backfill shall conform to applicable roadway standards or the District's Standard Details.
- The entrances and outlets to all culverts shall be stabilized with quarry rock or other energy dissipation methods to minimize scouring of the channel bottom and sides. These shall be designed by a Professional Engineer using published references such as the current version of the *Hydraulic Design of Energy Dissipaters for Culverts and Channels* (U.S. Department of Transportation, Federal Highway Administration) and other references.
- Rock protection at culvert entrances should extend upstream a minimum of 5 feet and shall have a minimum height of 1 foot above the design headwater elevation. Rock protection at the culvert outlet shall have the greater of:
  - A minimum height of 1 foot above the design tailwater elevation
  - 1 foot above the crown of the pipe
- When two parallel pipes are installed, the minimum separation between the exterior pipe walls shall be 3 feet or half the diameter of the larger pipe, whichever is greater. Pipe separations less than the stated minimum may be permitted on a case-by-case basis.

5.5.2 Culvert Materials

The pipe materials listed in Section 5.6 are approved for use for culverts, subject to the limitations listed in Section 5.5.1.

5.5.3 Headwalls/Endwalls

Pipe headwalls, endwalls, or other approved end protection shall be required where pipe material other than concrete or ductile iron is exposed in the design of an outlet or inlet pipe or where required to provide slope stability. Headwalls and endwalls should be built high enough to support the full depth of pipe cover recommended by pipe manufacture. Headwalls and endwalls built to the proper height improve pipe capacity during extremely high flows and help prevent pipe blockage, road washouts, and compounding damage caused by pipe failure.

No plastic pipes shall be exposed, which may require pipe transitions from underground plastic to exposed ductile iron pipe or mitered pipe end matching the slope with a paved concrete endwall. Concrete endwalls shall extend a minimum of 18-inches out from the end of pipe.

For culverts 18 inches in diameter and larger, the embankment around the culvert inlet shall be protected from erosion by armoring around the inlet with rock or other

protection. The armoring shall extend downstream from the culvert a minimum of 5 feet and shall be as high as the designed headwater elevation.

5.6 Pipe Systems

Pipe systems are comprised of more than one run of pipe and include at least one junction-type of structure such as a catch basin or manhole. The following section describes accepted criteria and methods for designing pipe systems.

5.6.1 General Pipe Design Criteria

Storm drainage pipe systems, sometimes referred to as storm sewers or lateral closed systems, are piped storm drainage systems used for transporting runoff from the roadway and other inlets to outfalls at structural stormwater management facilities and receiving waters. Pipe drain systems are suitable mainly for medium to high-density residential and commercial/industrial development where the use of natural drainageways and/or vegetated open channels is not feasible.

Storm Drainage System shall be designed to accommodate flows identified under Section 5 and include the design considerations of this section.

- Manning's equation shall be used to calculate pipe capacity. Open channel (gravity) flow is required.
- Storm management facilities shall be designed and constructed to accommodate all assumed future full build-out flows generated from upstream property within the basin.
- Storm Drainage System within the right-of-way shall be not less than 12-inches in diameter.
- Service Connections within the right-of-way shall not exceed ½ the diameter of the mainline and cannot exceed 8-inches in diameter. For larger Service Connections, a structure for maintenance access is required.
- Mainlines to be publicly maintained shall be not less than 12 inches in diameter.
- Private storm drains outside the public ROW or public easement shall not be less than 6 inches in diameter and permitted and inspected in accordance with the Oregon Plumbing Specialty Code (OPSC).
- Pipes from catch basins to the main line in the public right-of-way shall be not less than 12 inches in diameter.
- Storm pipes serving roof drain with no requirement to be extended shall be a minimum of 8-inches in diameter. Storm sewer Service Connections serving a house or commercial property shall generally be 6-inches in diameter or as approved by the District.
- The maximum pipe slope is 20 percent except as approved by the District. Pipes on slopes in excess of 20 percent shall be constructed with anchor walls per the standard details. Storm lines shall not decrease in size as they move downstream regardless of the slope provided on the pipe.
- Storm sewers shall be designed with a minimum slope of 0.5 percent. Exceptions will be made for topographic constraints, but the minimum acceptable pipe design must have sufficient slope to maintain a minimum flow velocity of 3.0 fps for a pipe flowing half-full.

- Any change in pipe size, alignment, grade, or material shall require a structure per the Standard Details.
- IE IN(s) and IE OUT crown elevations shall be matched for any changes in pipe size diameter from upstream to downstream the pipe.
- If trash racks or debris barriers are required by the District for pipe or culvert systems, the Engineer shall submit the trash-rack-debris barrier system design to the District for approval.

5.6.2 Pipe Material

Pipe materials shall conform to the District rules, regulations, and standards. Pipe material must also comply with the local road authority. Acceptable pipe materials and abbreviations are as follows:

- Concrete Sewer Pipe or Reinforced Concrete Pipe
- Concrete Lined Ductile Iron
- PVC
  - ASTM D3034 SDR 35, 4 to 24 inches
  - ASTM C-900 D-1784 DR, 4 to 24 inches (preferred by District)
  - ASTM C-905 D-1784 DR, 4 to 24 inches (preferred by District)
- HDPE, ASTM D-3035
- Polyethylene – Smoothed Wall (PE)

Where required for added strength, C905 or C900 PVC shall be used. Pipe with less than 3 feet of cover requires submittal of the manufacturer's specifications. The District may require pipe load analysis calculations in unusual situations, typically in areas where the depth of ground cover over the pipe is not within the limits specified by the District or the pipe manufacturer.

A minimum 75-year lifespan is required.

Alternate materials will be approved on a case-by-case basis. The design engineer shall provide manufacturer's specifications, design calculations, or other information as required by the District for review.

Trench backfill, compaction and testing shall conform to the District's Sanitary Standards Section 6.0 and Standard Detail Drawings.

5.6.3 Alignment and Location

The following bullets provide the criteria for the alignment and location of the storm drainage system

- Storm drainage systems within a public right-of-way shall be located in the center of the street and a minimum of 5 feet from the curb, unless otherwise approved by the District and the local road authority.
- Storm drainage systems shall be laid on a straight alignment and uniform grade between structures.
- Utility crossings shall be constructed as near 90 degrees as practicable. Utility crossings have the minimum separation of 12 inches of vertical separation

measured from the edge of each pipe. Any separation of less than 12 inches will be reviewed and approved on a case by case basis by the District.

- Unless approved by the District, the minimum separation distance between parallel sanitary and storm sewers and utilities shall be 5 feet measured from the edge of each pipe, and vertical separation between utilities is a minimum of 3 feet. Additional horizontal spacing may be required to allow for maintenance and repair access.
- If streets have curved alignments, whenever possible, the storm drain alignment shall be parallel with water and sanitary lines with a minimum separation of 10 feet with sanitary and 6 feet with water. The intent is to prevent conflict with sanitary and water lines while providing the fewest manholes required to traverse on curve and prevent a conflict with survey monuments.
- Where storm drains are located parallel with other utility pipe or conduit lines, the vertical and horizontal alignment shall permit future side connections of main or lateral storm drains and avoid conflicts with the parallel utility without abrupt changes in vertical grade of main or lateral storm drains.
- Storm drain alignments shall accommodate future planned projects such as street widening, changes in horizontal or vertical street alignment, and master plan water or sewer facilities.
- Storm drain lines shall enter a creek or drainage channel at 90 degrees or less to the direction of the flow. The outlet shall have a headwall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of the pipe and channel being entered will govern which protective measures are required.

5.6.4 Junctions

The following is required for pipe junctions:

- Connections to the existing public storm systems that are 8-inches diameter and greater.
- Manholes shall be provided at least every 500 feet, at every grade change, and at every change in alignment.
- Manhole lids shall not be located in a wheel path of the motor vehicle travel way.
- Manhole lids shall have a minimum of 12-inches clearance from the edge of a curb and gutter.
- All manholes shall be a minimum of 48-inches in diameter and have a minimum 12-inch ledge in the base.
- A detail shall be submitted with the plans where pipes into or out of a manhole are larger than 24 inches or where more than four mainline connections are made.
- A minimum of 8 inches of un-perforated wall separating the cut-outs or breakouts for the individual pipe connections shall be provided in manholes.
- Where a connection is proposed to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted as a detail on the plans.
- Manholes constructed on lines with 12 inch or smaller pipes shall have a minimum 0.2-foot fall through the manhole, unless otherwise approved by the District.

- Where different size public storm drainage pipes enter a manhole, the crowns of the upstream pipes shall be no lower than the crown on the downstream pipe without District approval.
- A lateral entering a manhole within a public storm drainage system shall be designed so that the invert of the lateral is 6 inches above the invert of the outlet pipe.
- All manhole bases shall be properly channelized.
- No more than three side laterals or side sewers are allowed to be connected to a manhole unless an exception is approved by the District.
- Manhole lids shall be in conformance with the *Standard Details*.
- A Curb Inlet Manhole or Modified Curb Inlet Manhole per *Standard Details* may be used in lieu of a manhole, when approved as part of a flow-through system.
- Storm drainpipe junctions shall be manholes, or other approved junctions, which conform to Oregon UPC and District requirements. Oversized manholes and other specialized junctions shall be approved on a case-by-case basis by the District.
- Public piped storm drain systems shall have junctions at not more than 500-foot intervals.
- Junctions located outside the public right-of-way shall generally be minimum 48-inch-diameter manhole structures except as approved by the District.
- Catch basins may be used as junctions only with pipes not greater than 12 inches in diameter for depths up to 5 feet from rim to invert with prior approval of the District.
- Cleanouts may only be used as junctions only with private pipes not greater than 6 inches in diameter for depths up to 5 feet from rim to invert with prior approval of the District.
- Catch basin laterals must be connected to the mainline at a manhole.
- Roof drain laterals may be tee connected into the mainline, manhole, or catch basin.
- Pipes entering manholes may have a maximum free fall of 4 feet as measured to the invert of the manhole base. A sump may be required for energy dissipation at the discretion of the District.

5.6.5 Inlets and catch basins

The following is required for inlets and catch basins:

- Curb and gutter requirements will be regulated by the local road authority.
- All inlets and catch basins shall be designed to accept a 25-year storm event. Grates shall, as far as practical, be designed to avoid failure due to accumulation of debris.
- Inlets shall be designed to completely intercept the design storm gutter flow with no greater than 250 feet between inlets. Flow paths shall not cross intersections, so inlets shall be installed at intersections as needed. In addition, catch basins shall be provided just prior to curb returns.
- Flow through catch basins are generally not allowed. The main storm line shall not pass through any catch basins.

- Type GB-2 catch basins, or equal are required for all curbed street inlets and shall be generally located within the public right-of-way, or an easement granted to the District.
- All catch basins shall be constructed with an 18-inch minimum sump.
- No more than three catch basins, with the maximum distance of 50 feet apart, may be connected in series before connecting to a main storm line.
- A ditch inlet or field inlet may be connected to the end of the main storm line through a structure.
- Inlets shall be located along the gutter line or open channel flowline. When streets are widened or otherwise modified, causing an inlet to be located outside a flowline, the inlet shall be removed entirely and reconstructed with a junction box, manhole, or other acceptable connection as specified by the District.
- Dual GB-2 catch basins are required at all roadway sags and cul-de-sac low points. A safe overflow pathway for the 100-year storm event shall be provided within the boundary of the plat as a tract of land, or onsite as a recorded easement.
- Catch basins, except for CG-48 manholes shall be a maximum depth of 6 ½ feet from the top of grate to the lowest pipe invert elevation, unless approved by the District.
- Where design criteria and methodology are not specified in this section, design shall follow the current versions of the ODOT *Hydraulics Manual or the* Hydraulic Engineering Circular No. 12 (FHWA-TS-84-202) Drainage of Highway Pavements.
- Ditch inlets and area drains in rear or side yards shall be equipped with an 18-inch sump.
- A main storm line shall not pass through an area drain or ditch inlet.
- Area drains or ditch inlets located at the upper terminus of a main storm line shall connect to the main storm line at a manhole.
- The maximum acceptable intake flow rates for area drains and ditch inlets with a grate angle of 30 degrees are shown in **Table 5-5** where H is the hydraulic head measured in feet from the bottom of the grate to headwater and Q is the flow rate in cubic fps.

Table 5-5. Maximum Intake Flow Rates for Area Drains and Ditch Inlets with Grate Angle of 30 degrees

H	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.0	10.0
Q	2.0	5.6	10.3	11.9	13.3	14.6	16.8	18.8	22.3	26.6

5.6.6 Pipe Cover Requirements

In paved areas or areas anticipated to receive vehicular traffic, pipe cover shall be measured from the top of the paved surface (finish grade) to the upper exterior surface of the pipe barrel. The pipe bell shall not intrude into the subbase. In areas without pavement or vehicular traffic, pipe cover shall be measured from finish grade to the upper exterior surface of the pipe barrel.

The minimum cover requirement for the mainline storm sewer shall be 36 inches unless an exception is approved by the District and roadway authority.

5.6.7 Storm Service Connections

The property owner(s) that benefits from the Service Connection is solely responsible for the cost to maintain, repair and/or replace the pipeline from the Building Sewer to and including the connection to the Public Stormwater Mainline. The District shall not be responsible for any damage accruing from the failure of a Service Connection, Building Sewer or of fixtures or appurtenances attached thereto.

The specifications contained herein, together with the Oregon Plumbing Specialty Code (OPSC) and all other requirements of Federal, State, and local law shall govern the installation of private piping systems on private property.

Public laterals installed within the ROW or easement granted to the District shall be constructed to District Standards

The provisions of the District ordinances requiring permits, fees, and other requirements shall be complied with prior to the start of work on any portion of the storm pipeline systems.

Planning Considerations

- Where a parcel requiring connection to a public storm drainage system cannot connect through a Service Connection meeting the requirements of this section, then extension of the public storm drainage system shall be required.
- Each parcel shall be served by individual storm Service Connection with a minimum diameter of 6 inches, except in the following situations: duplexes, townhouses, and other buildings that adjoining property lines may be served by a single storm Service Connection.

Design Considerations

- Storm sewer Service Connections shall provide gravity service to the entire roof area drain and foundation drains of buildings on a parcel.
- Service Connections shall connect to the mainline sewer with a 90-degree-tee or connect to a manhole at an angle of 60 to 90 degrees from the mainline sewer.
- Service Connections shall contain no horizontal bends from the mainline to the edge of right- of-way.
- A minimum grade of 2 percent is required for Service Connections unless a lesser grade is approved by the District.
- The use of an alternate storm and/or foundation drain termination may be allowed where all the following conditions are met:
  - Adequate fall exists so that foundation drains discharge by gravity to an approved discharge point.
  - Calculations are provided with submitted plans showing pipe slope and cover meet the minimums required by the reviewing authority.
  - All portions of the lot can be adequately drained, so runoff does not cross onto other adjacent property.
- Storm sewer Service Connections shall be marked as follows:

Each Service Connection shall be marked with a white 2x4 stake extended from the end of the pipe to 1-foot above the ground. Green magnetic marking tape labeled "STORM DRAIN" shall be laid about 6-inches above the pipe from the mainline to the top of the 2x4 white stake. ~~detectable underground magnetic tape. The magnetic tape shall be placed from the main pipeline to the end of the Service Connection with 18-inches vertical separation between the tape and pipe. The magnetic tape shall be green in color and marked "storm drain" with the following notice:~~

~~**CAUTION**~~
~~**STORM DRAIN BURIED BELOW**~~

1) A cleanout may be installed that is the same size and material as the Service Connection. ~~shall be installed at the end of the Service Connection.~~ The cleanout shall extend~~ing~~ from the invert of the pipe to 3 feet above the ground surface with a watertight cap. See Standard Detail Drawings.
2) The location of the storm Service Connections shall be indicated by a permanent marker, acceptable to the District:
   a) Where the service connection is located in a street with curbs, the marker shall be a permanent stamp on the top of the curb: ST – Storm Sewer; SS – Sanitary Sewer.
   b) Where the sewer is in a street without curbs, the marker shall be on the sidewalk.
   c) Where the sewer is in a street without curbs or sidewalks, the Engineer shall present to the District for approval an alternative permanent marking method.
   d) A storm sewer cleanout located on the private side of the right-of-way boundary is an acceptable permanent marker.

5.6.8 Connections to Pipe Systems

For all piped public storm drainage systems, excluding roof and foundation lines, connections may only be made at a structure, such as at a catch basin, tee in mainline or manhole. Wyes, saddles, or other types of connections to public storm drainage pipes will not be permitted, unless approved by the District.

Factory tee connections installed on the public storm system shall not exceed 6 inches in diameter. 8-inch-diameter pipes and larger shall be connected into manholes.

Inserta tee connections into the public storm system shall not exceed half the diameter of the mainline pipe. 8-inch-diameter pipes and larger shall be connected into manholes.

Private storm drains systems outside the public ROW and easements shall be permitted and constructed in accordance with Oregon Plumbing Specialty Code (OPSC).

Storm sewer Service Connections serving an individual house or small commercial property shall be at least 6 inches in diameter, or as approved by the District.

5.6.9 Storm Drainage Systems in ROW, Private Streets or Easements

All publicly maintained storm drainage systems shall be located within the ROW, or Private Street with Public easements that provide access to all structures. If the storm drainage system cannot be located in a ROW or Private Street, then an easement granted to the District will be provided.

Public Storm drainage systems in easements will be allowed only after all reasonable attempts to place the drains in the ROW have been exhausted. Provisions shall be made for vehicular access to manholes for preventive maintenance and emergency service.

See Section 5.9 for more discussion on easements.

5.7 Structures

The following section provides design criteria for storm drainage system structures.

5.7.1 Manholes

The following is required for manholes:

- Manholes or curb inlets with manhole-type access shall be installed at all pipe junctions where the depth from rim to invert exceeds 4 feet or where the pipe is 18 inches in diameter or greater.
- Manholes shall conform to the District's applicable standard drawings.
- Where minimum vertical distance is proposed between inlet and outlet pipes in a manhole (or inlet structure serving as a junction structure), pipes must be aligned vertically by one of the following criteria, in order of preference:
  - Standard manhole channel shall have a minimum channel drop across the manhole of 0.20-foot with a maximum drop of 1-foot.
  - Drops between the IE IN & OUT exceeding 1-foot across the manhole will not be channeled.
  - Drops exceeding 3-feet between the IE IN & OUT will require an 18-inch sump to dissipate the energy.
  - Drops exceeding 6-feet between the IE IN & OUT will not be prohibited.
  -
- Manholes shall be required at, but not limited to, the following locations:
  - Changes in vertical grade or horizontal alignment of storm drainpipes
  - Change in size of storm drainpipes
  - Uppermost extent of storm pipe not opened (daylighted) to receive ditch or other open storm drainage system flows. Cleanouts are not allowed in this situation.
- Manholes with pipe horizontal alignment changes of more than 30 degrees in angle shall have the outlet pipe invert at least 0.2 foot in elevation lower than all inflow pipe inverts. This is in addition to the normal grade crossing the manhole.
- In addition, a minimum 3-foot elevation difference between the rim and the top of pipe at all manholes with more than 30 degrees of alignment change is required.

This is to allow for containment of turbulence generated during high flows by such abrupt changes of alignment.

- Standard depth manhole rim frames shall be installed in all paved street locations.
- Manhole rims not in pavement areas, and not in the pavement section of a paved road, shall be set 6 inches above finished grade with a bolt down tamperproof lid.

5.7.2 Inlet Structures

The following is required for inlet structures:

- Inlet structures are required at the following locations, but in no case shall they be spaced farther apart than 250 feet:
  - At the ends of all dead-end streets with a descending grade.
  - At all impervious surface sags and low points.
- Inlet structures located in street sections where there is curb and gutter shall be a curb inlet catch basin per District standards, unless otherwise approved by the District.
- Catch basins with connector storm drains shall connect to a receiving storm drainage system pipe into a manhole, unless otherwise approved by the District.
- Ditch and/or area inlets shall be required to intercept existing flows and convey to the appropriate outlet.
- Any low point structure shall provide an emergency safe overflow pathway.

5.8 Outfalls

Outfalls from drainage facilities shall be designed with adequate energy dissipaters to minimize downstream damage and erosion. All outfalls with exit velocities of more than 4 fps shall be examined with respect to soil type to ensure adequate erosion control. Unless otherwise approved, an outfall elevation shall be submerged by the receiving creek or channel during the peak storm event as specified in Section 5.

Storm drain lines shall enter a creek or drainage channel at 90 degrees or less to the direction of the flow. The outlet shall have a headwall and scour pad or riprap to prevent erosion of the existing bank or channel bottom. The size of the pipe and channel being entered will govern which protective measures are required.

Engineered energy dissipaters, including but not limited to, stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, shall be designed using published references such as the current version of the Hydraulic Design of Energy Dissipaters for Culverts and Channels published by the Federal Highway Administration of the U.S. Department of Transportation, the current version of the ODOT Hydraulics Manual and others. The design reference shall be cited in the stormwater report.

Rock protection at outfalls shall be designed in accordance with information listed in **Table 5-6**.

Table 5-6. Rock Protection at Outfalls

Discharge velocity at design flow, fps	Minimum required protection dimensions

Greater than	Less than or equal to	Type	Thickness, feet	Width	Length (use greater of)	Height over crown, feet
0	5	ODOT Class 50 Riprap[a]	1.5	Diameter + 6 feet	8 feet –OR- 4 x diameter	1
5	10	ODOT Class 200 Riprap	2.5	Diameter + 6 feet	12 feet –OR- 4 x diameter	1
10		Engineered energy dissipater required				

a. The District may require ODOT Class 100 Riprap in areas with likelihood of vandalism.

If the outfall is located in an environmental overlay zone, additional requirements may apply. A permit from the USACE and/or the ODSL may be required. The applicant is responsible for obtaining the proper permits from the regulating agencies.

5.9 Easements and Setbacks

Piped storm drainage systems shall generally be located in the right-of-way. Public storm drainage system facilities not located in the public right-of-way shall be located within an easement granted to the District.

- When design conditions require locating storm drains in easements, the storm drain shall typically be centered in the easement.
- An easement shall be centered on the pipe centerline, unless otherwise approved by the District, and easements shall typically be exclusive. Combined easements shall be a minimum of 20 feet wide with a minimum separation of 5 feet between utilities and be approved by the District on a case-by-case basis.
- All public manholes, junction or inlet structures in easements shall be accessible to District maintenance personnel at all times. A minimum 15-foot-wide access easement is required between the nearest right-of-way and each structure. Paved or gravel access road maybe be required by the District, if access is deemed necessary, and otherwise unavailable.
- Unless shown on a proposed plat of subdivision, all onsite easements shall be furnished to the District for review, approval, and recordation prior to approving the stormwater management plan.
- All offsite easements shall be furnished to the District for review, approval, and recordation prior to approving the stormwater management plan.
- The District may require that an area 5 feet in all directions from the edge of a public manhole, catch basin, cleanout, or field inlet be encompassed in a public right of way or easement granted to the District.
- Access easements shall be provided to all stormwater structures such as manholes, catch basins, and other related structures, as required by the District.
- When a pipe will be stubbed, the easement shall extend a minimum of 5 feet past the end of the stub.
- The center of the Storm pipes in an easement shall be located no closer than 5 feet from the easement line.

The following easement requirements are the minimum requirements established to maintain, repair and/or replace the stormwater infrastructure or open storm drainage system.

- Easements shall be minimum 15-feet wide for pipes up to 24-inches in diameter.
- Easements for pipes over 24-inches in diameter shall be 20-feet wide or greater as determined by the District.
- The District may require wider easements for large trunk sewers, sewers greater than 10-feet deep and areas with topographic constraints such as steep slopes or sites where maintenance, repair or replacement would require a wider easement.
- A reduced easement width must be approved by the District.
- Easement widths shall be increased as required in 5-foot increments.

Table 5-7 lists minimum pipe easement widths per pipe size.

Table 5-7. Minimum Pipe versus Public Easement Widths

Pipe Size (inches)	Minimum Easement Width (feet)
6–12	15
15 < 24	15
24 < 54	20
> 54	30

When a conservation easement is not required, the minimum open storm channel easement width shall extend 5 feet from each side of the top of bank of the open channel.

Structures constructed within easements shall meet the following requirements:

- Structures constructed within easements shall require an encroachment agreement with the District. Approval of the encroachment is at the discretion of the District and may involve the imposition of specific conditions in the granting of such. The applicant will complete an encroachment agreement application and pay all applicable charges and fees.
- The encroachment agreement shall allow the District to remove the structure, as needed, to access the storm drainage system. Replacement of the structure shall be at the property owner's expense.
- The District may require increased protection for the storm drainage system in the vicinity of an encroachment. All special protection requirements and plans will be reviewed and approved by the District. All review and/or approval costs associated with this provision will be paid by the applicant.

5.10 Drains

The following requirements apply to drains installed with development activities.

5.10.1 Slope Intercept Drains

Slope intercept drains are allowed at the following locations:

- Along the upper and lower boundaries of a development where surface and/or ground water can be expected to migrate and cause adverse impacts to the future, or adjacent property owners.
- Along the upper and lower boundaries of a development where slope exceeds 10 percent to prevent drainage from the tributary area above the site.

- Along the top of all cut slopes which exceed two-horizontal to one-vertical (2H:1V) where the tributary drainage area above the cut slope has a drainage path greater than 40 feet as measured horizontally from the hinge point of the cut.

5.10.2 Subsurface Drains/Cutoff Trenches

Subsurface drains (underdrains) shall be provided at the following locations:

- Along the upper and lower boundaries of a development where surface and/or ground water can be expected to migrate and cause adverse impacts to the future, or adjacent property owners.
- For stability on cut and fill slopes, when required by the District.
- For all existing springs or springs intercepted during construction activity for other facilities.
- Where high groundwater exists or when it is necessary to reduce the piezometric surface to an acceptable level to prevent land slippage or under floor flooding of buildings.
- Where recommended by a geotechnical engineer.
- Where possible, a minimum slope of 0.15 foot per 100 feet should be used. The subsurface drain must be installed below the water flow to function properly. The use of a geotextile fabric to line the trench is recommended.

5.10.3 Foundation Drains

The following drainage provisions shall be made for foundation drains in a development:

- Foundation drains shall be piped directly to a storm drain system other than a street gutter. Provisions must be taken so that the design HGL of the receiving storm drainage system does not back up into the foundation drain.
- Foundation drains are prohibited to be piped directly onto the street. If directing drain onto the street is the only possible solution, then the District and local road authority shall consider the circumstances to determine the acceptable solution on a case by case basis. Otherwise, foundation drains shall be piped directly to a storm drain system other than a street gutter.
- Should site topography prevent connecting foundation drains directly to a public storm drain system, the drains for one or more lots shall be piped through a private system to the public storm drainage system. This private storm drainage system shall be located in a dedicated easement and the property owner shall be responsible for the private system maintenance. Any private storm drain piping shall be permitted and constructed in accordance with Oregon Plumbing Specialty Code (OPSC).

5.11 Private Stormwater Pumping Systems

Private stormwater pumping systems are only allowed for private commercial/industrial development. These private stormwater pumps will be permitted only after approval by the District. It is the District experience that pumping systems are not reliable in order to prevent flooding or property damage without the owner assuming significant liability and risk to itself, and the surrounding properties. Therefore, it is the District policy not to allow the pumping of stormwater runoff, unless the developer can meet all of the conditions listed within this section.

- The proposed pump system is not intended to circumvent any development that can provide a gravity storm drainage system, by means of obtaining an easement to provide the required gravity storm drainage system, and safe overflow pathway. Not being able to acquire the necessary easement does not authorize the pumping of stormwater runoff.
- Due to topology a pumping system may be considered, if there is no other possible engineered solution to providing a gravity system, and pumping is the only possible solution to alleviate flooding. Without pumping the property would have no means to develop.
- Pumping stormwater will not be allowed for facilities that are publicly maintained or have multi-property owners sharing the use of the pumping system, such as a partition, subdivision, or other similar development.
- Pumping will only be allowed if the use benefits a single property owner who is the sole responsible person for the liability, risk, ownership, operation, maintenance, replacement, and repair of the private pumping system.
- The pump system must provide storage for a minimum of 25 percent of the runoff volume from a 2-year, 24-hour storm event. An emergency backup power source may be required, at the discretion of the District.
- The pump system must include dual pumps with an external audible and visual alarm system.
- The pump system must be capable of discharging a 100-year storm event.
- The topology of the property must provide an off-site safe overflow pathway, to convey the stormwater runoff from 100-year storm event during a complete failure to an acceptable storm drainage system.
- Applicants will be required to provide assurance that no downstream impacts from the implementation of a stormwater pump system.
- Private storm drainage system for the pump system must transition to gravity and will only be allowed to discharge into an open storm drainage system.
- All pump systems must be privately operated and maintained by a single owner. Prior to final approval of the project served by such a pump system, an agreement establishing responsibility for payment of costs resulting from the operation and maintenance of the pump system must be approved by the District and must be legally recorded.
- An operations and maintenance plan and maintenance covenant, consistent with Section 8 shall be developed for all private stormwater pumps.

SECTION 6. SOURCE CONTROLS

This section presents the Stormwater Management Facility (SMF) source control requirements for site uses and characteristics that have the potential to generate higher levels of pollutants than typical stormwater runoff.

Some site characteristics/uses may generate specific pollutants of concern or levels of pollution that are not addressed solely through implementation of the pollution reduction measures identified in Section 4**.** The site characteristics/uses in this section have been identified as potential sources of chronic loadings or acute releases of pollutants such as oil and grease, toxic hydrocarbons, heavy metals, toxic compounds, solvents, abnormal pH levels, nutrients, organics, bacteria, chemicals, and suspended solids. This section presents controls for managing these pollutants at their source.

6.1 Introduction and Applicability

Source control requirements apply to all developments with high-risk characteristics as defined in Section 6.1.1 including new development, redevelopment, tenant improvements, or those existing sites proposing new offsite discharges.

Source controls shall be applied to the areas of the site with high-risk characteristics as well as any areas hydraulically connected to a high-risk area. With redevelopment projects, only areas that are being disturbed with the redevelopment are required to make structural source control changes.

6.1.1 Source Control Triggers

Projects with the following site uses/characteristics are considered to be high-risk and are subject to source control requirements. Refer to the applicable subsection of this section and follow the requirements to design source controls for the proposed site use.

- Fuel Dispensing Facilities and Surrounding Traffic Areas (Section 6.3)
- Above-Ground Storage of Liquid Materials (Section 6.4)
- Recycling and Solid Waste Storage Areas (Section 6.5)
- Exterior Storage of Bulk Materials (Section 6.6)
- Material Transfer Areas/Loading Docks (Section 6.7)
- Equipment and/or Vehicle Washing Facilities (Section 6.8)
- Equipment and/or Vehicle Repair Facilities (Section 6.9)
- Land with Suspected or Known Contamination (Section 6.10)
- Covered Vehicle Parking Areas for Commercial or Industrial Uses (Section 6.11)
- Industrial and Commercial High Traffic Areas (Section 6.12)

Applicants are required to address all high-risk site characteristics listed above. For example, if a development includes both a fuel dispensing area and a vehicle washing facility, the source controls in both Sections 6.3 and Section 6.8 will apply.

The requirements of this section are in addition to the applicable requirements as identified in other sections of these standards. Developments that have existing or

proposed offsite stormwater management facilities are not exempt from the source control requirements of this section.

6.1.2 Goals and Objectives for Source Control

The specific source control requirements are based on the following goals and objectives:

- Prevent stormwater pollution by eliminating pathways that may introduce pollutants into stormwater.
- Protect soil, groundwater, and surface water by capturing pollutants and reducing impacts to the environment.
- Redirect flows to the sanitary sewer system from areas with the potential for relatively consistent wastewater discharges (such as vehicle washing facilities).
- Direct areas that have the potential for pollutant releases or accidental spills and are not expected to regularly receive flow or require water use (such as covered fuel islands or covered containment areas) to an approved method of containment or disposal.
- Safely contain spills onsite, avoiding preventable discharges to any storm sewers, sanitary and/or storm drainage systems.
- Emphasize structural SMF controls over operational procedures. Structural SMF controls are not operator-dependent and are considered to provide more permanent and reliable source control. Any proposals for operation-based source controls need to describe the long-term viability of the maintenance program.

6.1.3 Request for Alternative Methods of Source Control

Applicants may request an alternative method of source control as part of the variance request process outlined in Section 1.4.1, though such a request may delay issuance of related site development, building and/or plumbing permits. Alternative methods of source control must be reviewed and approved by the District.

6.1.4 Other Applicable Codes or Regulations

Some facilities may be required to obtain a NPDES Industrial Stormwater General Permit 1200-Z issued by ODEQ before discharging to the District's storm sewer system or to waters of the state. The 1200-Z permit includes discharge benchmarks for facilities with industrial activities that are exposed to rainfall and stormwater runoff. The state also has water quality standards listed in Oregon Administrative Rules 340 Division 041 for discharges to surface waters.

Applicants may be required to obtain an Industrial Wastewater Discharge Permit from the wastewater service provider for discharges to the sanitary sewer system. Facilities subject to these requirements are generally commercial or industrial. Typical discharges include process wastewater, cooling water, or other discharges generated by some of the sources in this section that drain to a storm or sanitary sewer system.

Conformance with the requirements of this section does not relieve the applicant of other applicable local, state, or federal codes or regulations. Other applicable regulations may include the hazardous materials storage requirements of articles 79 and 80 of the Oregon State Fire Code; the Spill Prevention, Countermeasure, and

Containment regulations of the U.S. Environmental Protection Agency's 40 Code of Federal Regulations (CFR) 112; the Resource Conservation and Recovery Act; Willamette Basin total maximum daily load programs regulated by the ODEQ; or any other applicable local, state, or federal regulations or permit requirements.

In the event of a conflict, the most stringent local, state, or federal regulations generally apply.

6.2 Requirements for All Sites

The following requirements apply to all sites subject to source control.

6.2.1 Signage Requirements

Informational signage is required for some site uses and activities that have the potential to contaminate stormwater. Proper signage addresses good housekeeping rules and provides emergency response measures in case of an accidental spill.

All signage shall conform to the following requirements:

- Signs shall be located and plainly visible from applicable activity areas.
- More than one sign may be needed to accommodate larger activity areas.
- Signs shall be water and weather resistant.
- Signs shall include the following information:
  - Safety precautions
  - Immediate spill response procedures (for example: "Turn the valve located at..." or "Use absorbent materials")
  - Emergency contact(s) and telephone number(s)
- Signs may need to be in more than one language if required to communicate effectively with employees and delivery personnel.
- Signs may need to meet retro-reflectivity standards dependent on the use and intent of the sign.

6.2.2 Spill Control

Spill response supplies, such as absorbent material, containment booms, and protective clothing, shall be available at all potential spill areas. Any applicable spill response supplies need to be clearly marked and located where the signage is posted and near the high-risk activity area. The spill response supplies should be appropriate to the nature of the potential risk present at the site. More than one spill response kit may be necessary to accommodate larger activity areas.

Employees should be familiar with the site's O&M plan; Spill Prevention, Countermeasure, and Containment plan; and/or proper spill cleanup procedures.

6.2.3 Public Sanitary Sewer Discharge Permit

Many source control strategies require a connection of stormwater drains to the public sanitary sewer system. Connection/discharge to the public sanitary sewer system requires prior written approval by the District. A request to discharge to the public sanitary system shall be submitted as part of the permitting process. All impervious surface areas that can drain into the public sanitary sewer shall be

designed in a manner to eliminate stormwater runoff from entering the sanitary sewer system. The separation of stormwater into the sanitary sewer system is generally accomplished by covering the impervious area that drains into the sanitary sewer and grading the area in a manner that separated the flows.

6.2.4 Source Control Submittal

Applicants shall show the locations of proposed structural source controls (including spill control manholes and shutoff valves) and include documentation of high-risk site uses and the applicable source controls as part of the Stormwater Report and Stormwater Plans (Section 3).

6.3 Fuel Dispensing Facilities and Surrounding Traffic Areas

The requirements in this section apply to all development where vehicles, equipment, or fuel tanks are refueled on the premises, whether it is a gas station, a single-pump maintenance yard, or a small-sized fuel tank. A fuel dispensing facility is defined as the area where fuel is transferred from bulk storage tanks to vehicles, equipment, and/or mobile containers (including fuel islands, above- or below-ground fuel tanks, fuel pumps, and the surrounding pad). Propane tanks are exempt from these requirements.

Any discharge or point of connection to the public or private stormwater system must obtain authorization and permitting by the District. Discharges of hydrocarbons are prohibited to the public sanitary and stormwater sewer systems. When a containment or emergency storage device is used, the owner or responsible person shall contact the District's Environmental Monitoring Division for authorization to open any valve and discharge any substance to a public sanitary or stormwater sewer system. The District shall determine the conditions to discharge or dispose of the substance to safeguard the environment, public health, and safety.

Underground storage tanks or installations requiring a WPCF permit are exempt from these requirements but must go through ODEQ's WPCF permit process.

6.3.1 Cover

The fuel dispensing area shall be covered with a permanent canopy or roof so precipitation cannot come in contact with the fueling activity area. Rainfall shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

- **Covers 10 feet high or less** shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated fueling activity area it is to cover.
- **Covers higher than 10 feet** shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated fueling activity area it is to cover.

6.3.2 Pavement

A paved fueling pad of concrete shall be placed under and around the fueling activity area and shall meet all applicable building code requirements. Sizing of the paved area shall be adequate to cover the activity area, including placement and number of the vehicles or pieces of equipment to be fueled by each pump. Fuel pumps shall be located a minimum of 10 feet from the edge of the fueling pad.

6.3.3 Drainage

The impervious area beneath the cover shall be hydraulically isolated from the surrounding area through grading, berms, or drains.

Drainage from under the cover that is hydraulically isolated shall be directed to the sanitary sewer system. When connecting to sanitary sewer, an oil/water separator shall be installed to collect and detain the runoff from under the cover of a fuel dispensing area. Unless the District requires a different volume, the minimum storage capacity of the oil/water separator and, if needed, an upstream storage sump/vault shall be 1,000 gallons. A flow-stop or shut-off valve is required downstream of the oil/water separator prior to connection with the public sanitary sewer system.

Surrounding runoff must be directed away from the hydraulically isolated fueling pad to a stormwater discharge point that meets all stormwater management requirements of these standards and other applicable code requirements.

Traffic pathways that surround fueling pads are considered high use/high-risk areas and will require a valve on the storm drainage system. Valves installed on storm drainage systems must be installed downstream of all applicable private stormwater quality facilities to accommodate spill containment. These valves must be left open to facilitate stormwater flows during normal conditions, and immediately closed in the event of a spill.

6.3.4 Pretreatment: Oil/Water Separator

Runoff from the fuel dispensing area is required to be pretreated in an oil/water separator with coalescing plates prior to being discharged into the spill control manhole. The purpose of the device is to treat runoff from washing down and cleaning of the fueling area and to prevent small spills from entering the spill control manhole.

Coalescing plate separators shall be designed to achieve a 100-parts per million (ppm) non-polar oil and grease limit in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

- At a minimum, the device will be sized to treat the standard flow from a 5/8-inch hose which is estimated to be 10 gallons per minute.
- Each device shall be verified with the vendor to assure the treatment and flow rate capacity are within the parameters of the device.
- Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.
- All separators shall be maintained per the manufacturer specifications and the private maintenance plan approved by the District.

6.3.5 Spill Control Manholes

A spill control manhole shall be installed as the last device inline to collect and retain the runoff from the fuel dispensing area. The spill control manhole shall have a downstream inline valve prior to point of discharge into an approved storm drainage system. Spills and contaminants are treated and contained within the pretreatment device and spill control manhole until authorization is obtained by the District to release the substance into an approved point of discharge or dispose of it appropriately offsite. In general, with District approval of the acceptable level of contaminants and release method, the contaminants are allowed to be discharged into the public sanitary sewer system. The shut-off valve shall be located below the outlet elevation, and the manhole shall have a minimum dead storage capacity of 60 cubic feet in volume between the invert elevation of the inflow pipe and the invert elevation of the discharge pipe for storage of oil, grease, and solids. The tee section shall extend 18 inches below the outlet elevation. The manhole shall be located on private property and accessible for operation and maintenance activities.

6.3.6 Shut-Off Valves

Shut off valves are required to protect the public or private sanitary or storm drainage systems from risks that may present a danger or risk to the environment, public health, and safety.

Shut-off valves are required for any of the following situations:

- Site or activity areas are exposed to corrosives or oxidizers that can harm storm drainage system components (such as, but not limited to, battery acid).
- Substances (such as, but not limited to, oil and grease) that do not settle or remain in one location and are capable of being dissolved in or float on water. These substances can spread rapidly into downstream storm drainage system and disposal systems, causing widespread impacts and difficult cleanup situations.
- Substances that are known to infiltrate through soils and contaminate groundwater.
- Traffic pathways that surround fueling pads are considered high use/high-risk areas and will require a valve on the storm drainage system. Valves installed on storm drainage systems shall be installed downstream of all applicable private stormwater management facilities to accommodate spill containment. These valves shall be left open to facilitate stormwater flows during normal conditions, and ***immediately*** closed in the event of a spill.
- Fueling pads require a valve downstream of the spill control manhole. Valves installed on sanitary sewer systems shall be installed before the public sanitary sewer system tie-in. These valves shall be kept closed and opened upon approval by the District. The valve shall be closed ***immediately*** after the approved discharge activities are completed.
- Shut-off valves shall be located on private property and downstream of all stormwater management facilities. All valves shall be installed and maintained per the manufacturer's recommendations and the private maintenance plan approved by the District. The applicant must also obtain a plumbing permit from the Local Building Codes Division to install plumbing on private property.

6.3.7 Bulk Fuel Terminals

Bulk fuel terminals, also known as tank farms, require the following:

- **Secondary containment** equal to 110 percent of the product's largest container or 10 percent of the total volume of product stored, whichever is larger.
- **A separate containment area for all valves, pumps, and coupling areas,** with sub-bermed areas either in front of or inside the main containment areas. These sub-bermed areas shall have rain shields and be directed to a public sanitary sewer system with a valve maintained in the closed position to control unauthorized discharges. If no public sanitary sewer is available, drainage shall be directed to a temporary holding facility for proper disposal and may require a WPCF permit from the Water Quality Division of ODEQ.
- **An impervious floor within all containment areas** is required to prevent spills from contaminating the groundwater.
- **Truck loading and off-loading areas** shall be covered to prevent spills from entering the public sanitary or storm system. To prevent the discharge of spills a shut-off valve is required as identified for fuel dispensing facilities.
- **Shut-off valves** shall be installed for the drainage of the required containment facilities for a tank yard. The valves shall be installed downstream of the primary containment area and kept closed. Valves installed for the drainage of the truck pad and sub-bermed containment areas shall be installed downstream of the stormwater management facilities including the spill control manhole.
- **Approval of a batch discharge from the District** is required before discharging a containment area into a public sanitary or stormwater system. This approval will determine appropriate disposal methods, identify pretreatment requirements (if applicable), and approval of the discharge. Pretreatment and testing may be required to establish the specific characteristics of the substance to be discharged. Contact the District's Environmental Monitoring Division to request authorization for batch discharge.
- Underground fuel tanks less than 4,000 gallons in size are subject to additional permitting requirements by ODEQ, and tanks larger than 4,000 gallons are referred to the EPA. For technical questions and permitting, call ODEQ's Northwest Region Portland office and ask for the Underground Storage Tank Permitting Department. The installations of underground storage tanks are subject to all requirements and permits per the Local Building and Oregon Plumbing Specialty Code (OPSC).

6.3.8 Additional Fuel Dispensing Facilities Requirements

Track spill control manhole and shut-off valve installations.

Installation, alterations, or removal of above-ground fuel tanks larger than 55 gallons, and any related equipment may be subject to additional building permit and fire department requirements. For technical questions and permitting, contact the Local Building Code Authority and the District's Development Review Division.

6.4 Above-Ground Storage of Liquid Materials

The requirements in this section apply to all development where there is any exterior storage of liquid chemicals, food products, waste oils, solvents, process wastewaters, or petroleum products in above-ground containers, in quantities of 50 gallons or more. This includes both permanent storage and temporary storage areas.

6.4.1 Containment

Liquid materials shall be stored and contained in such a manner that if the container(s) is ruptured, the contents will not discharge, flow, or be washed into a drainageway, public storm or sanitary sewer system. A containment device and/or structure for accidental spills shall have capacity to capture a minimum of 110 percent of the product's largest container, or 10 percent of the total volume of product stored, whichever is larger.

Double-walled containers may be exempt from these spill containment requirements.

Quantity thresholds of products that are generally exempt from these spill containment measures include: Janitorial, cleaning, office and stationary supplies packaged for consumer use in containers less than 100 pounds net weight or 15 gallons net volume are exempt from spill containment measures.

Note: This does not include cleaners or solvents used for cleaning machinery or motor vehicle and machine parts.

6.4.2 Cover

Storage containers (other than tanks) shall be completely covered so rainfall and stormwater runoff cannot come in contact with them. Runoff shall be directed from the cover to a SMF that meets all applicable code requirements.

Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

6.4.3 Pavement (Impervious Surface)

An impervious surface storage area is required unless otherwise approved by the District's Development Review Division. The storage area shall be an impervious surface area and shall meet all applicable zoning and building code requirements. Compactors, containers, and drop boxes shall be located on a level Portland Cement concrete pad, a minimum four inches thick, at ground level or other location compatible with the local collection service franchisee's equipment at the time of construction. The pad shall be designed to discharge surface water runoff to avoid ponding. Sizing of the impervious areas shall be adequate to cover the area intended for storage.

6.4.4 Drainage

All impervious storage areas shall be hydraulically isolated through grading, berms, or drains.

- **Covered storage areas**. Significant amounts of precipitation are not expected to accumulate in covered storage areas, and drainage facilities *are not required* for the contained area beneath the cover. If the applicant elects to install drainage facilities, the drainage from the hydraulically isolated area shall be directed to an approved pretreatment, containment facility and point of discharge.
- **Uncovered storage areas with containment**. Water will accumulate in uncovered storage areas during and after rain. Any *contaminated* water cannot simply be drained from the area. It must be collected, inspected, and possibly tested at the expense of the property owner before proper disposal can be determined and authorized. Frequent draining may be required during the wet season, which may prove costly. Some type of monitoring may also be needed to determine the characteristics and level of contamination of the stormwater.

All substances and methods discharged to the sanitary sewer shall be authorized by the District prior to release. The District considers these batch discharges and shall require pretreatment prior to discharge. An industrial discharge permit may be required. Pretreatment requirements shall be set as part of the discharge approval process, based on the types and quantities of material to be discharged. A discharge evaluation shall be performed before connection to a sanitary sewer or storm sewer system. Testing may be required to establish characteristics of the wastewater or contaminated stormwater and to verify that local discharge limits are not exceeded. For batch discharge applications and industrial discharge permit requirements, call the District's Environmental Monitoring Division.

6.4.5 Additional Requirements

Additional requirements include:

- **Covered storage areas**: A shut-off valve may be required for the covered storage area if the applicant proposes to install drainage facilities to an approved public sanitary sewer connection. The District will make this determination based on the type of material stored and the proposed point of discharge.
- **Uncovered storage areas**: A shut-off valve shall be installed in the storage area so excess stormwater can be drained out of the activity area and directed either to the storm drainage facilities (*if clean*) or into the public sanitary sewer or authorized pretreatment facility (*if contaminated*). Except when stormwater is being discharged, the valve shall always be kept closed so any spills within the activity area can be effectively contained.
  - Tank farms shall follow the criteria established for bulk fuel terminals in Section 6.3. Exceptions may be granted, based on the product being stored. Requests for an exception will require an additional review process and may delay issuance of related building permits.
  - Storage of reactive, ignitable, or flammable liquids shall comply with the Uniform Fire Code as adopted by the State of Oregon. Source controls presented in this section are intended to complement, not conflict with, current fire code requirements. None of these requirements shall exclude or supersede any other requirements in this manual, other District permit

requirements, or State and Federal laws pertaining to water quality. Contact the District for further information and requirements.

6.5 Recycling and Solid Waste Storage Areas

The requirements in this section apply to all commercial and industrial development with facilities that store recycling materials and/or solid wastes (both food and non-food wastes). A solid waste storage area is a place where solid waste containers are collectively stored. Solid waste receptacles may include, but are not limited to compactors, containers, carts, barrels, dumpsters, and garbage cans. Requirements of this section also apply to areas used to collect and store refuse or recyclable materials. This section applies to multi-family residential sites of five or more units if a shared trash collection area is proposed. However, the requirements of this section do not apply to single-family homes or debris collection areas used for temporary storage of wood pallets or cardboard.

The following design requirements apply for approval of solid waste storage and handling activity areas in the District. All receptacles used for storage of solid waste and recyclables (except cardboard per Section 6.5) are required to be designed by the manufacturer to fully contain liquid waste if maintained properly and must remain in properly functioning condition throughout their period of use. Per the most current version of the Clackamas County Solid Waste and Recyclable Material collection code, containers used to store cooking oils, grease, or animal renderings for recycling or disposal shall not be located in the principal recyclable materials or solid waste storage areas.

These materials shall be stored in a separate storage area designed for such purpose. Restaurants and other businesses that collect and store oil and grease shall create a separate space under their covered enclosure to store the oil/grease container that does not block access to garbage, food, and recycling containers. Material collection, containers used to store cooking oils, grease, or animal renderings for recycling or disposal shall not be located in the principal recyclable materials or solid waste storage areas. These materials shall be stored in a separate storage area designed for such purpose.

6.5.1 Cover

Restaurants and other businesses that collect and store oil and grease shall create a separate space in accordance with local zoning and building codes. Additional details on these requirements can be found in the local Solid Waste and Recyclable Material collection code.

A permanent canopy, roof, or awning may be required to cover the solid waste storage area and shall be constructed to cover the activity area so rainfall and stormwater runoff cannot come in contact with the waste materials being stored. The cover shall be sized relative to the perimeter of the hydraulically isolated activity area it is to cover. Runoff shall be directed from the cover to a stormwater disposal point that meets all applicable code requirements.

If the structure is covered, then the building drain shall be connected to the public sanitary sewer in accordance with local building and plumbing codes. If the structure is not covered, it cannot be drained into the public sanitary sewer system. Uncovered structures shall drain into the storm drainage system with the applicable oil/water separator and cartridge filter water quality treatment.

6.5.2 Pavement

If a paved waste storage area is required. The structure and impervious surface area shall be designed and constructed in accordance with all applicable zoning, building and plumbing codes. The pad shall be designed to discharge surface water runoff to avoid ponding. Sizing of the paved area shall adequately cover the activity area intended for refuse storage, or the trash compactor(s) and associated equipment.

6.5.3 Isolation

Hydraulic isolation shall be provided for the solid waste storage activity area and shall be designed to prevent uncontaminated stormwater runoff from entering the area and carrying pollutants away. Runoff occurring outside the hydraulically isolated area shall be directed to a stormwater disposal point that meets all applicable code requirements. This can be achieved by reverse grading at the perimeter of an activity area, perimeter curbing or berming, or the use of area drains to collect and divert runoff.

6.5.4 Drainage

The paved area under the cover shall be hydraulically isolated, meaning no stormwater draining into or liquids draining out of the covered storage area. Hydraulic isolation may include installation of a berm or grading that prevents uncontaminated stormwater from running into the waste storage area and ensures that any fluid under the enclosure drains to the sanitary system. An oil/water separator may be required as pre-treatment before discharging to the sanitary system, per Section 6.3.4.

6.5.5 Non-gravity Option

Activity areas that do not have gravity sanitary sewer service may be allowed to install a pressurized system in accordance with local building and plumbing codes. With these types of installations, the following items shall be provided at the time of building permit application:

- Verification or evidence that gravity service cannot be obtained.
- Details of an electronic sump pump system equipped with a float switch.
- District approval.

Pressurized system installations are considered “permanent equipment” and deemed the property owner’s liability in the event of system failure or if the property becomes vacated.

The Local Building and Plumbing Codes Authorities will review all sump pump or sewage ejector installations for compliance with the UPC and Oregon State Plumbing Specialty Code.

6.6 Exterior Storage of Bulk Materials

The requirements of this section apply to developments that stockpile or store materials in outdoor containers that may erode or have negative stormwater impacts. The materials are separated into the following three categories, based on risk assessments for each material stored: high-risk, low-risk, and exempt materials.

These include, but are not limited to, the types found in **Table 6-1** below.

Table 6-1. Stormwater Impacts of General Material Types

High Risk Materials	Low Risk Materials	Exempt Materials
• Recycling materials with potential effluent (including mercury- containing items) • Corrosive materials (e.g., lead-acid batteries) • Storage and processing of food items • Chalk/gypsum products • Feedstock/grain • Material by-products with potential effluent • Fertilizer • Pesticides • Oily or otherwise contaminated vehicle/equipment parts • Lime/lye/soda ash • Animal/human wastes	• Recycling materials without potential effluent • Used tires • Non-oily scrap or salvage • Treated lumber • Metal • Sawdust/bark chips • Sand/dirt/soil (including contaminated soil piles) • Material by-products without potential effluent • Unwashed gravel/rock • Compost • Asphalt • Non-leaking vehicles in stages of disassembly	• Rock • Finished untreated lumber • Rubber and plastic products (hoses, gaskets, pipe, etc.) • Clean concrete products (blocks, pipe, etc.) • Glass products (new, non-recycled) • Inert products

Materials with any of the following characteristics are exempt from the requirements of this section:

- Have no measurable solubility or mobility in water and no hazardous, toxic, or flammable properties.
- Exist in a gaseous form at ambient temperature.
- Are contained in a manner that prevents contact with stormwater (excluding pesticides and fertilizers).

6.6.1 Cover

Low-risk materials shall be covered with a temporary plastic film or sheeting at a minimum.

High-risk materials shall be permanently covered with a canopy or roof to prevent stormwater contact and minimize the quantity of rainfall entering the storage area. Runoff shall be directed from the cover to an approved stormwater disposal point that meets all applicable code requirements.

Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated activity area.

6.6.2 Pavement

Low-risk material storage areas are not required to have an impermeable surface.

High-risk material storage areas shall be impervious beneath the structural cover. Sizing of the impervious surface area shall adequately cover the activity area intended for storage.

6.6.3 Drainage

Low-risk material storage areas are typically allowed in areas served by standard stormwater management facilities. However, all erodible materials being stored must be protected from rainfall and stormwater runoff.

If materials are erodible, a structural containment barrier shall be placed on at least three sides of every stockpile. The barrier shall be tall enough to prevent the contained and uncontaminated area from mixing stormwater runoff into the storage area with the stored materials as a result of being blown or washed away. If the area under the stockpile is paved, the barrier can be constructed of asphalt berms, concrete curbing, or retaining walls. If the area under the stockpile is unpaved, sunken retaining walls or ecology blocks can be used. The applicant shall clearly identify the method of containment on the building and/or site plans.

For high-risk material storage areas, the paved area beneath the structural cover shall be hydraulically isolated through grading, structural containment berms or walls, or perimeter drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. If significant amounts of precipitation are not expected to accumulate in covered storage areas, drainage facilities *are not required* for the contained area beneath the cover. If the applicant elects to install drainage facilities, the drainage from the hydraulically isolated area shall be pretreated and connected to a point of discharge approved by the District. In such a case, an evaluation will be done to determine if an NPDES Discharge permit is required.

6.6.4 Additional Requirements

Additional requirements include:

- Storage of pesticides and fertilizers may need to comply with specific regulations outlined by ODEQ. For answers to technical questions, call ODEQ's Northwest Region Portland office.
- A sampling manhole or other suitable stormwater monitoring access point may be required to monitor stormwater runoff from the storage area. This may apply to certain types of storage activities and materials if an alternative source control is proposed. The District's Development Review Division will review for applicability of this requirement.
- Hazardous materials signage shall be provided at the storage area where hazardous materials or other materials of concern are stored. Signage shall be located so it is plainly visible from all storage activity areas. More than one sign may be needed to accommodate large storage areas.
- A shut-off valve may be required for the structurally covered storage area if the applicant elects to install drainage facilities and discharge into a sanitary system. The District's Development Review Division will make this determination based on the type of material stored and the proposed system receiving the discharge.

6.7 Material Transfer Areas/Loading Docks

The requirements in this section apply to all developments proposing the installation of new material transfer areas, or structural alterations to existing material transfer areas (e.g., access ramp regrading, leveler installations).

The requirements apply to all material transfer areas, including loading/unloading docks, bay doors, and any other building access point(s) with the following characteristics:

- The area is designed (size, width, etc.) to accommodate a truck or trailer being backed up to or into it; and,
- The area is expected to be used specifically to receive or distribute materials to and from trucks or trailers.

The requirements may not apply to areas that are used only for mid-sized to small-sized passenger vehicles and that are restricted (by lease agreements or other regulatory requirements) to storing, transporting, or using materials that are classified as domestic use: Primary educational facilities (elementary, middle, or high schools), buildings used for temporary storage (a lease agreement will need to be provided), and churches. Contact the District's Development Review Division for help in determining if requirements apply.

6.7.1 Pavement

An impervious surface area such as asphalt or concrete shall be placed underneath and around the loading and unloading activity area and shall meet all applicable building code requirements. This will reduce the potential for soil contamination with potential impacts on groundwater and will help control any acute or chronic release of materials present in these areas.

6.7.2 Isolation

Loading Docks. The first 3 feet of the paved/covered area, measured from the building or dock face, shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away.

Bay Doors and Other Interior Transfer Areas. Bay doors and other interior transfer areas shall be designed so that stormwater runoff does not enter the building. This can be accomplished by grading or drains.

6.7.3 Drainage

Loading Docks. Drainage from the hydraulically isolated, covered area shall be directed to a pretreatment facility and then the sanitary sewer. Surrounding runoff and drainage from the access ramp shall be directed away from the hydraulically isolated area to a SMF that meets all applicable requirements of this manual.

Non-Gravity Option. Areas which cannot gravity discharge may be allowed to install a pressurized system. With these types of installations, the following items shall be provided at the time of building permit application:

- Proof that a gravity system cannot be obtained.
- Details of an electronic sump pump system equipped with a float switch.
- A point of discharge approved by the District.

Pressurized system installations are considered “permanent equipment” and deemed the property owner’s liability in the event of system failure or if the property becomes vacated.

The Local Building Codes Authority will review all sump pump or sewage ejector installations for compliance with the UPC and Oregon Plumbing Specialty Code (OPSC).. The District’s Development Review Division will review the pressurized systems for compliance with the Standards.

Bay Doors and Other Interior Transfer Areas. Because interior material transfer areas are not expected to accumulate precipitation, installation of floor drains is not required or recommended. It is preferable to handle these areas with a dry mop or absorbent material. If interior floor drains are installed, they shall be plumbed to an approved pretreatment facility and discharge into the public sanitary sewer.

6.7.4 Shut-off Valves

A shut-off valve downstream of the transfer area may be required to prevent spills and contamination from leaving this area. The District’s Development Review Division will make this determination, based on the type of material being transferred, pretreatment facility and the approved point of discharge.

Shut-off valves are required to protect health, safety and the environment from spills and substances that may provide a risk. Shut-off valves are required for any of the following situations:

- Site activity areas that are exposed to corrosives or oxidizers that can harm storm drainage system components (such as battery acid).
- Substances (such as oil and grease) that do not settle or remain in one location and are capable of being dissolved in or float on top of water. These substances can spread rapidly into downstream systems, causing widespread impacts and difficult clean-up situations.
- Substances that are known to infiltrate through soils and contaminate groundwater.

Valves located in material transfer areas are typically left open to facilitate drainage during normal conditions, and immediately closed in the event of a spill.

Prior to transfer activities of harmful substances, the valves shall be closed and reopened only after the transfer is complete. The shut-off valves must be located on private property and downstream of the exposed area’s collection system.

All valves shall be installed and maintained in accordance with manufacturer specifications. For additional information about installation of shut-off valves contact the Local Building Codes Authority.

6.7.5 Addition Requirements

Additional requirements include: Bay doors and other interior transfer areas shall provide a 10-foot “no obstruction zone” beyond the entrance within the building. This will allow the transfer of materials to occur with the truck or trailer end placed at least 5 feet inside the building, with an additional staging area of 5 feet beyond that. The “no obstruction” zone shall be clearly identified on the site plan at the time of the building permit application and shall be painted at the facility with bright or fluorescent floor paint.

6.8 Equipment and/or Vehicle Washing Facilities

The requirements in this section apply to all development within designated equipment, vehicle washing or cleaning areas. This includes smaller activity areas, such as wheel-washing stations. Residential sites are exempt.

6.8.1 Cover

The washing area shall be covered with a permanent canopy or roof so precipitation cannot come in contact with the washing activity area. Precipitation shall be directed from the cover to a SMF that meets all applicable code requirements.

- Covers 10 feet high or less shall have a minimum overhang of 3 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated washing activity area it is to cover.
- Covers higher than 10 feet shall have a minimum overhang of 5 feet on each side. The overhang shall be measured relative to the perimeter of the hydraulically isolated washing activity area it is to cover.

6.8.2 Pavement

The wash pad area shall be impervious surface such as asphalt or concrete placed under and around the washing activity area and shall meet all applicable building code requirements. Sizing of the paved area shall adequately cover the activity area, including the placement of the vehicle or piece of equipment to be cleaned.

6.8.3 Drainage

The paved area beneath the cover shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Drainage from the hydraulically isolated area shall be directed to a pretreatment facility and then the sanitary sewer. If connected to the public sanitary sewer, and, depending on the washing compounds used (i.e., brighteners), an industrial discharge permit to the public sanitary sewer system may be required. For further questions, contact the Development Review Division. Surrounding runoff shall be directed away from the hydraulically isolated washing pad to a SMF that meets all applicable requirements.

6.8.4 Oil Controls

All vehicle and equipment washing activities shall be equipped with an approved oil/water separator system. The system shall comply with the public sanitary sewer discharge limits. For discharge requirements and limitations to the public sanitary sewer system contact the District's Environmental Monitoring Division.

For washing areas protected with a cover or located inside a structure, the following design criteria apply to oil/water separators discharging a public sanitary sewer system:

- Baffled oil/water separators and spill control (SC-type) separators shall not be allowed for use with equipment and/or vehicle washing applications. Note: Activities and processes of a washing facility change over time, and the introduction of heat and surfactants may occur.

- Coalescing plate separators shall be designed to achieve a 100-ppm non-polar oil and grease limit in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.
  - The minimum design flow rate shall be 10 gallons per minute which is the estimated flow from a 5/8-inch hose.
  - For specially designed washing units, check the vendor specifications for maximum flow rates.
- Any pumping devices shall be installed downstream of the separator and pretreatment facility to prevent oil emulsification.
- Separator details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.
- All separators shall be maintained per the manufacturer specifications and District approved maintenance plan.

Onsite wash recycling systems may be used for oil control as long as they can meet effluent discharge limits for the public sanitary sewer system. A detail of the wash recycling system and vendor specifications identifying effluent efficiencies shall be submitted as part of the building plans at the time of the building permit application.

6.9 Equipment and/or Vehicle Repair Facilities

The requirements in this section apply to all development within designated equipment or vehicle repair including areas conducting body work.

6.9.1 Cover

Repair areas shall be located indoors so precipitation cannot come in contact with the repair area. Precipitation shall be directed from the repair facility roof to a SMF that meets all applicable District requirements.

6.9.2 Floors

The floor shall be impervious material such as concrete.

6.9.3 Drainage

The exterior of the repair area shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Runoff shall be directed away from the hydraulically isolated repair area to a SMF that meets all applicable requirements.

6.9.4 Storage

Interior: Chemicals used for cleaning machinery or motor vehicle and machine parts (including, but not limited to, lubricants, used fluids, solvents, cleaners, etc.) of any quantity must be stored in or on secondary containment structures.

Exterior: Chemicals and materials must be stored in a manner consistent with the requirements set forth in Section 6.4 and Section 6.6.

6.9.5 Oil Controls

All vehicle and equipment repair areas with floor drains and/or shop sinks must have an approved oil/water separator system and comply with the District's sanitary sewer discharge standards. Details on oil/water separator design criteria are located in Section 6.3.4.

6.10 Land with Suspected or Known Contamination

The requirements in this section apply to all development projects that disturb property at risk, suspected, or known to contain pollutants in the soil or groundwater. This includes development that is surrounded by properties found to have trace pollutants. These requirements will also be applied to any property that is seeking to make a new connection to a public storm system or drainageway from a property that is at risk, suspected, or known to contain pollutants in the soil or groundwater. To avoid confusion with references to water quality pollutants throughout this manual, this section refers to pollutants as contaminants and/or contamination.

Because of Local, State, and Federal regulations, special handling and management of soils, groundwater, and surface drainage may be necessary. As a result of these regulations, sites with suspected or known contamination require a more detailed review process that may delay issuance of related site plan and building permit approvals. Applicants are advised to contact the Development Review Division early in the planning process (before plan submittal) if they are aware or suspect the site has contaminants or is adjacent to a contaminated site.

To research contaminant information, refer to ODEQ's Environmental Cleanup Site Information database.

- If records indicate there is a potential of contamination on the site, the applicant must contact ODEQ prior to pre- and post-construction activities. For technical questions related to site contamination and clean-up, contact the Land Quality Division of ODEQ.
- All regulatory divisions or departments of ODEQ referenced in this section can be reached by calling ODEQ's Northwest Region Portland Office.
- If a Phase 1 ODEQ Site Assessment was required, the report will be submitted to the District for review.
- If contamination is discovered subsequent to site plan approval the owner shall immediately take steps to protect health, safety and the environment and contact the District and ODEQ. Plan approval is suspended until the contamination issues are resolved.

Contaminants have the potential to become entrained and transported through exposure to construction activities and post-construction design elements of a development. The requirements in this section apply to:

- Excavation and stockpiling of contaminated soils (soil management)
- Disposal or re-use facilities related to groundwater, foundation or footing drains, interior floor drains in basements or sub-grade structures, construction dewatering, and surface stormwater treatment and storm drainage systems.

Stormwater discharges from sites suspected of contamination, whether proposed as a temporary construction connection or as permanent connection to any public storm, sanitary sewer system or drainageway, will require a special authorization from the District and

Environmental Monitoring Division. After reviewing the proposal and a characterization of the contaminants on the site, the District and/or Environmental Monitoring Division will make one of the following decisions:

- Approve discharges to the public storm and/or sanitary sewer system with restrictions such as described in these pages or as is necessary given the nature of the discharge.
- Require the applicant to obtain an NPDES permit from ODEQ for the anticipated discharge prior to connection to a public system.
- Require the applicant to obtain a District's Industrial Pre-Treatment Permit.
- Deny the request to discharge to the public storm and/or sanitary sewer system.
- Allow unrestricted connection to the public storm and/or sanitary sewer system, with an approved monitoring/testing structure.

Contaminants, media, and site conditions are unique to each parcel of land. Sites at risk for contamination shall therefore be reviewed on a case-by-case basis.

6.10.1 Soil Management

Stockpiles of contaminated soils shall be covered with temporary plastic film or sheeting to prevent stormwater from contacting them.

Stockpile perimeters shall have a containment barrier on all four sides of every stockpile to prevent stormwater run-on and material run-off. Barriers can consist of concrete curbing, silt fencing, or other berm materials, depending on the activity, size, and resources available.

Areas under stockpiles of contaminated soils are not required to be paved. However, an impervious layer shall be placed beneath the stockpile to protect uncontaminated areas from potential leachate.

6.10.2 Construction Dewatering

For technical assistance on obtaining a batch discharge approval for construction dewatering activities, contact the District's Development Review Division. The following requirements apply:

- Construction dewatering discharges from contaminated sites to the District's stormwater system are prohibited. Upon approval by the District, these waste streams may be discharged to the sanitary sewer if the discharge meets all standards detailed in Section 6.2.3.
- Laboratory analysis reports with data for all pollutants of concern will be required.
- Installation of required pretreatment technology, an approved sampling point, and/or a meter may be required by the District prior to any discharge to the sanitary sewer is permitted.
- Contact the District for further information on discharging water to the sanitary sewer system.
- If onsite infiltration is the proposed method for disposal, authorizations are required from the District and the Land & Water Quality Divisions of ODEQ. Private infiltration facilities for construction dewatering shall be located and maintained on private property outside the public right-of-way.
- If a public sanitary system is the proposed method of disposal, authorizations are required from the District including the Environmental Monitoring Division and will

be allowed only if extensive pretreatment is implemented and the discharge is approved by the District. All groundwater and surface water discharges to a sanitary sewer system shall meet local discharge limits and will be subject to all fees and discharge volume charges.

- If a public stormwater system is the proposed method of disposal, evaluations of discharge to the public storm system will be based on whether discharges meet, or can be pretreated to meet, requirements of the District, NPDES Discharge Permit or other State and Federal regulations for the receiving drainageway.
- If a drainageway is the proposed method for disposal, authorizations are required from the District, Land and Water Quality Divisions of ODEQ.

6.10.3 Post-Construction Surface Drainage Systems

If onsite infiltration is the proposed method for disposal, authorizations are required from the District, Land Quality, and Water Quality Divisions of ODEQ. Private infiltration facilities shall be located and maintained on private property, outside the public right-of-way.

If a drainageway is the proposed method for disposal, authorizations are required from the District, the Army Corp of Engineers, and both the Land Quality and Water Quality Divisions of ODEQ.

If an offsite public storm or sanitary sewer system is the proposed method for disposal, authorization is required from the District. Evaluations for discharges from sites with suspected contamination will be based on the following:

- Surface drainage systems that are not exposed to industrial activities, contaminated soils, or subsurface discharges are not assumed to contain contaminants and do not pose a threat to public infrastructure. All discharges to a public sanitary sewer system will require an additional review and approval process.
- A permanent monitoring and testing point may be required to ensure compliance with discharge regulations. If monitoring is necessary, a permanent structure (such as a sampling manhole or flow-through vault) shall be constructed per District Standards and installed on the discharge line.

6.10.4 Laboratory Analysis Reports

Laboratory analysis reports are required to identify the characteristics and levels of contamination in the soils and groundwater of a site.

The District will determine the applicable process to review the laboratory reports to determine regulatory authority and requirements. Testing and analysis are highly recommended prior to submitting the site plan. ODEQ permitting and/or review may be required if contaminants are found and the levels of contamination appear to exceed the District discharge regulations. This may delay issuance of the site plans and related building permits.

Laboratory analysis reports shall include the following information:

- Analysis reports shall identify the elevation of the seasonal water table and identify the depth of any perched water aquifers.

- Analysis reports shall identify the method of laboratory testing, the detection level and analytical method used for detection, and the depth of any found contaminants in the soils.
- Minimum test parameters for baseline contaminants shall include metals (arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, silver, and zinc); total petroleum hydrocarbons; and benzene, toluene, ethyl benzene and xylene.
- Test parameters may be required to include other contaminants identified through historical data, research, and environmental assessments as recommended under Section 6.10.

6.10.5 Additional Requirements

Typical structural controls that would need District approval include containment areas, shut-off valves, oil/water separators and pretreatment facilities. If an applicant requests an alternative or exception to any of the source controls identified in this section, the applicant shall engage with District staff. These types of requests require an additional review process and may delay issuance of the site plans and related building or development permits.

6.11 Covered Vehicle Parking Areas for Commercial and Industrial Uses

The requirements in this section apply to all development with a covered vehicle parking area, *except single-family and duplex residential sites*. Projects that add a cover to an existing parking structure are not required to meet these requirements unless the project expands or replaces existing impervious surfaces.

- Top Floor Drainage of a Multi-Level Parking Structure. Stormwater runoff from the top floor shall be directed to a SMF and approved point of discharge that meets all requirements of these Standards.
- Lower Floor Drainage of a Multi-Level Parking Structure. Significant amounts of precipitation are not expected to accumulate in covered vehicle parking areas, and drainage facilities *are not required* for the lower floors. If the applicant elects to install drainage facilities, the drainage from the lower floors shall be directed to the public sanitary sewer system. Prior to discharge all applicable pretreatment and/or oil water separator requirements shall be met.
- Adjacent, Uncovered Portions of the Site. The surrounding uncovered portions of the site shall be designed so precipitation and stormwater runoff does not enter the covered parking areas. This can be accomplished through grading and/or drains.
- Single-level covers (canopies, overhangs, and carports) are exempt from the requirements of this section.

6.12 Industrial and Commercial High Traffic Areas

The requirements in this section apply to all new development with vehicle parking areas for developments zoned industrial or commercial with high-traffic volumes. High-traffic volumes are defined as an average daily traffic of 2,500 vehicles, consistent with ODEQ's Industrial Stormwater Best Management Practices Manual (February 2013).

Industrial and commercial high-traffic areas with a drainage area of over 10,000 SF directed to a single shall have an adequate oil control facility located upstream of the SMF. Parking areas of over 10,000 SF that are divided into drainage areas of less than 10,000 SF do not require this pretreatment.

6.12.1 Oil Controls

An oil/water separator with coalescing plates shall be installed between the surface drainage catchment structure and the stormwater management treatment facility. The purpose of the device is to treat and prevent hydrocarbons from entering the SMF. This device shall be maintained per the manufacturer's specifications and the approved operations and maintenance plan.

Coalescing plate separators shall be designed to achieve a 100-ppm non-polar oil and grease limit in the effluent from the peak flow generated by the washing activity. Testing information must be submitted by the manufacturer of the unit that supports the 100-ppm effluent standard at the calculated flow rate.

Flow rates will be determined by the drainage area served by the device. The device will be sized to treat the Water Quality Storm Event as specified in Section 4.2.

For Proprietary Stormwater Treatment Devices (see Section 4.5.10), check the vendor specifications for design flow rates.

Oil controls and pretreatment facility details must be shown on the building plans submitted at the time of building permit application and shall match manufacturer specifications and details, including the unit flow rate, effluent water quality, and maximum process flow rate.

All oil controls and pretreatment facilities shall be maintained per the manufacturer specifications and the approved operation and maintenance plan.

SECTION 7. EPSC MEASURES DURING CONSTRUCTION

All development, regardless of permit status, shall keep sediment laden water and any other forms of stormwater pollution from entering natural drainage systems or the storm drainage system. The requirements for erosion prevention and sediment control shall be implemented in accordance with the District's Erosion Prevention and Sediment Control (EPSC) requirements included in these standards, the District's Sanitary and Stormwater Rules and Regulations and the most current version of the Clackamas County WES EPSC Planning and Design Manual. The applicant for a development permit shall submit an EPSC plan as part of their application specifying appropriate best management practices (BMPs). For site disturbances of 5 acres or larger, the applicant must demonstrate that they also have an ODEQ-approved 1200-C permit.

The applicant for a development permit is ultimately responsible for retaining all soil on the project site and must recognize the potential for changing, or unexpected site and weather conditions. If at any time the District approved EPSC plan is determined to be ineffective, District will require additional controls to be implemented until a site is stabilized. The applicant is responsible for updating the EPSC plan and resubmitting it to the District.

7.1 General Provisions

The following general erosion prevention and sediment control provisions apply to all properties within the District boundary, regardless of whether that property is involved in a construction or development activity.

- The use of erosion prevention techniques, including proper site planning and construction phasing, shall be emphasized, rather than sediment control measures. Erosion and sediment control practices shall be designed and implemented to maintain water quality; protect fish and wildlife habitat; maintain natural vegetation; reduce the use of pesticides, fertilizers, chemicals; and manage dust.
- Construction within waterways shall be pursuant to permits issued by State and Federal agencies having jurisdiction and shall apply their regulations. Pollutants such as, but not limited to, fuels, lubricants, asphalt, concrete, bitumens, raw sewage, and other harmful materials shall not be discharged into rivers, wetlands, streams, impoundments, undisturbed Buffers, or any storm drainage system, or at such proximity that the pollutants flow to these watercourses.
- The use of water from a stream or impoundment, wetland, or sensitive area, shall not result in altering the temperature or water quality of the water body in violation of Oregon Administrative Rules, and shall be subject to water rights laws. All sediment-laden water from construction operations shall be routed through sedimentation basins, filtered, or otherwise treated to remove the sediment load before release into the surface water system.
- Construction shall be done in a manner to minimize adverse effects on wildlife and fishery resources pursuant to the requirements of local, state, and federal agencies charged with wildlife and fish protection.
- Natural Vegetation

– As far as is practicable, natural native vegetation shall be protected and left in place. Disturbed areas shall be carefully located and marked to reduce potential damage.

- Trees shall not be used as anchors for stabilizing working equipment.
- During clearing operations, trees shall not be permitted to fall outside the disturbed area. In areas designated for selective cutting or clearing, care in falling and removing trees and brush shall be taken to avoid injuring trees and shrubs to be left in place.
- Where natural vegetation has been removed, or the original land contours disturbed, vegetative ground cover shall be planted and established in accordance with the wet weather standards in Section 7.2.6.
  - The use of hazardous chemicals, including pesticides, insecticides, herbicides, defoliants, soil sterilant, and fertilizers, must strictly adhere to Federal, State, County, and Local restrictions.
  - All pesticides, fertilizers, and chemicals delivered to the job site shall be covered and protected from the weather. None of the materials shall be exposed during storage. Waste materials, rinsing fluids, and other such material shall be disposed of in such a manner that pollution of groundwater, surface water, or the air does not occur. In no case shall toxic materials be dumped into drainageways.
  - Dust and other particulate matters caused by development activity containing pollutants may not settle on property and/or be carried to waters of the state through rainfall or other means. Dust shall be minimized to the extent practicable as per Section 7.6.5.

7.2 EPSC Standards

This section provides criteria regarding erosion prevention and sediment control standards. The requirements of this section shall apply to all activities requiring an Erosion Prevention and Sediment Control Permit. The applicant for the Erosion Prevention and Sediment Control Permit shall be responsible for meeting these requirements.

7.2.1 Erosion Prohibited

Visible or measurable erosion as defined in Section 5.6 of the District's Rules and Regulations, which enters, or is likely to enter, the public or private storm and surface water system or other properties, is hereby prohibited, and is a violation of these standards, unless authorized by a state or federal permit or certification.

Unless authorized by a State or Federal permit or certification, no person shall create physical erosion by dragging, dropping, tracking, or otherwise placing or depositing, or permitting to be deposited, mud, dirt, rock or other such debris upon a public street or into any part of the public storm and surface water system, or any part of a private storm and surface water system which drains or connects to the public storm and surface water system. Any such deposit of material shall be immediately removed using hand labor or mechanical means. No material shall be washed or flushed into any part of the storm and surface water system until all mechanical means to remove the debris have been exhausted and preventative sediment filtration is in place. The applicant of the property, permittee, under a site development permit, together with any person or persons, including but not limited to the Contractor or the Engineer who causes such erosion, shall be held responsible for violation of these standards.

7.2.2 EPSC Plan

An EPSC plan shall be prepared in accordance with the requirements of Section 7.4 of these standards for all sites where an EPSC Permit is required.

7.2.3 EPSC Permits

The applicant for a development permit shall submit an EPSC plan as part of their application specifying appropriate BMPs.

An Erosion Prevention and Sediment Control permit is required under the following conditions:

- Prior to placement of fill, site clearing, or land disturbances, including but not limited to grubbing, clearing or removal of ground vegetation, grading, excavation, or other activities, any of which results in the disturbance or exposure of soils covering an area of 800 SF or greater.
- For disturbed areas or exposed soils of areas less than 800 SF, where the District has determined that site conditions may result in visible and measurable erosion and where the District has provided written notice of the requirement to obtain an erosion prevention and sediment control permit to the property owner. Upon notice by the District, all work shall cease pending receipt of an Erosion Prevention and Sediment Control permit and installation of approved EPSC measures.
- For any lot that includes natural resources regulated by the District, an EPSC permit may be required prior to placement of fill, site clearing, or land disturbances, including but not limited to grubbing, clearing or removal of ground vegetation, grading, excavation, or other activities, any of which has the potential for, or results in visible and measurable erosion, regardless of the area of disturbance.

An EPSC permit shall not be issued for activities on lots that include natural resources, where the site activity has not been authorized, or is not exempt under the provisions of Natural Resources as determined by the District. This provision does not apply where the erosion control permit is associated with correction of a violation of the District Standards or as necessary for public safety, or the protection of property or water quality.

7.2.4 NPDES 1200-CN and 1200-C Permit

In addition to the District EPSC Permit, a NPDES 1200-CN permit is required for projects disturbing one acre up to less than 5 acres of disturbance. The 1200-CN shall be issued by the District along with the local permit.

For disturbances of 5 acres or greater, a District EPSC permit and an ODEQ 1200-C permit is required. The local permit shall be issued by the District. The 1200-C permit shall be obtained directly from ODEQ.

7.2.5 Maintenance and Removal of Stormwater Best Management Practices

The permittee shall maintain the BMPs contained in the approved EPSC plan to continue to be effective during the construction phase, post construction phase, establishment of permanent vegetation, or any other permitted activity. If the stormwater BMPs approved in an EPSC plan are not effective or sufficient as determined by District site inspection, the permittee shall submit a revised plan within three (3) working days of written notification by District. Upon approval of the revised plan by the District, the permittee shall immediately implement the additional BMPs included in the revised plan. In cases where erosion is likely to occur, the District may require the applicant to install interim control measures prior to submittal and/or approval of the revised EPSC plan.

Temporary BMPs, such as sediment fences, shall be removed after permanent vegetation is established.

7.2.6 Wet Weather Stabilization

Where natural vegetation has been removed, or the original land contours disturbed, vegetative ground cover shall be planted and established by October 1 and continue to function through May 31 of the following year, or as approved by the District. If ground cover is not established by October 1, the open areas shall be protected through May 31 of the following year with straw mulch, erosion blankets, or other methods approved by the District. The site shall be revegetated per a submitted and approved seeding and maintenance plan as soon as practicable after construction has commenced, but not later than September 1. After that date, a stabilization plan approved by the District must be used.

7.2.7 Contaminated Soils

In the event the construction process reveals soils contaminated with hazardous materials or chemicals, all parties shall stop work immediately, ensure no contaminated material is hauled from the site, remove work forces from the immediate area of the contamination, leaving all machinery and equipment, and secure the area from access by the public until such time as a response team has evaluated the situation and identified an appropriate course of action. The applicant and the Contractor shall notify OSHA and ODEQ of the situation upon discovery. The applicant and the Contractor must comply with OSHA and ODEQ statutes and rules.

7.3 Establishing Protective Vegetative Cover Upon Completion of Final Grading

To prevent and minimize erosion, all development shall implement best management practices as required by the EPSC requirements in these Stormwater Standards including, but not limited to, the following stages of a project:

- Vegetation is to be established as soon as practicable after completion of final grading to minimize erosion.
- Prior to final project acceptance, the site shall be permanently stabilized with approved cover or permanent landscaping.
- In cases of a land division, temporary groundcover will be accepted on each lot where home construction will begin within 30 days of project completion.
- To the extent practicable, all stormwater facilities and open channel storm drainage system shall be permanently stabilized prior to use.
- Erosion control measures shall be continued after construction has been completed until the permanent stabilization measures and vegetative ground cover for the site is established and functioning such that erosion has ceased.
- The developer will be responsible for all erosion prevention and sediment control for individual lots until ownership has changed.
- In cases with developments with 1200-C permits, the permittee is responsible for erosion prevention and sediment control until the 1200-C permit is terminated by the state.
- Temporary EPSC measures shall be removed by the developer when permanent stabilization or landscaping has been installed and is functioning.

7.4 EPSC Plan

An EPSC plan shall be prepared in accordance with the requirements of the most current version of the Clackamas WES EPSC Planning and Design Manual and these Standards for all sites where an EPSC Permit is required. The EPSC shall include the items listed below. If a 1200-C or 1200-CN permit is required, the EPSC Plan shall meet the requirements of the 1200-C Program, in addition to the following list.

- The total acreage of the site and the total acreage of the proposed disturbed area.
- Adjacent offsite drainage patterns indicated by arrows.
- Contours at 2-foot intervals. Where slopes exceed 15 percent, contours may be shown at 5-foot intervals.
- North arrow.
- Existing and proposed structures for the project site.
- Existing and proposed access location for the project site.
- Existing project boundaries, rights-of-way, easements, and jurisdictional boundaries clearly identified by note, symbol, or key.
- Adjacent streets with street names and right-of-way boundaries.
- Capacity and condition of existing drainage facilities, including roadside or other drainage ditches, that transport surface water onto, across, or from the project site.
- Existing Sensitive Areas, Vegetated Corridors, and water quality and quantity facilities. For natural drainage features, show direction of flow, Drainage Hazard Areas, and the 100-year floodplain.
- Clearing and grubbing limits.
- Proposed ground contours.
- For multi-phase projects, phasing of any EPSC work clearly indicated on the plan.
- Details of proposed EPSC BMPs EPSC plan to include a KEY signifying BMP measures used and placement on EPSC plan.
- When sedimentation ponds are proposed, at least one cross section detail shall be shown.
- Vegetation/Permanent site stabilization measures.
- If submitted independently of the full project plans, a cover sheet with the proposed name of the development, the name and address of the applicant and developer, the name and address of the Engineer, and the land use authority case file number.

7.5 Supplemental Plans

This section provides criteria for supplemental plan submittals.

- **Mass Grading and Runoff Control:** A phased mass grading and runoff control plan is required for projects where clearing and mass grading activities are proposed during the wet weather period defined in Section 7.2. The runoff control plan shall identify BMPs from Section 7.6.3, **Table 7-2**, or approved alternatives, and be submitted with, or as a revision to, the EPSC plan. All stormwater BMPs specified on the runoff control plan shall be in place and functional prior to commencement of mass grading.
- **Dewatering:** A dewatering plan is required for projects with anticipated excavation activities at or below the ground water table, or if ground water is encountered during

construction. The supplemental plan shall be submitted with, or as a revision to, the EPSC plan and shall identify how dewatering discharges will be managed.

- **Cement Treatment:** A cement treatment plan is required for projects where cement treatment is proposed as a soil amendment (including, but not limited to Portland cement-treated base [CTB], cement kiln dust [CKD], or fly ash). The supplemental plan shall indicate an application rate, work schedule, and limits of work areas proposed for cement treatment. If cement treatment will occur during the wet weather period, the following conditions will also apply:

– The project shall be phased in small manageable areas to minimize the risk for erosion.
– Contractor shall have sufficient erosion prevention stormwater best management practices on site to cover all exposed soil.
– Each phase must be stabilized with temporary or permanent erosion prevention stormwater best management practices before disturbing additional phases.
– The plan shall indicate how runoff from areas treated with cement will not cause or accelerate erosion of soils not treated with cement.
– If the runoff has a high pH (8.5 standard units or higher) then the plan must include an engineered sediment basin or similar impoundment must be used for treatment before discharge. The operator is required to determine the acceptable pH water quality criteria range of site discharge based on criteria of the receiving waterbody according to OAR 340-041-0021. If necessary the operator must adjust or neutralize the high pH water until it is in the range of pH Standard Units (su) using an appropriate treatment BMP such as carbon dioxide (CO_2) sparging or dry ice. The operator must conduct and document pH monitoring of stormwater captured in the sediment impoundment as described below:
    - The operator must begin the pH monitoring period when the engineered soils are first exposed to precipitation and must continue every 7 calendar days and within 24 hours of the occurrence of discharge from the site, or the occurrence of a storm event of 0.10 inches or greater until final stabilization of the area of engineered soils is established.
    - Document date soil amendments were added and final stabilization achieved in the Inspection Reports.
    - The operator must monitor the pH of stormwater in the sediment basins/impoundments and at discharge point locations that receive stormwater runoff from the area of engineered soils before the stormwater discharges to surface waters. Testing shall be done by an approved method and protocol and be performed by an operator knowledgeable in the testing method.
    - The benchmark value for pH is defined in Standard Units (su), and determined by the river basin containing the receiving waterbody according to OAR 340-041-0021. Anytime monitoring indicates that the pH is the maximum allowed su or greater, the operator must either:
        i. Prevent the high pH water from entering storm sewer systems or surface waters; or
        ii. If necessary, adjust or neutralize the high pH water until it is in the range of pH su acceptable for discharge to the river basin containing the receiving waterbody by using an appropriate treatment BMP such as carbon dioxide (CO_2) sparging or dry ice.

The operator must obtain written permission from District (and/or other authorities as applicable) before using any form of chemical treatment other than CO_2 sparging or dry ice.

- If visible or measurable erosion is occurring, all cement treatment activities shall be suspended, and approved erosion prevention facilities shall be applied to all exposed soil.
  - **Chitosan Treatment Systems:** A chitosan treatment plan is required where chitosan is proposed as a BMP. The supplemental plan must include a statement of the intent to use chitosan, the reason for its use and the name, experience and training of the qualified operator who will be monitoring the use of chitosan. Additional requirements are dependent on the form of chitosan proposed, as detailed below:
- **Chitosan acetate:** If chitosan acetate is proposed, the system must be a Chitosan Enhanced Sand Filtration system. The supplemental plan must demonstrate that the system is consistent with the protocol outlined in Washington Department of Ecology's General Use Level Designation for Chitosan Enhanced Sand Filtration.
- **Chitosan lactate (cartridge):** If chitosan lactate is proposed, the system shall be designed by a registered Professional Engineer to meet site specific conditions and comply with the manufacturer's recommendations. A supplemental plan must include the following:
  - Location and design schematic of treatment system, location of inlet and location of discharge and dispersion device design.
  - Method for ensuring filtration or settlement of treated stormwater to comply with the following discharge standards:
- Residual chitosan must not exceed 1 mg/L,
- Turbidity must not exceed ODEQ's Water Quality Standard
- pH must remain within a range of 6.5-8.5
  - Installation protocol: Qualified operator inspection and certification of consistency with the design, prior to system operation and use.
  - Testing and monitoring protocol, including at minimum:
- Qualified operator must field test discharge using a Residual Chitosan Lactate Field Screening Test Kit, or District approved equal.
- Field tests shall be performed during the first discharge of treated water and weekly thereafter for as long as chitosan is being used.
- Response protocol, if field testing demonstrates exceedance of discharge standards, including immediate notification to the District, modification to the treatment system, and implementation of additional erosion control facilities.
  - Notification protocol to the District if any modifications to the treatment system are made.
  - Maintenance protocol of treatment system

7.6 Stormwater Best Management Practices

This section provides a list of approved stormwater best management practices. Each BMP shall be implemented consistent with additional information in the Standard Details and the most current District EPSC Planning and Design Manual.

Depending on site-specific conditions, the required base measures may be inadequate to prevent erosion and control sediment discharges. In these cases, additional stormwater best management practices shall be applied to the site to meet the EPSC standards.

7.6.1 Base Measures

The following stormwater best management practices, as described in **Table 7-3** below, shall be implemented on all sites requiring an Erosion Control Permit:

- Gravel Construction Entrance/Exit
- Linear Barrier or Downslope Perimeter Control (e.g., Sediment Fence, straw wattles, or similar measure)
- Storm Drain Inlet Protection

7.6.2 Erosion Prevention Stormwater BMPs

Erosion prevention is the highest priority in the overall EPSC plan and shall be integrated into a project throughout the planning, design, scheduling, and construction phases. Erosion prevention Stormwater Best Management Practices shall be included in the approved EPSC plan. **Table 7-1** below lists approved erosion prevention Facilities.

Table 7-1. Erosion Prevention Stormwater Best Management Practices (BMPs)

Name	Std. Detail[a]	Description
Preserve Natural Vegetation	NA	Maintain existing vegetation or place vegetative buffer strips. This SMF is especially effective for sites with sensitive resources like wetlands, stream corridors, lakes, and steep slopes.
Buffer Zone	NA	An undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff. A Vegetated Corridor shall not be used or considered a buffer zone under this section.
Temporary and Permanent Seeding	NA	Vegetative cover established on disturbed areas to reduce erosion by seeding (applied by hand or hydroseeding) with appropriate and rapidly growing grasses. Permanent seeding can be used in conjunction with erosion control blankets and mats to provide both temporary and permanent erosion prevention control.
Ground Cover	NA	A protective layer of straw or other suitable material applied to the soil surface. Various ground cover methods include straw mulch and compost blankets.
Hydraulic Application	NA	A mechanical method of applying erosion control materials, other than simply hydroseeding, to bare soil. This BMP is often called Bonded Fiber Matrix. Bonded Fiber Matrix can be used without seed in upland areas to stabilize and prevent erosion. This BMP cannot be used in areas of concentrated flow or water quality facilities. This BMP may be used in place of straw, mulch, compost, or matting depending on site and weather conditions.
Sod	NA	Permanent or temporary turf for immediate erosion protection and stabilization.

Commented [A9]: Verify detail #'s in Table 1,2, and 3 once details added to Appendix D

Matting	4-1 and 4-2	A class of products that includes manufactured mulch materials that are produced in a roll configuration that is placed on the ground and held in place by stakes, metal staples, geotextile pins, or other fastening system. Matting shall be 100% biodegradable fibers or approved equal. Refer to the Floodplain, Wetland and Stream Construction Strategies Handbook for a comparison of matting types for work in sensitive areas.
Soil Binders	NA	Materials that are applied to the soil surface for dust control and temporary erosion control. These are also known as hydraulic soil stabilizers.
Stockpile Management	4-3	Methods to reduce or eliminate loss of sediment from temporary stockpiles of soil.
Dust Control	NA	Water applied over susceptible areas, typically due to dry soil conditions, during high wind periods. (Also see Section 7.6.5).
a. Standard Details taken from the Erosion Prevention Planning and Design Manual.		

7.6.3 Runoff Control Stormwater BMPs

The purpose of runoff control BMPs is to control stormwater runoff and drainage patterns at construction sites. Runoff control BMPs shall be included in the EPSC plan. **Table 7-2** provides a list of approved runoff control BMPs.

Table 7-2. Runoff Control Stormwater Best Management Practices for All Sites

BMP	Std. Detail[a]	Description
Pipe Slope Drain	4-9	The pipe slope drain carries concentrated runoff down steep slopes without causing gullies, erosion, or saturation of slide-prone soils. It should be designed to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area.
Outlet Protection	4-7 and 4-8	Outlet protections are physical structures that reduce the velocity and energy of concentrated flow to prevent scour at storm drainage system outlets. Outlet protection includes riprap-lined basins, concrete aprons, and stilling basins.
Surface Roughening	4-10 and 4-11	Soil surface is roughened by mechanical methods. All slopes prepared by surface roughening shall meet engineering compaction requirements. This BMP is intended to only affect the surface of soils and is not intended to compromise slope stability or overall compaction.
Check Dams	4-4 and 4-5	Small, temporary dams placed across a natural or man-made channel or drainage ditch and designed to reduce drainage ditch erosion caused by stormwater runoff by reducing the velocity of flow in the ditch. Check dams are often used as a temporary measure while a channel is being permanently lined with vegetation or other materials to prevent erosion.
Diversion Swale or Dike	4-6	A ridge of compacted soil or a vegetated lined swale located at the top, base or somewhere along a sloping disturbed area.
a. Standard Details taken from the Erosion Prevention Planning and Design Manual.		

7.6.4 Sediment Control Stormwater BMPs

Sediment control BMPs include any practice that traps soil particles after they are dislodged and moved by wind, water, or mechanical means. These BMPs are usually passive systems that rely on filtering or settling particles out of the water or wind once they have become suspended. Soil that accumulates in or near sediment control BMPs is a waste product that must be removed and disposed of at an approved location. Uncontaminated sediment/soil can be placed back on site and protected with appropriate erosion control BMPs.

Sediment control BMPs are considered the last line of defense before stormwater runoff leaves a site and are not to be used as the primary methods for EPSC.

Table 7-3 lists approved sediment control BMPs. These BMPs are to be applied prior to and during earthwork. Sediment control BMPs shall be included in the approved EPSC plan.

The perimeter sediment barrier identified in **Table 7-3** is not required where:

- Flows are collected through the use of temporary or permanent grading or other means such that the flows are routed to an approved settling pond, filtering system, or sediment control BMP.
- There are no concentrated flows, slopes are less than 10 percent, and runoff passes through a grass area which is either owned by the applicant or such use is allowed, through written agreement, by the applicant of the grass area. The grass area shall be at least equal in dimensions to the project area. The grass area shall not be located in a Vegetated Corridor or Sensitive Area.
- The surface is protected by re-established permanent vegetation.

Table 7-3. Sediment Control Stormwater Best Management Practices

BMP	Std. Detail[a]	Description
Gravel Construction Entrance/Exit[b]	4-13	Gravel construction entrances/exits shall be required at each entrance/exit to and from the site. If a property contains or is adjacent to a stream, watercourse, stormwater facility, wetlands, or other water quality sensitive area, BMPs in addition to a gravel construction entrance/exit shall be required to prevent physical erosion into the water quality sensitive area.
Tire Wash Facility	4-26	The wheel wash, which shall be incorporated with a stabilized construction entrance, shall be designed and constructed for anticipated traffic loads.
Linear Barrier or Perimeter Control[b]	4-23	Linear barrier (sediment fence) shall be installed around the down-gradient perimeter of the site to control sheet flow from the site. Sediment fence shall not be placed in areas of concentrated flow or across stream channels.
Wattles	4-27	Wattles are small, cylindrical barriers composed of biodegradable fibers encased in photodegradable open-weave netting. Wattles are placed in shallow trenches and staked along the contour of newly constructed or disturbed slopes.

Table 7-3. Sediment Control Stormwater Best Management Practices		
BMP	**Std. Detail[a]**	**Description**
Storm Drain Inlet Protection[b]	4-15 through 4-20	Temporary inlet protection shall be provided for all active inlets for the duration of construction to keep sediment, trash, and other construction-related pollutants out of the storm drain system.
Rock or Brush Filter Berm	4-14	Rock or brush filter berms are temporary barriers composed of brush, wrapped in filter cloth, and secured or rock anchored in place. These are designed for sheet flow, not concentrated flow, and shall not be placed across a stream or channel.
Sidewalk Subgrade Gravel Barrier	4-25	Undercut lots or sidewalk subgrades with rock base are linear drainage barriers that provide an effective sediment filtration and retention area behind the curb. If weep holes exist, they must be plugged when using this BMP.
Dewatering		Separation of sediment and water achieved through filtration, either by gravity or with pressure.
Sediment Trap	4-24	A sediment trap consists of a small, temporary ponding area with a rock weir or perforated riser pipe at the outlet. This BMP is not to be used for drainage areas greater than 5 acres.
Sediment Basin	4-22	A temporary sediment basin has one or more inflow points and baffles to spread the flow for wet and dry storage. The sediment basin is effective for about one year with a drainage area less than 10 acres.
Turbidity Curtains	NA	A turbidity curtain is a pre-manufactured floating geotextile structure which minimizes turbidity transport from a disturbed area adjacent to or within a body of water. This BMP can be used to minimize the mixing of turbid water with adjacent clean water and/or contain soil particles during construction and/or repair activities.
Sediment Entrapment Mats	4-21	This is a flat layered pad that provides filtration and settling of sediment. BMP may be incorporated into the permanent stabilization/revegetation process if used in conjunction with mulch and/or seed.

a. Standard Details taken from the Erosion Prevention Planning and Design Manual.

b. These measures are minimum requirements for all projects per Section 7.6.1.

7.6.5 Dust Control Stormwater BMPs

Dust shall be minimized to the extent practicable, using all measures necessary, including, but not limited to the following BMPs.

- Sprinkling the haul and access roads and other exposed dust producing areas with water.
- Application of dust palliatives on access and haul roads as approved by the District.
- Establishing temporary vegetative cover.
- Placing wood chips or other effective mulches on vehicle and pedestrian use areas.
- Maintaining the proper moisture condition on all fill surfaces.
- Pre-wetting cut and borrow area surfaces.

- Use of covered haul equipment.

7.6.6 Non-Stormwater Pollution Control Stormwater BMPs

For the purposes of this section, non-stormwater pollution includes, but is not limited to, concrete truck wastewater, paint, fuel, hydraulic fluid, solvents, glues, and other waste materials characteristic of construction sites. Non-stormwater pollutants are prohibited from entering a public or private street or storm system or surface waters.

Non-stormwater pollution controls consist of general site and materials management measures that directly or indirectly aid in minimizing the discharge of sediment and other construction related pollutants from the construction site.

Approved non-stormwater pollution control BMPs include:

- Concrete truck washout areas
- Written spill prevention and response procedures
- Employee training on spill prevention and proper disposal procedures
- Protected areas for equipment storage and maintenance where the risk of pollution is minimal
- Debris boxes to contain construction wastes.

7.7 Inspection

This section provides criteria for EPSC inspections during a project's construction.

7.7.1 Pre-Construction Conference

Prior to the initial EPSC inspection, the District may require, or the permittee, applicant or Contractor may request, a pre-construction conference to review and discuss the EPSC plan for the site.

A pre-construction conference shall be required when the risk of erosion is high due to one or more of the following factors:

- Wet weather construction
- Steep slopes with severe erosion potential
- Construction adjacent to a sensitive area or vegetated corridor
- Mass grading on a large site

7.7.2 District's Initial EPSC Inspection

On all projects, except single family home construction sites, EPSC base measures shall be installed by the permittee and then inspected and approved by the District's inspector prior to the start of any permitted activity.

For single-family home construction sites, EPSC measures for each property shall be installed by the permittee and then inspected and approved by the District's inspector prior to the building foundation installation. Foundation approvals shall not be given until EPSC measures are approved.

7.7.3 Permittee Inspections

The permittee or applicant's authorized agent shall provide ongoing inspection of the site in accordance with approved plans to ensure compliance with the standards specified in Section 7. The permittee or applicant's authorized agent for inspections shall be knowledgeable in EPSC BMP selection, installation and maintenance. They shall also possess the technical skills to assess conditions at the construction site that could impact stormwater quality, and to assess the effectiveness of EPSC BMPs selected. If the permittee or representative determines the stormwater best management practices approved in the EPSC plan are not effective or sufficient to ensure compliance, additional stormwater best management practices must be implemented and identified in a revised plan.

For single family developments that disturb 1 acre or greater and all non-single-family developments the permittee's inspector shall:

- meet the applicable DEQ qualifying inspection certifications;
- inspect the site once every 14 calendar days; and within 24 hours of any storm event, including snowmelt, that results in discharge from the site;
- ~~shall~~ maintain records of their EPSC inspection and maintenance activities. Records shall be made no later than 48 hours after inspection by the permittee or their authorized agent. Records shall be made available to the District inspector upon request.

For single family developments that disturb less than 1 acre, the permittee's or representative shall:

- inspect the EPSC measures and provide maintenance as required to maintain the functionality of the BMP measures.
- inspect site daily when stormwater runoff, including runoff from snow melt, is occurring, once per week on active sites when runoff not occurring or once every two weeks on inactive sites
- keep onsite documentation of their EPSC activities for reference during operations, maintenance activities, and inspections.

7.7.4 Final Inspection

A final erosion control inspection shall be required on all sites after they have been stabilized and prior to approval of the Certificate of Occupancy. All temporary BMPs shall be removed prior to final inspection.

For single family sites seeking final erosion control inspection between September 1 and May 31, groundcover, using approved techniques, shall be completed before the single-family site can be deemed complete.

Commented [A10]: For sites < 1 acre whether we should require that they document their epsc inspection and maintenance activities is undecided. LO and Gresham does this.

Commented [A11]: We need to determine the need of an inspection frequency for single family or sites < one acre.
Gresham has:
The permittee shall inspect the EPSC measures and provide maintenance as required to maintain the functionality of the BMP measures. Minimum inspection frequency requirements are: • Daily when stormwater runoff, including runoff from snow melt, is occurring • Once per week on active sites when runoff not occurring • Once every two weeks on inactive sites

Commented [A12]: Need to determine the need for specifics (i.e. list the current approved certifications) if we leave it like this, if DEQ adds additional approved certifications, there is no need to update our standards.

Commented [A13]: Need to review. This added language would be in line with the MS4 permit requirements as well as Lake O, CWS, OC and Gresham.

SECTION 8. OPERATION AND MAINTENANCE

The purpose of the District's O&M program is to assure perpetual maintenance of stormwater facilities within the boundaries of the District, Happy Valley and the Clackamas County Department of Transportation and Development and as required in the District's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit. The program is required to provide a mechanism to ensure long-term functionality of constructed stormwater management facilities.

The O&M requirements in this section apply to all stormwater management facilities constructed as a requirement of these standards. Maintenance activities, including routine maintenance, restorative maintenance, and rehabilitation are required to ensure the long-term function and effectiveness of stormwater management facilities and infrastructure. Initial site planning must incorporate provisions for adequate access and space to perform maintenance activities for all stormwater management facilities.

8.1 General Requirements

The District is responsible for ensuring the O&M of stormwater management facilities within the district boundary. All Stormwater Management Facility (SMF) designs will be held to the same standards regardless of the organization or entity that has accepted responsibility for the maintenance. There are two categories of maintenance for SMFs, described below.

- **Privately maintained**. These are stormwater management facilities which only convey Private Stormwater that generally benefit one owner or entity. They include residential, multi-family, commercial, and industrial types of developments. These stormwater management facilities require a maintenance covenant recorded with the title that describes the types of facilities and necessary maintenance.
- **Publicly maintained**. These are regional and sub-regional stormwater management facilities which convey Public Stormwater that benefit the public in general and any facility located within the public right-of-way. These stormwater management facilities can be used for any type of development if shown to have sufficient capacity. Stormwater management facilities that serve multiple properties (e.g., facilities for residential subdivisions) shall be transferred to public ownership following the 2-year warranty period.

8.2 O&M Plans

All stormwater management facilities require the applicant to execute and record an O&M plan. The plan shall ensure that owners maintain and operate the SMF to preserve and continue its function. O&M plans require SMF owners to properly maintain, repair, modify or reconstruct (if necessary) the facility, and provide a schedule for the maintenance frequency for the facility.

8.2.1 O&M Plan Development

O&M plans shall be required for all permanent stormwater management facilities to ensure that they function as designed. The purpose of an O&M plan is to provide

guidance to those who are responsible for the long-term inspection and maintenance of the facility.

To ensure functionality of the stormwater management facilities, owners are required to inspect facilities regularly per the approved O&M plan to determine maintenance needs. Routine inspection and maintenance can help to keep overall maintenance costs low by detecting problems early and avoiding large repair or replacement costs.

The facility design and maintenance specifications in **Appendix H** can be used to create the O&M plan. If the proposed facility types do not match the SMFs in **Appendix H**, the applicant and design engineer will be responsible for creating any drawings, maintenance specifications, and an inspection checklist to be incorporated into the O&M plan.

O&M plans for privately owned/maintained facilities shall be recorded with the Recording Office of Clackamas County as an exhibit to the maintenance covenant referenced in Section 8.3 before issuance of a building permit or final plat approval.

8.2.2 O&M Plan Elements

The following outline can be used to prepare an O&M plan.

- Introduction and general information
  - Facility Information. Facility type and identifying name or number, as applicable. Include the number of each type of structure including the manufacturer's model number where applicable.
  - Contact. Name and contact information for the organization or individual responsible for conducting maintenance and/or ensuring maintenance is conducted.
  - Narrative. Written overview describing the site, drainage areas, and intended function of the facility.
- Operations and Maintenance
  - Operating Procedures. Normal operating procedures for facility function, including any seasonal modifications, adjustments, and manufacture's recommendations.
  - Regular Maintenance. Required maintenance activities and schedule (e.g., landscape maintenance, sediment removal, pipe cleaning).
  - Inspections. Required inspection frequency to verify facilities are being maintained and functioning as designed.
  - Maintenance Standards. Minimum standards that are required for the SMF to produce desired results and maintenance actions when the minimum standards are not met (See **Appendix H**). Where applicable, the minimum maintenance standards should include manufacturer's recommendations.
  - Lifespan. Expected lifespan of the facility components (i.e., the time when owners should expect to replace growing media, plantings, cartridges, and control structure elements). Proprietary facility lifespan information, if known.

  - Connected Facilities. List of interrelated or connected stormwater management facilities and description of how each facility works with the next one.
- O&M Plan Responsibility
  - Responsible Party. Identify the person(s) or organization(s) responsible for inspections of stormwater management facilities.
  - Funding. Identify the funding source for maintenance.
- Attachments
  - Site Plan. Include a site plan to identify the location of the facility/facilities, sources of runoff entering each facility, and ultimate stormwater disposal point.
  - Facility Details. Include the SMF detail sheet(s) and O&M Plan and checklist(s) (when applicable, use details in **Appendix D** for reference).
  - Maintenance Agreement or Covenant. Include a copy of the public maintenance agreement and/or private maintenance covenant that will be used to assign maintenance responsibility and/or to allow access for maintenance or inspection of the stormwater management facilities.

8.2.3 O&M Plan Review and Approval Process

The O&M plan and associated agreements, covenants, and easements will be reviewed as part of the District's overall plan review and approval process.

8.3 Privately Owned and Maintained Facilities

Generally, stormwater management facilities convey Private Stormwater that benefit a single owner or entity shall be privately-owned and maintained. All stormwater management facilities to be maintained privately require an O&M plan that is reviewed and approved as part of the overall plan review process.

8.3.1 Maintenance Covenant for Private Stormwater Facilities

Maintenance of all privately-owned stormwater management facilities shall be ensured through the creation of a formal maintenance covenant that must be approved by the District and recorded into the land record prior to final plan and/or plat approval. The O&M plan, including scheduled inspections and regular maintenance activities, shall be referenced in the maintenance covenant.

8.3.2 Access Easement

Prior to the issuance of any permit that includes a SMF, the applicant or owner of the site must execute a maintenance covenant that includes public access rights, to inspect the facility and ensure that it is maintained in proper working condition. This includes the right to enter a property when the District has a reasonable basis to believe that a violation of District standards and/or rules and regulations is occurring or has occurred, and to enter when necessary for abatement of a public nuisance or correction of a District violation. The access easement shall be included in the maintenance covenant, as approved by the District and recorded at the Recording Office of Clackamas County.

8.3.3 Annual Inspection and Maintenance

Annual inspections are to be conducted by the Responsible Party identified within the O&M Plan and may be reviewed by the District upon request. All stormwater management facilities must undergo an annual inspection to document maintenance and repair needs and ensure compliance with the requirements of these standards. Maintenance needs may include, but not limited to the following: removal of silt, litter and other debris from all stormwater structures and facilities; grass cutting and invasive vegetation removal; and necessary replacement of water quality vegetation. Any maintenance needs identified must be addressed by the Responsible Party in a timely manner. The inspection and maintenance frequency may be increased as deemed necessary to ensure proper functioning of the SMF.

8.3.4 Records of Maintenance Activity

Facility owners shall keep records of all maintenance and repairs and shall retain the records for at least three (3) years. These records shall be made available to the District staff during inspection of the facility and at other reasonable times upon request. The owner shall submit a copy of the SMF maintenance and inspection records to the District annually.

8.3.5 Inspection of Stormwater Management Facilities

Inspections may be conducted by the District at any time, including but not limited to, routine inspections, random inspections, inspections based on complaints or other notice of possible violations, inspections related to the District's NPDES MS4 Permit, and joint inspections with other agencies done under environmental or safety laws. Inspections may include, but are not limited to, review of maintenance and repair records; sampling discharges, surface water, groundwater, or material/water in stormwater management facilities; and facility condition evaluations.

8.3.6 Failure to Comply with the O&M Plan

If a SMF becomes a danger to public safety or public health, the District shall notify in writing the party responsible for maintenance of the SMF. Upon receipt of the written notice, the responsible person shall have 30 days, unless otherwise specified by the District, to complete the necessary maintenance and repair of the facility in an approved manner. If a responsible party fails or refuses to meet the requirements of the maintenance covenant, the District, after reasonable notice, may correct a violation of the design standards or maintenance needs by performing all necessary work to return the facility to proper working condition. If the property owner does not comply with their O&M Plan, after proper notice, the District shall assess the owner of the facility for the cost of repair work and any penalties.

8.3.7 Modifications to the O&M Plan

If it is determined that the O&M plan requires modification to maintain the functionality of the facility, then modifications to the O&M plan shall be submitted to the District for review and approval. Written approval from the District is required prior to modifying the O&M plan. The approved modified plan shall be recorded at the Recording Office of Clackamas County.

8.4 Publicly Owned and Maintained Facilities

Generally, publicly owned and maintained stormwater management facilities are facilities that convey Public Stormwater and serve multiple property owners or the general public. Publicly owned stormwater management facilities can serve any type of development (residential, multi-family, commercial, industrial). Publicly owned facilities may be constructed by the District, or they may be constructed by private parties, with maintenance responsibilities transferred to the District following the 2-year warranty period.

8.4.1 Location

All publicly owned stormwater management facilities shall be located in a public right of way or separate tract with adequate maintenance access with an easement granting rights to the District.

8.4.2 O&M Plan

All stormwater management facilities to be maintained by the District require an O&M plan that is reviewed and approved as part of the overall plan review process. The O&M plan is prepared by the applicant, identifying the District as the responsible party for inspection and maintenance following the 2-year warranty period.

During the 2-year warranty period, the applicant is responsible for all maintenance and documentation requirements outlined within the O&M plan. Prior to the completion of the warranty period, the District will require all maintenance records and documents be reviewed and deficiencies addressed prior to the transfer of maintenance responsibilities.

The applicant shall enter into a maintenance agreement with the District establishing bonding, surety, or payment for maintenance of the facility during the 2-year warranty period. The O&M Plan must be recorded with the property.

8.4.3 Maintenance Fees

The District may establish maintenance fees for publicly maintained stormwater management facilities that serve multiple private owners. When separate maintenance fees are established, they will be distributed proportionally among the owners that use the facility for stormwater management.

APPENDIX A

Permitting Process

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LIST OF FIGURES

APPENDIX A. PERMITTING

Appendix A outlines the planning, plan review, and project completion requirements for both sanitary and storm sewer projects and is included in both the Sanitary Standards and the Stormwater Standards. This section is intended to standardize the submittals and clearly outline the minimum requirements. The requirement for a complete submittal package is intended to reduce the overall plan approval processing time.

A.1 GENERAL PROCESSES

The following is a generalized overview of the District development review and permitting processes. This process may vary from one application, submittal and/or building permit to another and is only shown as a general outline of procedures and processes involved in the review and approval of projects located within the District. To obtain further information on a specific plan review or permit process contact a Development Review staff member.

A.1.1 General Plan Review and Approval Process

This subsection describes the most common elements of the general development review process for a typical partition, subdivision, multi-family, commercial or industrial project. It is important to discuss your project with the District and Local Planning Authority early to understand the review and approval process required for your specific project.

1. **Pre-Application Conference** – The applicant may elect to meet with the Local Planning Authority, District, and other related departments to discuss the proposed project to better understand the potential requirements. It is best if the applicant submits a preliminary concept or plan, so the District is better prepared to discuss the proposed development. The Site Planning guidance in Section 2 of the Stormwater Standards is a resource to help the applicant explore potential low impact development and green infrastructure strategies. Contact the local planning authority to schedule the pre-application meeting. The planning authority will invite the District to the meeting.
2. **Service Provider Letter** – Applicants proposing to develop or redevelop property shall obtain a Service Provider Letter from the District prior to submitting the land-use or design review application to the Local Planning Authority. See Section 3.2 of the Stormwater Standards for Service Provider Letter requirements.
3. **Water Quality Resource Area Boundary Verification** – If applicable, prior to the District issuing a Service Provider Letter, the Local Planning Authority must approve a WQRA Boundary Verification (see WES Buffer Standards) for water quality Vegetated Buffer requirements.
4. **Conditions of Approval** – The Local Planning Authority will process the land use/design review application and route a copy of the application for District review. The District will review the application and submit comments to the Planning Authority to be included as conditions.
5. **Jurisdictional Authority**– If the proposed project is outside the service area boundaries of the District, the developer must petition for annexation to the District. The annexation must be approved by the Clackamas Board of County Commissioners before final occupancy or plat approval. The applicant shall

submit a complete annexation packet to WES prior to any plan approvals by WES.

6. **Pre-Design Meeting** – The applicant may elect to coordinate a meeting with the Local Planning Authority and/or the District to discuss the project and requirements outlined in the conditions.
7. **Plan Submittal** – Upon land use approval, the applicant must submit required fees, civil plans and supporting documentation as specified in these standards for plan review and approval (See Section 3 of the Stormwater Standards and Section 4 of the Sanitary Standards for submittal requirements)
8. **Other approvals** – Other permits and approvals may be required prior to the District approving the plans (i.e., County, City, State or Federal).
9. **Approved Plan(s)** – Plans and applicable building permit applications will be reviewed, approved, and then signed by an authorized representative of the District. If applicable, it may be necessary to hold a Pre-Construction Meeting with the Engineer, Contractor, Applicant, District, and other related agency representatives to discuss project requirements, including processes to complete the project as specified in the Engineering Agreement.
10. **Construction** – The public sanitary and stormwater management infrastructure shall be constructed under the supervision of the Engineer as specified in the Sanitary and Stormwater Engineering Agreements.
11. **Construction Completed** – Upon final completion of the construction, the Engineer will certify the project was constructed in accordance with the approved plans, and the as-built plans are an actual record of what was constructed.

    The following items will be completed and submitted prior to requesting the final inspection of the public sanitary and/or stormwater infrastructure:

    a. All sanitary and/or stormwater infrastructure shall be cleaned of sediment and debris.
    b. A *Certification of Completion* shall be submitted – Certifies the project was constructed in accordance with the approved plans and District Standards.
    c. If applicable, A *Vegetated Planting Certification* shall be submitted – Certifies water quality plantings were planted in accordance with the approved plans and these Standards.
    d. Two paper copies of the as-built drawings shall be submitted.
    e. If applicable, submit the video testing of the public sanitary and stormwater conveyance piping systems, along with the contractor's reports for review and approval. The Engineer shall review the video and reports, and note any deficiencies discovered in the system(s) prior to submitting the items to the District.
    f. Submit a copy of the Engineer inspection reports.
    g. Submit Service Connection drawings prepared by the Engineer (if required).
12. **Final Inspection** – The District will review the required as-built submittals and, if acceptable, will schedule the final field inspection. All repairs and corrections shall be made prior to the District deeming the project complete.

13. **Final As-built Drawings** – When requested by the District, the Engineer shall submit the corrected final as-built drawings on electronic CAD and PDF files of the as-built civil construction plan set.
14. **Warranty Surety** – Upon completion of the public sanitary and stormwater final inspection, the applicant will submit a sanitary and/or stormwater warranty surety in the amount of 25% of the actual cost to construct the public infrastructure. The warranty surety will be held for a minimum period of 2 years from the date of completion, or until all the requested system repairs are completed. For additional information see **Section A.8.4** and the District *Warranty Surety Form* which can be found on the District's website or provided upon request.
15. **Letter of Completion and Acceptance –** Upon final approval of the construction of the public sanitary and stormwater infrastructure, and all of the above noted items have been reviewed and approved by the District, then the District will issue a letter of completion of the stormwater infrastructure, and letter of acceptance of the public sanitary sewer system.
16. **Warranty Surety Inspection** – Between 20-24 months after issuance of the letter of completion and acceptance, the District will inspect the public facilities at the request of the owner. The inspection will include all public sanitary and stormwater infrastructure, included the plantings and other related improvements. Once all deficiencies are corrected, the District will issue a warranty surety release letter. For additional information see **Section A.8.4** and the *District Warranty Surety Form* which can be found on the District's website or provided upon request.

A.2 SERVICE PROVIDER LETTER

The intent of the Service Provider Letter is that, prior to applying for Land Use/Design Review to the local planning authority, the applicant must demonstrate the proposed development is viable in accordance with District Rules, Regulations, and Standards. The Service Provider Letter will only be issued once the applicant has provided sufficient plans, reports, studies, and agency approvals needed for preliminary review by the District. Based on the preliminary review, the District may require additional information prior to issuance of the letter or as part of the forthcoming land use application. Receipt of the Service Provider Letter does not imply that all District requirements have been met or guarantee that land use approval for the development will be granted.

A.2.1 Submittal for Service Provider Letter

Applicants must submit the following to the District for review:

- Preliminary Plat (if applicable)
- Preliminary Proposal for Public and Private Sanitary Infrastructure
- Proposed sanitary system layout, including compliance with minimum design standards
- Points of connection to public sanitary sewer system
- Service proposal for upstream properties
- Preliminary Stormwater Management Plan and Drainage Report (see Sections 3.3 & 3.4)

Commented [A14]: We are removing references to the Site Planning Guide. This could still be posted on the website and referenced during pre-apps.

- Site Assessment and Maps
- Proposed Storm Drainage System and Stormwater Facilities:
  - Infiltration, detention, and water quality facilities
  - Conveyance system design
  - Point of discharge
  - Safe Emergency overflow pathway
  - Service proposal for upstream properties
- Geotechnical report and analysis (see Section 1.5.2)
- Drainage area maps
- Infiltration testing results (see Section 2.4)
- Drainage System Analysis (upstream and downstream, see Section 2.3)
- Sizing and conveyance calculations
- Other supporting reports and information (as deemed necessary by the District)
- BMP Sizing Tool calculations
- WQRA Boundary Verification or Natural Resource Assessment
- Preliminary Approval for Off-Site Easements
- Offsite Mitigation Measures for Downstream Conveyance

A.3 LAND USE/DESIGN REVIEW SUBMITTAL REQUIREMENTS

As part of the land use/design review application process, the local Planning Agency will route applicable sanitary and stormwater plans and reports to District for comment. The applicant must provide sufficient plans, reports, studies, and agency approvals needed for preliminary review by the District. The applicant's materials shall include any additional information or revisions requested by the District with issuance of the Service Provider Letter.

A.4 PLAN REVIEW SUBMITTAL REQUIREMENTS

The Developer's engineer shall submit sufficient supporting information to indicate that the proposed plan design meets all the provisions within these Standards, including the land-use conditions. The submittal information shall include, but not be limited to, the items listed within this section.

Initial/First submittal requirements:

The following is a list of application submittals required by the District for a typical development:

- WQRA Boundary Verification and WQRA Development Permit, submit to the local planning authority as required (see WES Buffer Standards)
- Stormwater Management Plan complete set of drawings
- Existing Conditions
- Infiltration Testing (See Section 2.4 and **Appendix B** of the Stormwater Standards)

- Proposed On-site Storm Drainage System and Stormwater Facilities
- Proposed Grading Plan
- Existing and Proposed Off-site Improvements
- Erosion Control Plan
- Details and Notes
- Stormwater Management Report (see Section 3 of the Stormwater Standards) that includes:
  - The Engineered, or BMP Sizing Tool Method used to size the stormwater facilities. BMP Tool is available online
  - A Storm Drainage System/Hydrologic and Hydraulic Calculations Report (see Section 5)
  - Hydrology and hydraulic calculations with drainage area maps
  - Tributary drainage areas shall be calculated in table form and identified on maps submitted with the report
  - Geotechnical/Geologist Report
    - Infiltration Testing
    - Soils Report
    - Geology Report

Other submittal requirements required by the District prior to final plan approval (forms available on District website)

- Standard Forms
  - Sanitary and Storm Sewer Engineering Agreement
  - Sanitary and Storm System Construction and Engineering Costs Data Sheet
  - ~~What about sanitary forms – engineering agreement, cost estimate, etc.~~
- Non-Residential Questionnaire
- Easements/Agreements, as applicable
  - Public/Private Sanitary and Stormwater Easements
  - Public/Private Storm Facility Operation and Maintenance Plan/Agreements

Commented [A15]: Need to be reviewed.

A.5 PLAN SUBMITTALS

This section contains specific information and drawing specifications for submittals made to the District. This section is intended to standardize the submittals and clearly outline the minimum requirements. The requirement for a complete submittal package is intended to reduce the overall plan approval processing time. Plans will not be reviewed until a complete plan has been submitted. A complete plan shall include at a minimum all requirements listed in this section.

A.5.1 Specific Sheet Submittal Requirements and Specifications

The following sheets are required as part of a complete Stormwater Management Plan submittal:

1. Title Sheet (see Section A.5.2)
2. Composite Utility Plan (see Section A.5.3)

3. Composite Stormwater Management Plan Cover Sheet (see Section A.5.4)
4. Stormwater and Sanitary Sewer Plans and Profiles (see Section A.5.5)
5. Grading Plan (Section A.5.6)
6. Erosion and Sedimentation Control Plan (see Section A.5.7)
7. Vegetated Buffer Planting Plan (see Section A.5.8)
8. Stormwater BMP Facility Planting Plan (see Section A.5.9)
9. Standard and Non-Standard Drawings/Detail Sheets (see Section A.5.10)
10. Standard and Non-Standard Construction Notes (see Section A.5.11)

All applicable standard drawings shall be included on a separate sheet in a clear and legible size.

A.5.2 Title Sheet

As a minimum the following information shall be found on the title sheet:

- Index of Sheets.
- Complete legend of symbols used.
- Vicinity Map to a scale of not less than 1" = 800' showing the project location.
- Site Plan of the entire project showing street right-of-way and/or subdivision layout.
- Temporary and permanent benchmarks including their descriptions. Total acreage including streets directly served.

A.5.3 Composite Utility Plan

The Composite Utility plan shall be scaled to show the entire site on one sheet unless otherwise approved by the District and shall show:

- All proposed sanitary and storm improvements
- All other proposed improvements
- All existing utilities and utilities adjacent to and within 100 feet of the project
- Existing natural or artificial drainage features
- Tract names and numbers
- Property lines with tax lot numbers and addresses
- Street names at a minimum shall be shown.

A.5.4 Composite Plan Cover Sheet (separate sanitary & storm)

The following information shall be included on the Composite Plan cover sheet:

- The scale shall be scale-appropriate to fit the entire site on one sheet, unless otherwise approved by the District

- Show the appropriate contour lines to demonstrate the overall site topography. Generally, these are 1', 2', 5', or 10' contour lines. The topography must extend a minimum of 50' to 100' beyond the proposed limits of development
- Show the entire systems
- Show the stormwater BMP Facilities
- Shade all other utilities not related to sanitary sewer or stormwater drainage systems.
- Show drainageway(s) as existing and/or proposed.
- Show safe overflow pathway(s) to an acceptable point of discharge.
- Show existing and/or proposed storm drainage and conservation easements.
- Show Vegetated Buffers and associated sensitive areas.
- Show all site and roadway improvements.
- Show the Subdivision, Phase Lines or Plat boundaries.

A.5.5 Plan and Profile Views

Plan and Profile views shall include the following information:

A.5.5.1 Plan View

Plan views shall contain as a minimum the following information:

- The scale shall be 1” = 50’ horizontal. Alternative scales may be approved by the District on a case by case basis. The scale shall be shown for each plan and profile view.
- Entire sanitary and storm sewers clearly shown and labeled.
- Plan views showing north predominantly to the top or left of each sheet.
- Plan views showing accurate 1’ or 2’ contour lines and extending a minimum of 50’ to 100’ beyond the limits of the development. Alternative contour spacing may be approved by the District on a case by case basis.
- All proposed extensions of the conveyance systems showing mainlines, manholes and Service Connections.
- Manholes identified and stationed to facilitate comparison of the plan view and the profile view.
- Manhole callouts in District format.
- District stationing formats for new lines and manholes.
- Size and type of pipe, backfill material, and location.
- Sanitary/Storm Service Connection tees off the mainline. For each lot being served, show the mainline stationing, pipe size, length, and depth of Service Connection at end of pipe.
- Right-of-way, property, and easement lines.

- Location of water courses, stream and railroad crossings, culverts and storm drains that cross the alignment.
- Subdivision names, roadway names and lot/parcel numbers or tax lot numbers.
- Existing and proposed Sensitive Areas and the required Vegetated Buffer.
- Existing utilities, all manholes, water mains, services, gas mains, underground power, and other utilities and structures, including hydrants, pedestals, signs, mailboxes, light poles, wells, water mains, valves, pumps stations, and blowoff structures, manholes, valves, meter boxes, power poles, handicap ramps, striping, and trees.
- Existing and proposed edge of pavement on both sides of the street, including shoulders, curb, sidewalk, ditch line, culverts, and driveways.
- Plan view including the above items for a minimum distance of 50 feet to a maximum of 500 feet may be required beyond the proposed improvement in order to prevent future improvement conflicts.
- Location and dimensions of all BMP facilities, including the following:
  - Setbacks from property lines and structures,
  - Facility wall material, if required, and geotextile/waterproofing membrane specifications,
  - Growing medium specifications,
  - Drain rock and filter fabric specifications,
  - All stormwater piping associated with each facility including pipe materials, sizes, slopes, invert elevations at bends and connections,
  - Ground elevations at catchment locations, channel inverts, top and toe of slope surrounding detention/retention areas,
  - Ground slopes of channel inverts and sides, parking lots, bottoms and sides of facilities and adjacent surroundings,
  - Invert and top or bottom elevations (if applicable) of pipes, catch basins, overflows, manholes or other similar structures.
  - Location of construction fencing used to protect proposed stormwater BMP facilities from compaction and other construction disturbance.
    - Location of all drainage ways and the 100-year flood plain.
    - Show the location and direction of any surface stormwater conveyance path(s).
    - Location and detail of all existing facilities on which work is to be performed, i.e., installation, repair, or removal.
    - Location and description of all known existing property monuments, including, but not limited to, section corners, quarter corners, donation land claim corners and any other county control monuments.
    - Street stationing may be shown on the construction plans, but later removed on the final as-built plans.
    - Roof drain connection points shall be shown using the ® symbol.

- Sanitary and storm structures should be easily visible and shown drawn at least 2x the size of the line width and in proportion to the line weight.

A.5.5.2 Profile View

Profile views shall contain as a minimum the following information:

- Plan and profiles on each sheet shall match and line up on at least one edge of the drawing (i.e., profile to show pipe in same direction as the plan view and lined up plan view over profile).
- The scale shall be 1" = 50' horizontal and 1" = 10' Vertical. Alternative scales may be approved by the District on a case by case basis. The scale shall be shown for each plan and profile view.
- Location of existing and proposed manholes and other appurtenances with each manhole numbered and stationed. Manhole numbers to be provided by District, if applicable. Manhole callouts shall be in the District format. The benchmark used as a basis for vertical control in the design shall be referenced on the plans.
- The location and elevation of an approved benchmark shall be shown on the plans or, if not within the proposed area of work, shall be referenced by number and location. Elevations shall be based on the NGVD88 datum if the project is within ½ mile of a County benchmark. A conversion factor to relate the existing connection point elevations to the plan elevations and benchmark.
- Grid lines using the horizontal and vertical scale.
- Existing and proposed ground and/or pavement surface with elevations noted at critical points.
- Sanitary/Storm lines shall be labeled with the name of the mainline centered under the profile view in large bold letters.
- Sanitary/Storm lines shall be labeled with the pipe size, material, slope (as a %), length and type of backfill between manholes.
- Nonstandard manholes must be labeled with the type (i.e., tamperproof, drop, flat top, etc.).
- Railroad, culvert, ditch, or stream crossings with elevations of the ditch or streambed and casing details.
- All existing and proposed storm, water, and any other crossing utility lines greater than 6 inches in diameter.
- Non-Standard stormwater management facilities and appurtenances shall show a typical cross-section with dimensions.

A.5.6 Grading Plan

Projects requiring grading and/or fill activities will require the submittal and approval of grading plans prior to the beginning of such operations. The District will review the grading plan in the context of the overall stormwater management plan. Generally, an additional grading permit and/or approval are required by the Local authority or State agency governing such activities. It is the responsibility of the applicant to obtain all necessary permits and approvals prior to beginning any grading activity.

Grading Plan views shall contain as a minimum the following information:

- Total land area and proposed disturbed area,
- Existing topography and impervious area,
- Proposed topography and impervious area,
- 1', 2', or 10' contour intervals (as applicable),
- Elevations of all existing and proposed streets, alleys, utilities, sanitary and stormwater sewers, and existing buildings and structures,
- Natural or artificial drainageways,
- Limits of flood plains (as applicable),
- Existing and proposed slopes, terraces, or retaining walls,
- All existing and proposed stormwater BMP facilities, drainage structures and/or features, and devices used to protect these areas during construction,
- All stormwater structures/features on-site, upstream, and downstream of the site,
- Erosion Prevention Control and Sedimentation Control Plans (as applicable),
- Drainage calculations when required,
- Drainage easements when required,
- Geotechnical report (if applicable),
- Any other supporting documentation necessary to evaluate the existing and/or proposed site conditions for stormwater management.

A.5.7 Erosion and Sedimentation Control Plan

The general process and requirements for erosion and sedimentation control plans is outlined in Section 7 of the Stormwater Standards. For specific details on erosion control BMP measures and applications see the **Erosion Prevention and Sediment Control Planning and Design Manual** adopted by the District. A link to this manual can be found on the District website.

A.5.8 Vegetated Buffer Planting Plan

If restoration of a Water Quality Resource Area or Vegetated Buffer is required in the Stormwater Standards, a plan addressing the requirements shall be submitted which includes the following:

A.5.8.1 Preparation of Construction Plans and Specifications

The construction plans and specifications shall include:

- Water Quality Resource Area and Required Vegetated Buffer boundaries.
- The limits of any approved, temporary construction encroachment.
- Orange construction fencing noted at Vegetated Buffers as well as at encroachment limits during construction.

- Permanent type fencing and signage at the development and the vegetated buffer boundary noted and details shown.
- Conservation Easement documents prepared and easement area shown on the plan.
- Site Preparation plan and specifications, including limits of clearing, existing plants and trees to be preserved, and methods for removal and control of invasive, non-native species, and location and depth of topsoil and or compost to be added to re-vegetation area.

A.5.8.2 Planting Plan and Specifications

Planting Plans and specifications shall include the following information:

- Planting table that documents the common name, scientific name, distribution (planting zone, spacing, and quantity), condition and size of plantings, and installation methods for plant materials listed,
- Mulching rates,
- Plant tagging for identification noted,
- Plant protection methods,
- Seeding mix, methods, rates, and areas delineated.
- Irrigation plan and specifications, including identification of water source, watering timing and frequency, and maintenance of the system,
- Maintenance schedule, including responsible party and contact information; dates of inspection (minimum three per growing season and one prior to onset of growing season); and, estimated maintenance schedule (as necessary) over the two-year monitoring period,
- Good rated corridor notes (i.e., invasive species removal shall be replanted with native vegetation),
- Access points for installation and maintenance, including vehicle access if available,
- Standard drawing details (north arrow, scale bar, property boundaries, project name, drawing date, name of designer and Property Owner).

A.5.9 Stormwater BMP Facility Planting Plan

The Stormwater BMP Facility Planting Plan shall include planting information for each stormwater management facility based on requirements of Section 4 and plant materials per **Appendix F**.

Planting plan specifications and plans must address all elements that ensure plant survival and overall stormwater facility functional success. At a minimum, landscape specifications and plans must include:

- A planting plan that indicates existing vegetation to be preserved; protective construction fencing; the location of all landscape elements; and the size, species, and location of all proposed plantings. The plant species should be

selected and placed in accordance with proper delineation and location of moisture zones where appropriate.

- A plant list or table that includes botanic and common names; size at time of planting; quantity; spacing; type of container; evergreen or deciduous; and, other information related to the facility-specific planting in accordance with landscape industry standards. Also include the square footage of each plant zone and the numbers and types of each plant required and provided in each zone.
- A soil analysis for the stormwater facility growing medium (required for all public facilities and may be required for private facilities. A soil analysis is not required for single-family residential sites). The source of the growing medium must be provided. The location of all stockpiles must be indicated on plans, and erosion protection measures included on the Erosion and Sedimentation Control Plan.
- The method of temporary irrigation to be used for the plant establishment period.
- Stormwater BMP Facility Planting Plan shall also include all areas requiring protective construction fencing to shield the area from construction traffic and compaction.

A.5.10 Standard Drawings/Detail Sheets

The construction plans shall include a sheet containing all the standard details applicable to a specific project.

The purpose of the District Standard Drawings and Details is to provide basic information as a convenience to those who use them in their designs. These drawings and details are also intended to communicate design standards and practices to the Design Engineer.

Detailed drawings shall be included with all construction plans where standard drawings do not apply. If a standard drawing, such as a manhole, must be modified to fit existing, or unique conditions, the modified detailed drawing shall be shown on the plan and profile sheet. When appropriate, due to required detail complexity, a separate detail sheet shall be used.

- Standard drawings are available for use on development projects and cannot be modified by designers on a project-by-project basis. It is the responsibility of the project Engineer of record to incorporate these drawings as originally intended.
- Non-standard detail drawings shall be the responsibility of the project Engineer to demonstrate that site conditions require a non-typical device or structure and submit the specifications and supporting documentation to the District for approval. All non-standard details shall be shown on the Stormwater Management Plan.
- Stormwater BMP Facility Detail sheets are included in **Appendix D.** A link to additional Standard Details can be found on the District website.

A.5.11 General Sanitary/Stormwater Construction Notes

General construction notes required on the plans can be found on the District website or provided upon request. These general construction notes shall be included on the sanitary and stormwater management plans. These notes are

required, and the design professional may include other applicable notes they deem necessary.

A.5.12 General Sheet Submittal Specifications and As-built Requirements

The following subsections outline general submittal specifications for sheet size, scales, north arrow, text, labeling callout, and title block specification requirements.

A.5.12.1 Sheet Dimension Requirements

Construction plans shall be clear and legible and submitted on blue-line paper 22 by 34 inches or 24 by 36 inches in size with a 1½ inch clear margin on the left edge and ½ inch margins on all other edges.

A.5.12.2 Title Block

Located on the bottom edge or at the right side of the drawing, showing:

- The project name, drawing name/type, completed modification date table, the submittal date, drawing number, engineer's name, address and official stamp, the owner/developer's name and address and where applicable, the name of the plat of subdivision and/or name of development.

A.5.12.3 Drawing Scale Requirements

The following general layout guideline shall be used:

- Plan and Profile sheets shall be 1" = 50' horizontal and 1" = 10' vertical. The District may approve alternative scales on a case by case basis.
- Each sheet shall include a bar scale with text.

A.5.12.4 North Arrow Requirements

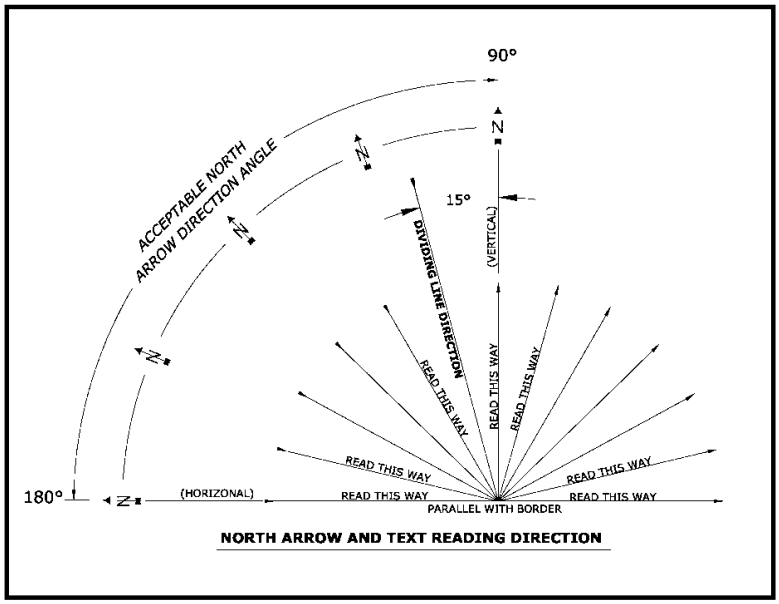

Fig. 1North Arrow and Text Reading

Each sheet shall include a north arrow. Each separate view on each sheet shall have its own north arrow. The north arrow in each view should face the top (VERTICAL) on the sheet if possible. It is acceptable to align the north arrow off vertical if the project doesn't fit vertically facing north; it can be rotated counterclockwise as much as 90 degrees.

For acceptable north arrow angle directions see **Fig. 1 North Arrow and Text Reading.**

A.5.12.5 Lettering/Text Requirements

- Text Rotation
  - Text should be readable from either the bottom or right edge of the sheet. For acceptable text reading direction see **Fig. 1 North Arrow and Text Reading**.
- Lettering Size and Style
  - Lettering Size
    - The minimum lettering size shall be eight-hundredths (0.08) of an inch high for existing items and a minimum lettering size shall be ten-hundredths (0.10) of an inch high for new items. Items shall be legible and reproducible.
  - Lettering Style
    - Standard text styles should be used. All lettering should be upper case.

A.5.12.6 Labeling Requirements

- Sanitary/Storm structures, proposed and existing, shall be labeled on each sheet.
- All street names are to be labeled in each model space window.
- All tax lots and easements within the development and surrounding area pertaining to the project shall be clearly labeled.
- Non-standard storm structures (e.g., Flat Top Manhole) shall be labeled with the unique structure type after the structure name. See below.

A.5.12.7 Plan and Profile Views-Structure and Pipe Callouts

- ***Plan View Leader Line Requirements***
  - Leader lines must angle off horizontal and vertical planes from the center point of the structure as shown in **Fig. 3** in plan view. Horizontal and vertical leader lines are acceptable in profile view.
  - Leader lines should have an arrow. See **Fig. 3**.
  - The leader line arrow should touch the edge of the symbol and point to the center of the structure. See **Fig. 3.**

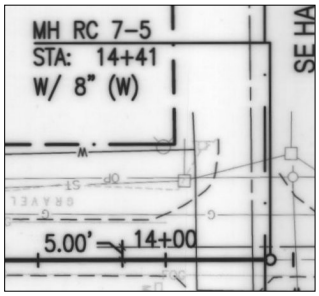

Fig. 2Not accepted leader practice

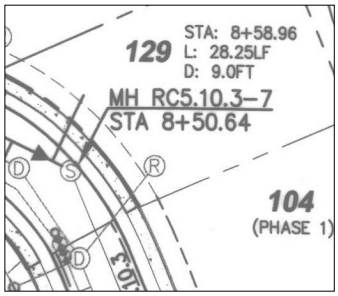

Fig. 3Accepted leader practice

- ***General Sanitary/Storm Structure Callouts in Plan and Profile Views***
  - Street stationing and other related information is allowed on the construction plans; however, this must be removed on the accepted as-built plans.

    - **Plan View–Non-Typical Manhole Callout:**

HV20-1, Flat Top
STA. 15+00

    - **Plan View–Manhole Callout:**

MH3B-2
STA 3+49.40

    - **Plan View–Catch Basin and Other Structures:**

CB 3B-1
STA 3+70
RIM 486.50
IE OUT 478.40 (8”N)
15.00 LF PVC, 12” ↓
@ S = 35.67%

    - **Profile View–Manhole Callout:**

MH3B-2
STA 3+49.40
RIM 486.50
IE IN 478.60 (10”N)
IE OUT 478.40(10”E)

    - **Profile View–Catch Basin and Other Structures:**

CB 3B-1
STA 3+70
RIM 486.50
IE OUT 478.40 (8”N)
15.00 LF PVC, 12” ↓
@ S = 35.67%

    - **Profile View–Manhole Callout with Multi IE IN:**

MH3B-2
STA 3+49.40 =
STA 0+00 STM 4
RIM 486.50
IE IN 478.60 (8”N)
IE IN 478.60 (8”E)
IE OUT 478 (8”S)

- ***Reference Balloons***

  In general, note reference balloons are not allowed. The District will determine the type and format of all callouts on the final as-built drawings if notes are included. If reference balloons are used on construction drawings, then the structure name callout must precede the number as shown below in **Fig. 4**.

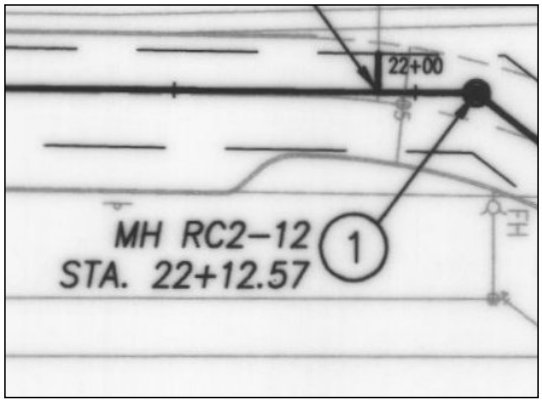

Fig. 4 Balloon

- ***Utility Crossings***

  Show and label all storm, sanitary, waterline, gas and all other utilities that are 6 inches or larger that cross the pipeline alignment in the profile view. Utility invert and crown elevations may be required if they are in close proximity to a proposed storm line. See **Fig. 5**.

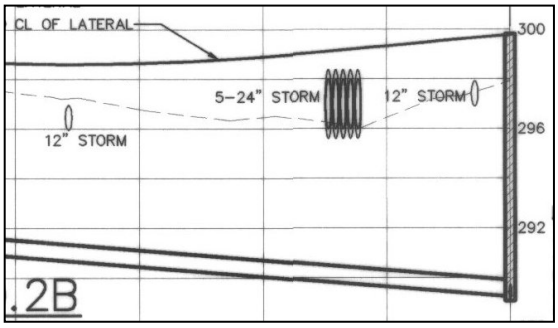

Fig. 5 Utility Profile

A.5.13 Plan and Profile View Sheet Specifications

Plan and Profile Views shall contain the following information:

- Follow the Line Weight Guide for Drawing Submittals, **Fig. 6**.
- Screening layers during plotting will not be permitted for any line types on plots except for widely spaced hatching. Screening lines are not allowed on as-built record drawings.
- The primary structures and pipes (storm) shall appear **BOLD** and stand out against all other background features in both the plan and profile views, i.e., only the applicable conveyance lines and appurtenances should appear bold on submittals.

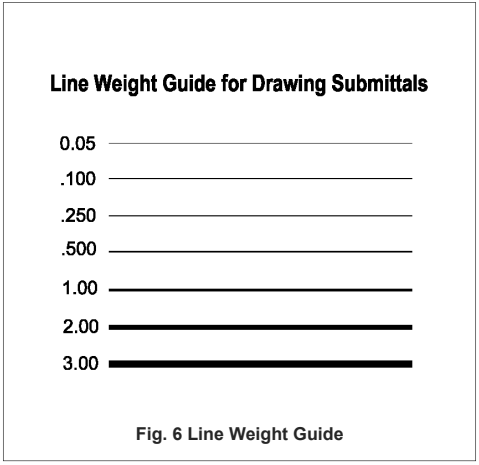

Fig. 6 Line Weight Guide

- ***Plotted Line Widths:***
  - Lines shall be plotted in millimeters and widths and plotted at 1” = 50’ in model space and 1:1 in paper space. The line widths should be plotted the thickness of the lines as illustrated in **Fig. 6**.
  - Screening of line weights is prohibited for illustration of line weights. Solid gray lines may be used in place of screening lines.
- ***Plan View:***
  - The plan and profile showing the proposed mainline extensions and Service Connections shall have a line weight of 3.00 mm (black). The sanitary or storm in the background shall have a width of 1.00 mm.
  - Existing contour lines in the plan view may be drawn as a dashed or solid line type; black or gray; between 0.250-0.500 mm in weight.

- ***Profile View:***
  - Profile view of the proposed system mainline shall be drawn at a line weight of 2.00 mm. Other utilities shown in the background shall be drawn at a line weight of 0.500 mm in either black or gray.
  - Existing sanitary/storm lines shall be shown in the profile view as a dashed black or a gray line in a line weight of 1.00 mm.
- ***Other associated line specifications for plan and profile views:***
  - Profile view gridlines:
    - Primary – 0.250 mm/black
    - Secondary – 0.050 mm/black
    - Tax lots, parcels, property, and easement lines – 1.00 mm/black
    - Roadway improvements – 0.500 mm/black
    - All other utilities – 0.250 mm/black or gray
  - Subdivision or plat boundary – 2.00 mm/black or gray

A.5.14 Landscape Plans

Landscape plans for publicly maintained stormwater management facilities shall be prepared, stamped with the seal of, and signed by, a Landscape Architect, registered in the State of Oregon. Plans for privately maintained stormwater management facilities do not require the involvement of a Landscape Architect. Landscape Plans shall include the following:

- A detailed landscape plan, at a scale of 1-inch equals 20 feet shall be provided for each landscaped stormwater management facility. This plan may be combined with the stormwater management facility grading plan (Section A.5.6). The landscape plan shall include the following:
  - Existing vegetation to be preserved and protective construction fencing.
  - Areas of stormwater management facilities to be designated with construction fencing to protect from construction traffic and compaction.
  - Final ground contours at a minimum of a 2-foot contour interval.
  - Location of top and toe of slope.
  - Limits of embankment designed to impound water.
  - Location of all drainage structures as well as any other piped utilities in the vicinity.
  - Limits of areas to receive amended topsoil and growing medium.
  - A plant list or table, including botanic and common names, size at time of planting, quantity, spacing, type of container, evergreen or deciduous, and other information related to the facility-specific planting, in accordance with landscape industry standards.
  - Location of stockpiles (erosion protection measures must be shown on the EPSC plan).

- Method of temporary irrigation to be used for the establishment period.
- Location of maintenance access, as applicable.

A.6 AS-BUILT SUBMITTAL REQUIREMENTS

The District requires the sanitary and storm plans shall be as-built prior to the acceptance of the project. As-built drawings are necessary to assure the project was constructed per the approved plans and/or meet the requirements of these Standards. The Engineer of record is responsible for record keeping, inspection, and preparation of the as-built drawings. Final as-built drawings will be submitted in the following manner, CAD files and PDF files.

A.6.1 As-built Drawing Requirements

As-built drawings shall contain, at a minimum, the following information:

- For all publicly maintained systems and all public and private detention and stormwater BMP facilities, the engineer shall submit certified as-built plans and profile drawings.
- Each page shall be stamped by the Engineer and stated in writing that it is an as-built drawing.
- Show final pipe alignment, slope, pipe size, and pipe material type in the appropriate view.
- Indicate areas of rock removal not completed by standard backhoe, i.e., splitter or blasting.
- As-built drawings and electronic drawings shall become the unencumbered property of the District and are public records that may be distributed as the District deems necessary.
- Two (2) sets of full sized “Draft” as-built drawings on blue-line shall be submitted to the District for review and redline mark-up prior to final electronic file format submittal, and PDF files.
- On the applicable Plan View sheet show a table listing the following information for each sanitary and/or storm Service Connection; mainline stationing, measurement in linear feet of the location of the Service Connection from the center of the upstream and downstream manholes, pipe size, pipe length, and pipe depth of the Service Connection at the property line.
- Street stationing and information not related to the storm system construction is not allowed on the as-built plans; however, this information is acceptable on the construction plans.
- Remove all hatching associated with material type.

A.6.2 CAD Requirements for As-Built Drawings

The following provides CAD requirements for as-built drawings.

- ***General Requirements:***
  - AutoCAD electronic files must be compatible with the AutoCAD version the District is currently running.
  - Standard fonts, shapes and line types are required.

- All drawings are to be plotted in paper space at a scale of 1:1.
- For specific line weight requirements see Section A.5.13.
- Show the project boundary in **BOLD** type.
- All manholes, catch basins, fire hydrants, valves, meters, etc. are to be inserted as blocks. All blocks are to be created on layer 0.
- Not allowed are blocked x-refs and preferences or permissions set, so that the District cannot access each layer individually.
- All drawings are to be seamless and drawn in model space.
- Drawings are NOT to be rotated off of world coordinate bases.
- Drawings are to be delivered purged of all unused layers, blocks, line types, and styles.
- The AutoCAD and pdf drawing files must be saved to disk and shall be ready to plot when opened and be the same dated file used to plot the as-built drawings.
- SoftDesk point files are not requested and should not be transmitted. Combination files are acceptable.
- The final as-built drawing files are to be saved under one file folder. All drawings, x-refs, plot files, images, text, and shape files are to be in this one file folder.
- Only pertinent files are to be submitted in this project folder. NO revisions, SoftDesk files, log times, or miscellaneous DWGs are to be submitted.
- Before approval will be given, the digital file and hard copy will be evaluated to verify that they are the identical drawings and to make sure all required and only necessary files are included.
- The electronic as-built drawings shall be submitted along with a completed "*As-built Release of Liability Form*" and all contents shall become the property of the District.
- Provide the CAD as-built project drawings in digital data and saved to compact disk or flash drive for transmittal to the District.
- Use of a self-extracting PKZIP file format is acceptable. Use of compressed file(s) is allowed only if the decompression program is included.

- ***Disks Labeling Requirements:***
  - Title of project
  - The District (WES Log#) project file number
  - Specify contents of the disk (DWGs)
  - Name of the engineering firm submitting the files
  - The project completion date.

A.6.3 PDF File Requirements for As-Built Drawings

- AutoCAD and PDF electronic files must be compatible with the District's current version of the programs.
- As-built drawings and electronic drawings shall become the unencumbered property of the District and are public records that may be distributed as the District deems necessary.
- The PDF files shall represent an exact copy of the final as-built drawings.

A.7 GENERAL BUILDING PERMIT, PARTITION/SUBDIVISION APPROVAL PROCESSES

The following is general information on the District processes for approving building permit applications, partitions, and subdivision plats.

A.7.1 Building Permit Review and Approval

The following items must be completed prior to District approval of a building permit application:

- District review and approval of applicable sanitary, stormwater, and erosion control plan(s)
- Payment of applicable charges and fees by the applicant

A.7.2 Partition/Subdivision Plat Review and Approval

The applicant shall submit a preliminary plat to the Local Planning Authority, who will coordinate plat review with the District. The District will only perform an official review of plats received from the Local Planning Authority. The District will review the plat in accordance with the approved sanitary and stormwater management plans and return comments to the Local Planning Authority. Prior to final plat approval by the District, the developer shall address the following:

- Sanitary and Stormwater Construction plans shall be approved by the District.
- All associated agreements and easements shall be reviewed and approved by the District. The District will deliver the signed documents to the County Surveyor's Office at the time of plat approval.
- Sanitary and Stormwater Improvements shall be:
  - Fully constructed in accordance with the approved plans, or
  - The applicant shall obtain a performance surety for all proposed sanitary and stormwater improvements on the approved plan. If the construction work is partially completed, the surety will be based on a status report submitted by the Engineer.
- Public easement documents shall include a site plan and specify the entitlements within the boundary of the easement.
- Deferred Improvements – In some situations, the responsibility to construct improvements may be deferred to the future owner of a specific lot. Deferrals are at the discretion of the District and will be reviewed on a case-by-case basis. All deferred improvement(s) shall be fully constructed and completed in accordance with the RR&S, prior to any future occupancy permit approvals by the District. All responsibilities of the future owner to construct the deferred improvements shall be stipulated in a separate document recorded as a covenant with the plat.

  - **Subdivision Plats** – Any deferred improvements must be part of a District-approved subdivision improvement plan.
  - **Partition Plats** – Eligible improvements are limited to Service Connections, conveyance system, pervious surfaces, and stormwater facilities that either benefit one lot, or are shared facilities. In the case of shared facilities, the deferred improvements will be the responsibility of the first future lot owner to submit a building permit application.
- Other related agreements and documents (i.e., Homeowner's Association CC&Rs, maintenance agreements, etc.)

A.8 GENERAL CONDITIONS FOR PERFORMANCE AND WARRANTY SURETY

The District may require the Applicant to submit a surety to guarantee performance or warranty in completion of the improvements required by these standards. Upon default, the District may draw upon the surety or available funds to complete the remaining work or remedy violations. The different types of acceptable surety are listed below.

A.8.1 Surety – Types of Acceptable Guarantees

Surety shall be provided only through State regulated surety companies while assignment or commitment of savings or loan proceeds shall be through State regulated financial institutions. Cash surety shall be held by a bank for the sole benefit of the District.

A.8.2 Surety Forms

All sureties shall be submitted with forms provided by the District or other authority having jurisdiction to permit or regulate the activity. All sureties are subject to review and approval by the District's legal department.

A.8.3 Performance Surety

The applicant shall provide a Performance Surety acceptable to the District prior to recording of the plat for residential developments or the issuance of building permits for commercial or industrial developments, if the required public improvements are not completed and/or accepted by the District.

The following conditions shall be met prior to acceptance of the Performance Surety:

- The Performance Surety shall be in the amount of 125% of the engineer's cost estimate for all approved but uncompleted sanitary and stormwater improvements, including landscaping requirements. The engineer's cost estimate for the required improvements will be approved by the District.
- Nothing herein shall limit the owner's responsibility for repair and maintenance to the amount of the surety.

The following conditions shall be met prior to release of the Performance Surety:

- All improvements must be completed as shown on the approved plans and accepted by the District in accordance with the Rules, Regulations, and Standards.
- A warranty surety shall be provided to the District prior to release of the Performance Surety.

If the applicant fails to comply with the conditions of approval and the approved plans, the District may call upon the Performance Surety to complete the improvements according to the approved plans.

At the end of the surety period when all conditions are satisfied, the residual surety amount shall be released.

A.8.4 Warranty Surety

In general, the Warranty Surety is posted by the surety principal to the District to ensure the principal will maintain, repair, replace and be responsible for damage to the improvements for a period of 2 years following the date the District deems the improvements complete and a letter of completion and/or acceptance is issued.

The following conditions shall be met prior to acceptance of the Warranty Surety:

- The Warranty Surety shall be in the amount of 25% of the actual constructed cost for all constructed sanitary, stormwater, and vegetated buffer vegetated buffers are covered in the warranty bond improvements. The engineer's cost data sheet will be approved by the District.
- The Warranty Surety shall be in favor of the District and be issued for a minimum two-year period from the date of completion of the sanitary or storm system.
- Nothing herein shall limit the owner's responsibility for repair and maintenance to the amount of the surety.
- Upon notification from the District, the principal shall, within 30 days complete corrective measures to the satisfaction of the District.
- The District may perform emergency work without notice to the principal or surety.
- All work performed by the District due to the nonperformance of the principal or in response to an emergency shall be reimbursed to the District within 30 days of invoice.
- If the principal fails to reimburse the District in 30 days, the District may demand payment from the Surety.
- The warranty period may be extended, if the required improvements show any signs of failure during a final warranty release inspection.

The following conditions shall be met prior to release of the Warranty Surety:

- The owner or developer shall perform a thorough cleaning of all sanitary and stormwater improvements.
- The owner or developer shall have a qualified professional verify the condition of all of the stormwater facilities planting prior to releasing the Warranty Surety. If

the plantings within a Stormwater BMP facility or Vegetated Buffer are not in compliance with the approved plans, then the vegetated plantings will be replanted and/or repaired to meet the requirements of the approved plans. If replanting of the Stormwater BMP facility or Vegetated Buffer is required, then an additional 1-year warranty surety in the amount of 25% of the cost of replanting all of the effected vegetated planting areas shall be required. The additional 1-year warranty surety will be renewed annually until the Vegetated Plantings are acceptable to the District.

- The District shall make a determination of final completion in conformance with the approved plans, specifications, and District standards as well as conduct a final warranty surety inspection of all sanitary and stormwater improvements, including landscaping in any stormwater BMP facility and vegetated buffer.
- Any deficiencies resulting in non-acceptance of the work permitted shall be identified in writing on a final punch list and presented to the principal and/or permittee with a date named for correction and completion. Upon correction of the noted deficiencies and the determination that all work is in conformance with District Standards, the work will be deemed complete and all sureties shall be released.

APPENDIX B

Infiltration Testing Guide

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B.1 General

To properly size and locate stormwater management facilities, it is necessary to characterize the soil infiltration conditions at the location of the proposed facility. All projects that require a stormwater management facility shall evaluate existing site conditions and determine if the site's infiltration rate is adequate to support the proposed stormwater management facility. The following sections provide the approved methods for testing infiltration and setting the design infiltration rate. District staff may require additional testing on a case-by-case basis.

B.2 Basic Method – Open Pit Test

The Basic Method – Open Pit Test (Basic Method) is applicable only to projects on private property with less than 10,000 SF of new or redeveloped impervious area. The results of infiltration testing shall be documented on the Basic Method Form. The Basic Method cannot be used for projects that have known downstream conveyance problems.

The intent of the Basic Method is to determine whether or not the local infiltration rate is adequate (0.5 inches/hour) to support an infiltration facility. It is recommended but not required that The Basic Method infiltration test is conducted by a licensed professional.

B.2.1. Basic Method Instructions

1. Conduct one test for each proposed stormwater management facility. The test should be where the facility is proposed or within the direct vicinity.
2. Excavate a test hole to the depth of the bottom of the infiltration system, or otherwise to 4 feet. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or posthole digger.
3. If a layer hard enough to prevent further excavation is encountered, or if noticeable moisture/water is encountered in the soil, stop, measure, and record this depth from the surface. Proceed with the test at this depth.
4. Fill the hole with water to a height of about 6 inches from the bottom of the hole (or to one-half the maximum depth of the proposed facility) and record the exact time. Check the water level at regular intervals (every 1 minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from the top edge of the hole.
5. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to portray the soil's ability to infiltrate at different levels of saturation accurately. The third test provides the best measure of the saturated infiltration rate.
6. For each test pit required, submit all three testing results with the date, duration, drop in water height, and conversion into inches per hour.

If the results of the Basic Method show an infiltration rate greater than 0.5 inches per hour, the applicant can proceed with stormwater management facility design that uses infiltration. If the applicant would like to use an infiltration rate for design purposes, a Professional Method Infiltration Test shall be conducted.

B.3 Professional Method

The Professional Method shall be used for all public and private developments with more than 10,000 SF of new or redeveloped impervious area. The Professional Method shall also be used for all public and private developments with known downstream conveyance problems.

Three infiltration testing methods are available, as outlined in Sections B.3.5 through B.3.7. The qualified professional shall exercise judgment in the selection of the infiltration test method.

B.3.1. Testing Criteria

1. Testing shall be conducted or observed by a qualified professional. This professional shall be a Professional Engineer (PE), Registered Geologist (RG), or Certified Engineering Geologist (CEG) licensed in the state of Oregon.
2. The location and depth of the test shall correspond to the facility location and depth.
3. Infiltration testing should not be conducted in engineered or undocumented fill.
4. Boring logs shall be provided as supporting information with infiltration and depth to groundwater tests.
5. All testing data shall be documented in the project submittals. The submittals shall demonstrate that the proposed facilities are sized appropriately for the tested infiltration rates.

B.3.2. Depth and Location of Required Tests

Infiltration tests shall be performed at the base of the proposed facility.

If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing shall be conducted within that confining layer.

Tests shall be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location.

For relatively deep stormwater facilities, a hollow stem auger with an electronic measuring tape can be used, provided there is an adequate seal between the auger and the native soil.

B.3.3. Minimum Number of Required Tests

The total number of infiltration tests is at the discretion of the qualified professional assessing the site and the District Engineer, provided the following minimums are met:

- At least one test for any proposed street facility.
- One test for every 100 linear feet or 1,000 SF of proposed infiltration facility.
- Where multiple types of facilities are used, it is likely that multiple tests will be necessary since an infiltration test can test only a single soil stratum. It is highly recommended to conduct an infiltration test at each stratum used.

B.3.4. Factors of Safety

Table B-1 lists the recommended factors of safety to be applied to field-obtained infiltration rates for use in stormwater system design. To obtain the infiltration rate used in design, divide the infiltration rate measured in the field by the factor of safety. The factor of safety used in design should be chosen by collaboration between the geotechnical engineer or geologist overseeing the infiltration testing and the civil engineer designing the stormwater management system.

Determination of the factor of safety shall include consideration of project specific conditions such as soil variability, testing methods, consequences of system failure, complexity of proposed construction, and other pertinent conditions. The design infiltration rate after applying the safety factor shall not exceed 100 in/hr for non-vegetative facilities, such as drywells or infiltration chambers. Vegetated facilities with growing media shall be designed at a maximum infiltration rate of 6.0 in/hr through the growing media.

Table B-1. Infiltration Rate Safety Factors

Test Method	Recommended Correction Factors
Encased Falling head	3
Open Pit Falling Head	2
Double-Ring Infiltrometer	Public Facilities: 1 Private Facilities: 2

B.3.5. Open Pit Falling Head Procedure

The open pit falling head procedure is based on the Environmental Protection Agency (EPA) Falling Head Percolation Test Procedure (Onsite Wastewater Treatment and Disposal Systems Design Manual, EPA/625/1-80-012, 1980). The test is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration.

1. Excavate an approximately 2-foot by 2-foot-wide hole into the native soil to the elevation of the proposed facility bottom. The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, posthole digger, or hand auger. If smooth auguring tools or a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp-pointed instrument, and remove the loose material from the bottom of the test hole.
2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.
3. Fill the hole with clean water a minimum of 1 foot above the soil to be tested and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material.
4. Percolation rate measurements shall be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period shall be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

5. In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
6. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points. The tester and excavator should conduct all testing in accordance with OSHA regulations.
7. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
8. Successive trials shall be run until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials shall be conducted. After each trial, the water level is readjusted to the 12-inch level. Enter results into the **Infiltration Test Data Table** provided at the end of this section.
9. The results of the last water level drop are used to calculate the tested infiltration rate. The final rate shall be reported in inches per hour. See the calculation following the **Infiltration Test Data Table** provided at the end of this section.
10. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:
    a. Approximate the area over which the water is infiltrating.
    b. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.
    c. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches).
11. Upon completion of the testing, the excavation shall be backfilled.

B.3.6. Encased Falling Head Test Procedure

The encased falling head procedure is based on a modification of the EPA Falling Head Percolation Test Procedure (Onsite Wastewater Treatment and Disposal Systems Design Manual, EPA/625/1-80-012, 1980). The most significant modification is that this test is performed with a 6-inch casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1. Embed a solid 6-inch-diameter casing into the native soil at the elevation of the proposed facility bottom (see **Figure B-1**). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be applied to testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.

2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.
3. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material.

   Percolation rate measurements shall be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period shall be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

   In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
4. To conduct the first trial of the test, fill the pipe to approximately 6 inches above the soil and measure the water level to the nearest 0.01 foot (1/8 inch). The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.
5. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. The infiltration test is continued until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials shall be conducted. After each trial, the water level is readjusted to the 6-inch level. Enter results into the **Infiltration Test Data Table** provided at the end of this section. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
6. The result of the last water level drop is used to calculate the tested infiltration rate. The final rate shall be reported in inches per hour.
7. Upon completion of the testing, the casings shall be immediately pulled, and the test pit shall be backfilled.

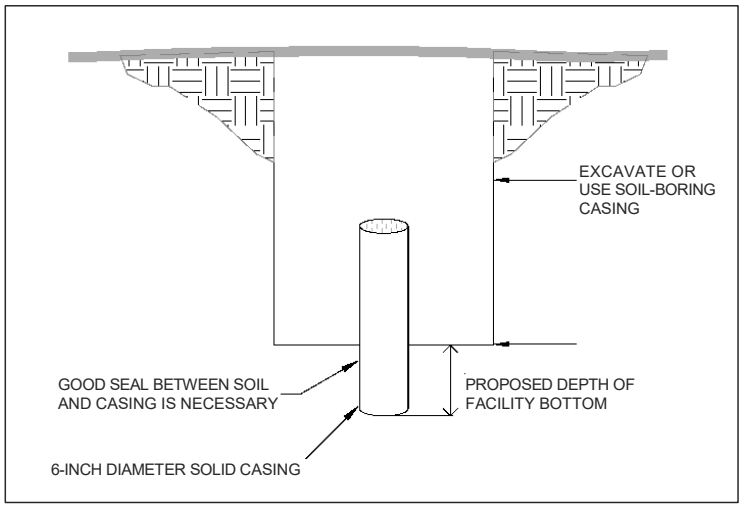

Figure B-1. Encased Falling Head Procedure

B.3.7. Double Ring Infiltrometer Test

The double-ring infiltrometer test procedure shall conform with ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established.

This test may be difficult to perform where the tested soil strata are in a pit since careful regulation of the static volumes is necessary.

B.4Reporting Requirements

In addition to the information required by the state for a signed and stamped Geotechnical Engineering Report, the following information shall be included in the project's submittals.

1. Infiltration results in inches per hour.
2. Location and depth of excavation. The excavation should be deep enough to verify that there is a 5-foot separation between the final depth of the facility (rock gallery) and the seasonal high groundwater or soil layer that could reduce the infiltration rate.
3. Summary and discussion of infiltration testing, including number of tests, amounts of water used in each test (inches, gallons, etc.), and time of each test. Testing is required to show that an accurate rate was achieved.

4. Discussion of how the test was performed:
    - Open pit (size of area)
    - Encased falling head
        - Pipe type and size
        - Embedment depth
    - Double-ring infiltrometer
        - Pipe type and size
        - Embedment depth
5. **Table B-2. Infiltration Test Data Table** provided at the end of this appendix.
6. Soil types with depth.
7. Groundwater observations – seasonal high groundwater level estimation.

Table B-2. Infiltration Test Data Table		
Location:	**Date:**	**Test Hole Number:**
Depth to bottom of hole:	**Diameter of hole:**	**Test Method:**
Tester's Name: **Tester's Company:**	**Tester's Contact Number:**	

Depth, feet	Soil Texture

Time	Time interval, minutes	Measurement, feet	Drop in water level, feet	Percolation rate, inches per hour	Remarks

Infiltration Test Data Table Example		
Location: Lot 105, Low Point Heights Subdivision	**Date:** 6/28/2010	**Test Hole Number:** 3
Depth to bottom of hole: 57 inches	**Diameter of hole:** 0.5 feet	**Test Method:** Encased falling head
Tester's Name: C.J. Tester **Tester's Company:** Tester Company		**Tester's Contact Number:** 555-1212

Depth, feet	Soil Texture
0-0.5	Black Topsoil
0.5-1.0	Brown SM
1.0-2.2	Brown ML
2.2-5.1	Brown CL

Time	Time interval, minutes	Measurement, feet	Drop in water level, feet	Percolation rate, inches per hour	Remarks
9:00	0	3.75	-		Filled with 6"
9:20	20	3.83	0.08		
9:40	20	3.91	0.08	2.88	
10:00	20	3.98	0.07	2.52	
10:20	20	4.04	0.06	2.16	
10:40	20	4.11	0.07	2.52	
11:00	20	4.17	0.06	2.16	
11:20	20	4.225	0.055	1.98	
					Adjusted to 6" level for Trial #2

Calculation is performed for each water level drop

= (Drop in water level/Time Interval) x conversion

= 0.055ft/20min x (12in/ft) x (60min/hr)

= 1.98 inches per hour

The design infiltration rate of two successive trials shall have a difference of 5% or less.

APPENDIX C

Stormwater Management Facilities Selection Worksheets

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Appendix C – Typical Facility Drawings

Table 1. Acceptable Stormwater Facilities for WES

	Facility Selection Worksheet		
	Facilities within a Public Street/ROW (see note 1)	**Publicly Maintained Facilities (see notes 1 & 3)**	**Privately Maintained Facilities (see note 2)**
Stormwater Planter	YES	YES	YES
Rain Garden	YES	YES	YES
Vegetated Swale	YES	YES	YES
Filter Strip	YES	YES	YES
Drywell	YES	YES	YES
Infiltration Gallery or Trench	NO	YES	YES
Constructed Wetland	NO	YES	YES
Detention or Infiltration Ponds	NO	YES	YES
Structural Detention	NO	YES	YES
Manufactured Treatment	YES	YES	YES
Sheet Flow Dispersion	YES	YES	YES
Pervious Pavement	NO	YES	YES
Green Roof	NO	NO	YES

Notes:

(1) Publicly Maintained Stormwater Facilities - Stormwater Facilities and storm drainage systems that convey stormwater runoff from any public rights-of-way must be maintained by the public.

(2) Privately Maintained Stormwater Facilities - Stormwater runoff fully contained on private property and mitigated through a privately owned facility must be maintained by the property owner(s). An on-site maintenance agreement must be recorded as a land record specifying the minimum required amount of maintenance in accordance with District Rules, Regulations, and Standards.

(3) Pervious pavement constructed within the public right of way requires the approval of the local roadway authority.

Table 2. Acceptable Stormwater Facilities for Happy Valley and DTD

	Facility Selection Worksheet		
	Facilities within a Public Street/ROW (1)	**Publicly Maintained Facilities (1)**	**Privately Maintained Facilities (2)**
Stormwater Planter	YES	YES	YES
Rain Garden	YES	YES	YES
Vegetated Swale	YES	YES	YES
Filter Strip	YES	YES	YES
Drywell	YES (with WES maintenance)	YES (with WES maintenance)	YES
Infiltration Gallery or Trench	NO	NO	YES
Constructed Wetland	NO	YES	YES
Detention or Infiltration Ponds	NO	YES	YES
Structural Detention	YES	YES	YES
Manufactured Treatment	YES (WES maintenance for DTD facilities)	YES	YES
Sheet Flow Dispersion	YES (WES maintenance for DTD facilities)	YES (WES maintenance for DTD facilities)	YES
Pervious Pavement	NO	NO	YES
Green Roof	NO	NO	YES

Notes:

(1) Publicly Maintained Stormwater Facilities - Stormwater Facilities and storm drainage systems that convey stormwater runoff from any public rights-of-way___0 must be maintained by the public.

(2) Privately Maintained Stormwater Facilities - Stormwater runoff fully contained on private property and mitigated through a privately owned facility must be maintained by the property owner(s). An on-site maintenance agreement must be recorded as a land record specifying the minimum required amount of maintenance in accordance with District Rules, Regulations, and Standards.

APPENDIX D

Typical Facility Drawings and Standard Details

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Appendix D – Typical Facility Drawings

Commented [A16]: Details are in separate CAD file (to be added)

APPENDIX E

Hydrology Methodology

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E.1 Santa Barbara Urban Hydrograph Method

The Santa Barbara Urban Hydrograph (SBUH) method is a single-event model that estimates a flow hydrograph for a representative rainfall event. The SBUH method was developed by the Santa Barbara County Flood Control and Water Conservation District. Applicable to urban areas, it converts design storm incremental rainfall depths into instantaneous unit hydrographs (Debo and Reese 2003).

E.1.1. Elements of the SBUH Method

The SBUH method depends on several variables:

- Pervious (A_p) and impervious (A_{imp}) land areas
- Time of concentration (T_c) calculations
- Runoff curve numbers (CN) applicable to the site
- Design storms

Assumptions for these variables must be explained and justified in the design report.

E.1.2. Land Area

The total area, including the pervious and impervious areas within a drainage basin, shall be quantified in order to evaluate critical contributing areas and the resulting site runoff. Each area with a basin shall be analyzed separately and their hydrographs combined to determine the total basin hydrograph. Areas shall be selected to represent homogenous land use/development units.

E.1.3. Time of Concentration

Time of concentration, Tc, is the time for a theoretical drop of water to travel from the furthest point in the drainage basin to the facility being designed. In this case, Tc is derived by calculating the overland flow time of concentration and the channelized flow time of concentration. Tc depends on several factors, including ground slope, ground roughness, and distance of flow. The formula for determining Tc is found in **Table E-2** which includes standard equations.

When calculating T_c, the following limitations apply:

- Overland sheet flow (flow across a flat area that does not form into channels or rivulets) shall not extend for more than 300 feet.
- For flow paths through closed conveyance facilities such as pipes and culverts, standard hydraulic formulas shall be used for establishing velocity and travel time (See **Section 5** and **Figure E-1** for more data on pipe flow rates and velocities.)
- Flow paths through lakes or wetlands may be assumed to be zero (i.e., $T_c = 0$).

E.1.4. Runoff Curve Numbers

Runoff curve numbers were developed by the Natural Resources Conservation Service (NRCS) after studying the runoff characteristics of various types of land. Curve numbers (CN) were developed to reduce diverse characteristics such as soil type, land usage, and vegetation into a single variable for use in runoff calculations. The runoff curve numbers approved by the District for water quantity/quality calculations are included in **Table E-3**.

The curve numbers presented in **Table E-3** are for wet antecedent moisture conditions. Wet conditions assume previous rainstorms have reduced the capacity of soil to absorb water.

Given the frequency of storms in Clackamas County, wet conditions are most likely, and result in conservative hydrographic values.

E.1.5. Design Storm

The SBUH method also requires a design storm to perform the runoff calculations. For flow control calculations, the District uses an NRCS Type 1A 24-hour storm distribution. The rainfall depths for 2-year through 100-year storm events are shown in **Table E-1**.

Table E-1. WES Design Storms

Design Storm/Recurrence Interval (years)	24-Hour Rainfall Depth (inches)
Water Quality	1.0
2-year	2.4
5-year	2.85
10-year	3.2
25-year	4.0
50-year	4.13
100-year	4.8

E.2 Soils Information

Soils information can be found in the latest Soil Survey for Clackamas County, Oregon. Soils information may be obtained electronically from the USDA Natural Resources Conservation Services (NRCS) websoil survey at the link below:

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

1. Select Start WSS.
2. Navigate by: State and County (Oregon; Clackamas).
3. Define your area of interest (AOI) using the graphic tool.
4. Determine the portions of the site that fall under each of the four hydrologic soil groups listed below.

Hydrologic Soil Groups

Group A Soils having a high infiltration rate (low runoff potential) when thoroughly wet (deep, well drained to excessively drained sands or gravelly sands)

Group B Soils having a moderate infiltration rate when thoroughly wet (moderately deep or deep, moderately well drained, or well drained soils that have moderately fine texture to moderately coarse texture)

Group C Soils having a slow infiltration rate when thoroughly wet (soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture)

Group D Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet (clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material)

Table E-2. Standard Equations

MANNING'S EQUATION: (Open Channel Flow}

$$Q = \left(\frac{1.486}{n}\right) A R^{2/3} S^{1/2}$$

Manning's Equation for circular pipe flowing full

$$Q = \frac{0.463}{n} D^{2/3} S^{1/2}$$

$$V = \frac{0.590}{n} D^{2/3} S^{1/2}$$

$$V = \left(\frac{1.486}{n}\right) R^{2/3} S^{1/2}$$

Q *Quantity of flow*, cubic feet per second
V Velocity of flow, feet per second
n Manning's coefficient of roughness (see **TABLES 5-2 and 5-3** of these standards)
A Cross-sectional area, square feet
R Hydraulic radius (area of flow divided by wetted perimeter), feet
S Slope of the pipe or energy line, feet per foot
0 Diameter of pipe, feet

RATIONAL METHOD: (Stormwater Design Flows)

Q = CIA (Max. drainage area=100 acres-- Max. time: *60 minutes*)

Q Quantity of runoff, cubic feet per second
C Coefficient of runoff (ratio of runoff to rainfall), percent (See **TABLE E-4**)
I Intensity of rainfall, inches per hour
A Area of tributary drainage basin, acres

GUTTER FLOW CAPACITY: (Manning's Equation Modified)

$$Q = 0.56 \frac{\frac{1}{Sx}}{n} S^{0.5} d^{2.67} \quad \text{or} \quad Q = \frac{0.56}{n} Sx^{1.67} S^{0.5} T^{2.67} \qquad V = \frac{1.12}{n} S^{0.5} Sx^{0.67} T^{2.67}$$

Q Quantity of flow, cubic feet per second
Sx Street cross slope, feet per loot
S Street longitudinal slope, feet per foot
n Manning's coefficient of roughness for the gutter, (normally 0.018)
D Depth of flow at the curb, test
T Total width of flow in the gutter, feet

TIME OF CONCENTRATION: (Overland Stormwater Flow)

Tt = L/60V (for conversion of velocity to travel time)

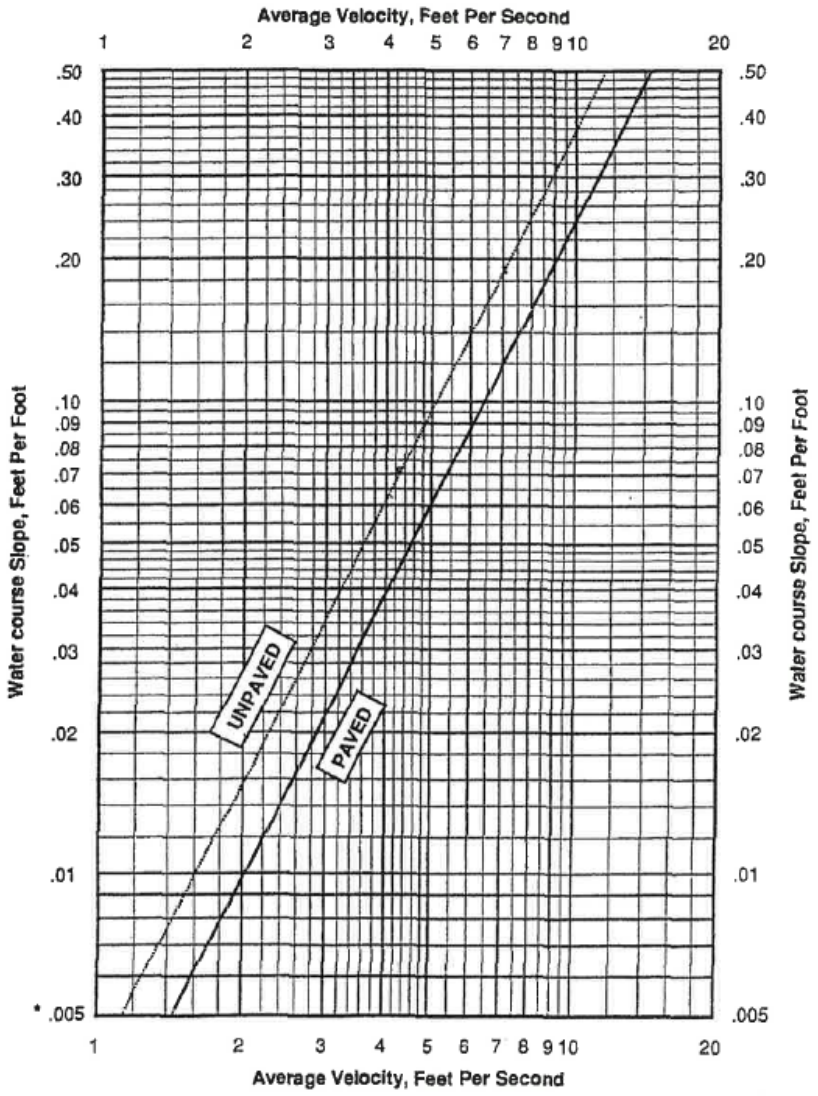
Tc = $T_{11} + T_{12} + \ldots . T_{1m}$

Tt = $\frac{0.42\ (nL)^{0.8}}{1.58\ (S)^{0.4}}$ (Manning's kinematic solution for sheet flow less than 300 feet)

V = 16.1345 $(S)^{0.5}$ (Unpaved surfaces)
V = 20.3282 $(S)^{0.5}$ (Paved surfaces)

Shallow concentrated flow for slopes less than 0.005 ft/ft. For steeper slopes, see **FIGURE E-1.**

Tt Travel time, minutes
L Flow length, feet
V Average veracity of flow, *feet per second*
60 Conversion factor from seconds to minutes
Tc *Total time of concentration, minutes* {minimum Tc = 5.0 minutes)
n Manning's roughness coefficient for various surfaces, (see **TABLES 5-2 and 5-3**)
S Slope of the hydraulic grade line (land or watercourse slope), feet per foot
1.58 A factor derived from Ref. No. 8 (P2, from 2-year, 24-hr precipitation chart, for the Portland, Oregon area [P 2°·5 = 2.5°·5=1.58])



* For slopes less than 0.005 ft/ft, use the following equations:
$V = 16.1345 (S)^{0.5}$ = fps (Unpaved surfaces)
$V = 20.3282 (S)^{0.5}$ = fps (Paved surfaces)

FIGURE E-1. AVERAGE VELOCITIES FOR SHALLOW CONCENTRATED FLOW

Source: BES, August 7 1990

Table E-3. Runoff Curve Numbers

Description	Curve Numbers for Hydrological Soil Groups			
	A	B	C	D
Open space (lawns, parks, golf courses, cemeteries)				
Poor condition (< 50% grass coverage)	68	79	86	89
Fair condition (50 to 75% grass coverage)	49	69	79	84
Good condition (>75% grass coverage)	39	61	74	80
Impervious Areas				
Paved areas (parking lots, roofs, driveways)	98	98	98	98
Streets and roads				
Paved with curbs	98	98	98	98
Paved with open ditches	83	89	92	93
Gravel	76	85	89	91
Dirt	72	82	87	89
Urban Districts				
Commercial and business (85% impervious)	89	92	94	95
Industrial (72% impervious)	81	88	91	93
Residential districts by average lot size				
1/8 acre or less (65% impervious)	77	85	90	92
1/4 acre (38% impervious)	61	75	83	87
1/3 acre (30% impervious)	57	72	81	86
1/2 acre (25% impervious)	54	70	80	85
Woods (Good Hydrologic Condition)	70*			

** CN for Predeveloped Forest Condition is assumed to be equivalent to Woods condition with Hydrologic Soil Group C.*

Source: SCS 1986. Urban Hydrology for Small Watersheds. USDA Soil Conservation Service Engineering Division TR-55. June

Source: BES, August 7 1990

Table E-4. Runoff Coefficients *

% IMPERVIOUS	SOIL** TYPE	DRAINAGE AREA SLOPE Under 5%	5% to 10%	Over 10%	TYPICAL LAND USE***
0 to 10	A	0.19	0.24	0.29	**Zones:** OS, RF **Other:** Parks, Cemetaries & Playgrounds
	B	0.28	0.33	0.38	
	C	0.33	0.43	0.52	
10 to 20	A	0.26	0.31	0.36	**Zones:** R20
	B	0.35	0.40	0.45	
	C	0.39	0.48	0.57	
20 to 30	A	0.34	0.39	0.44	**Zones:** R10
	B	0.41	0.46	0.51	
	C	0.45	0.54	0.62	
30 to 40	A	0.41	0.46	0.51	**Zones:** R7, R5
	B	0.48	0.53	0.58	
	C	0.51	0.59	0.67	
40 to 50	A	0.49	0.54	0.59	**Zones:** R2.5, R3
	B	0.54	0.59	0.64	
	C	0.57	0.65	0.72	
50 to 60	A	0.56	0.61	0.66	**Zones:** R2, CO1 **Streets:** Neighborhood - 20' in 35' ROW **Other:** Schools
	B	0.61	0.66	0.71	
	C	0.63	0.70	0.77	
60 to 70	A	0.64	0.69	0.74	**Zones:** R1, CN2, CO2 **Streets:** Neighborhood - 24' to 28' in 40' ROW 32' to 35' in 50' ROW Neighborhood Collector
	B	0.67	0.72	0.77	
	C	0.69	0.76	0.82	
70 to 80	A	0.71	0.76	0.81	**Streets:** Neighborhood - 36' in 50' ROW 28' in 40' ROW **Other:** Hospitals
	B	0.74	0.79	0.84	
	C	0.75	0.81	0.87	
80 to 90	A	0.79	0.84	0.89	**Zones:** RH, CN1, CM, CS, CG, EG1, EG2, IG1, IG2
	B	0.80	0.85	0.90	
	C	0.81	0.87	0.92	
90 to 100	A	0.86	0.91	0.96	**Zones:** RX, CX, EX, IH **Streets:** Community Arterial Commercial Paved Portion Of Any Street
	B	0.87	0.92	0.97	
	C	0.87	0.92	0.97	

SURFACE CHARACTERISTICS	DRAINAGE AREA SLOPE Under 5%	5% to 10%	Over 10%
Woodlands			
Type A Soil	0.10	0.15	0.20
Type B Soil	0.20	0.25	0.30
Type C Soil	0.30	0.35	0.40
Lawns, Pasture And Meadows			
Type A Soil	0.15	0.20	0.25
Type B Soil	0.25	0.30	0.35
Type C Soil	0.30	0.40	0.50
Cultivated Land			
Type A Soil	0.25	0.35	0.50
Type B Soil	0.40	0.55	0.70
Type C Soil	0.50	0.65	0.80
Gravel Areas & Walks			
Loose	0.30	0.40	0.50
Packed	0.70	0.75	0.80
Pavements & Roofs	0.90	0.95	1.00

* Runoff coefficients may be adjusted to the nearest 0.05, if adjusted consistently throughout the project.

** Soil Types:
A = Gravel & sandy Loam
B = Light Clay & Silt Loam
C = Tight Clay

*** The land uses are typical for a given percent of impervious surface. Where there is or will be any significant variation from typical conditions, another percentage range should be used.

Source: BES, August 7 1990

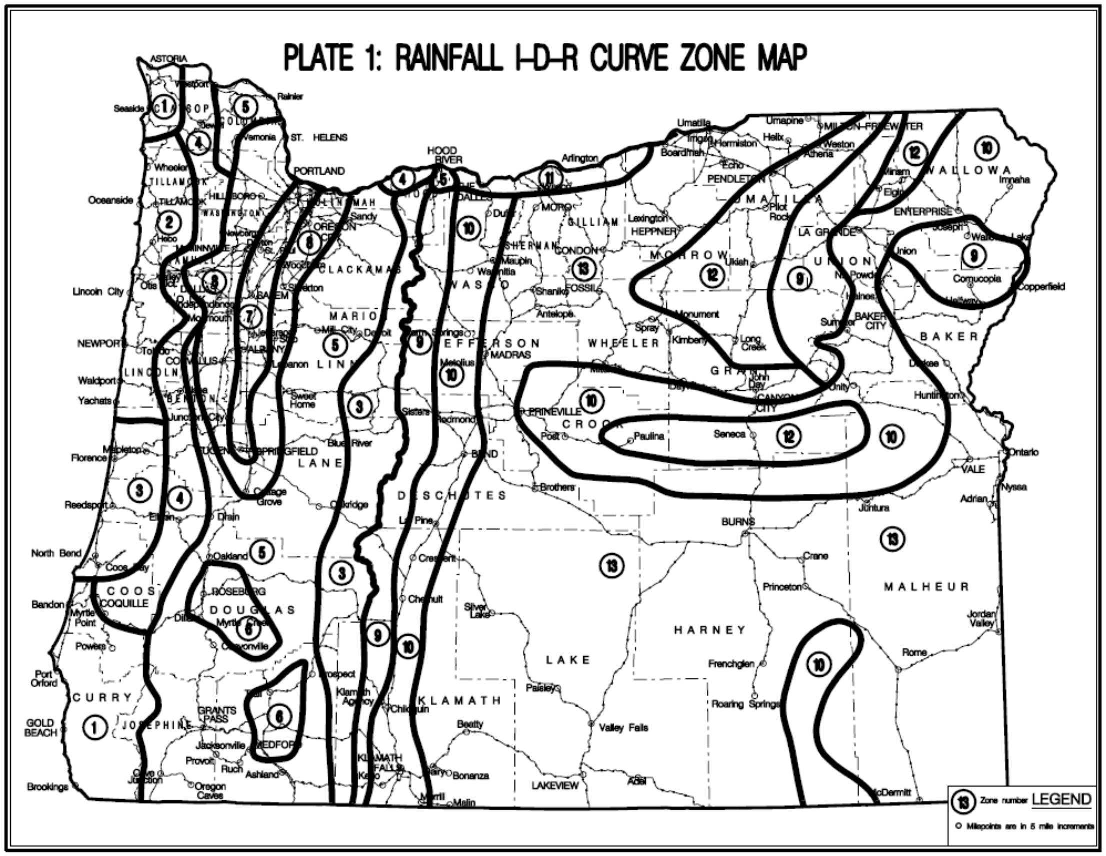


FIGURE E-2. RAINFALL I-D-R CURVE ZONE MAP

Source: Precipitation Frequency Atlas of the Western United States, DOC/NOAA/NWS > National Weather Service, NOAA, U.S. Department of Commerce

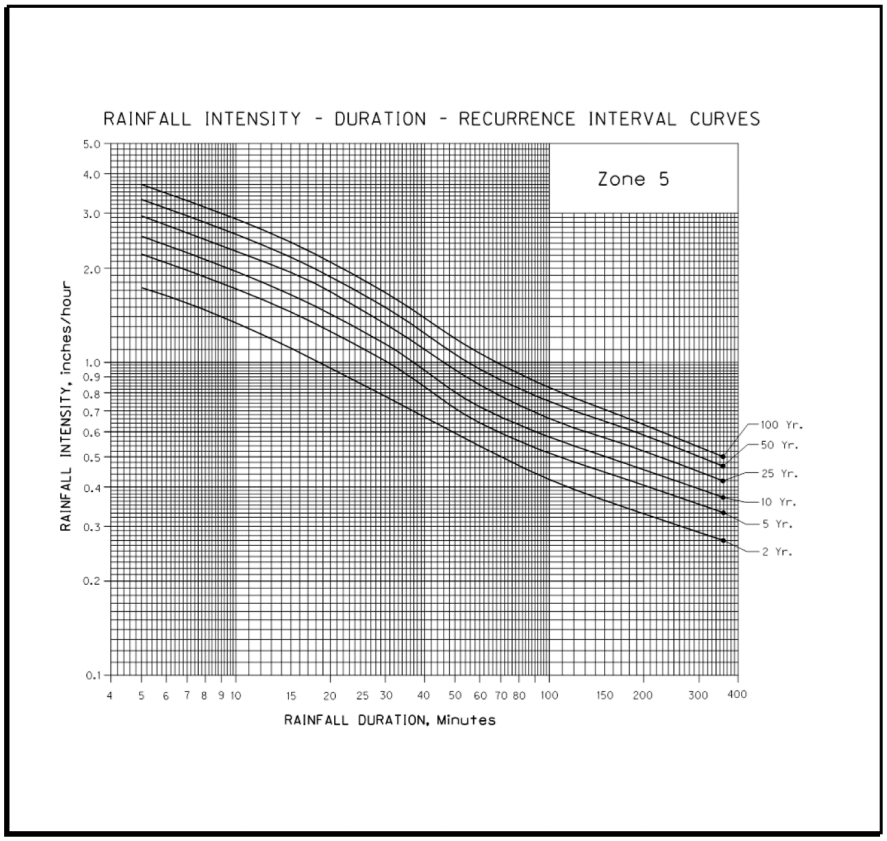


FIGURE E-3. RAINFALL INTENSITY RECURRENCE CURVES (ZONE 5)

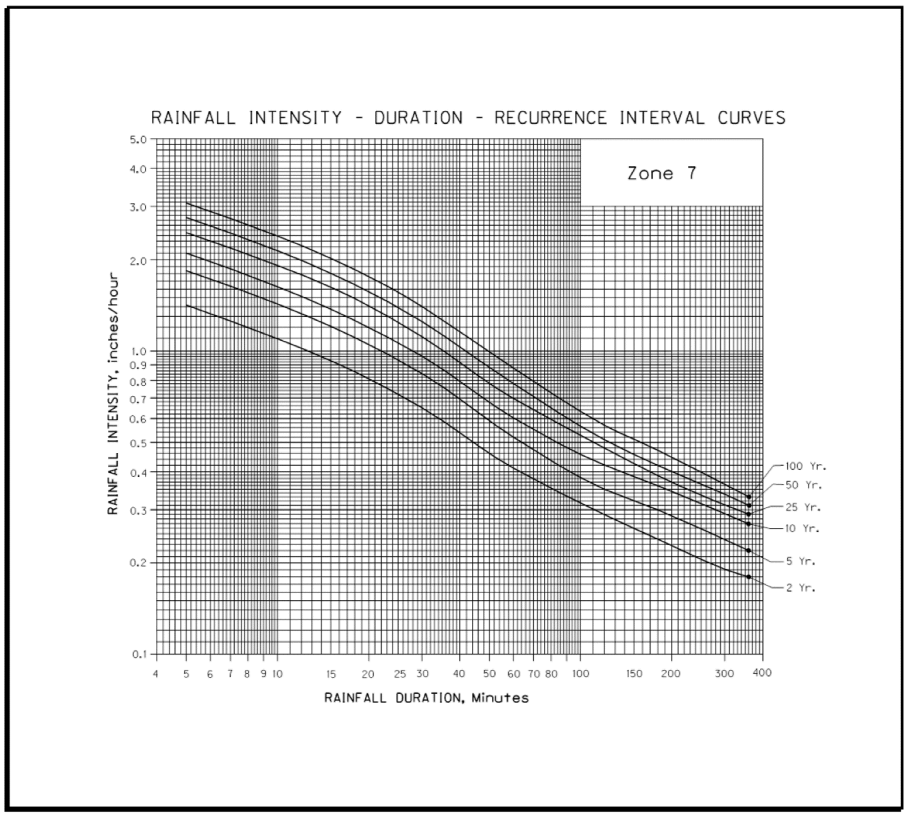


FIGURE E-4. RAINFALL INTENSITY RECURRENCE CURVES (ZONE 7)

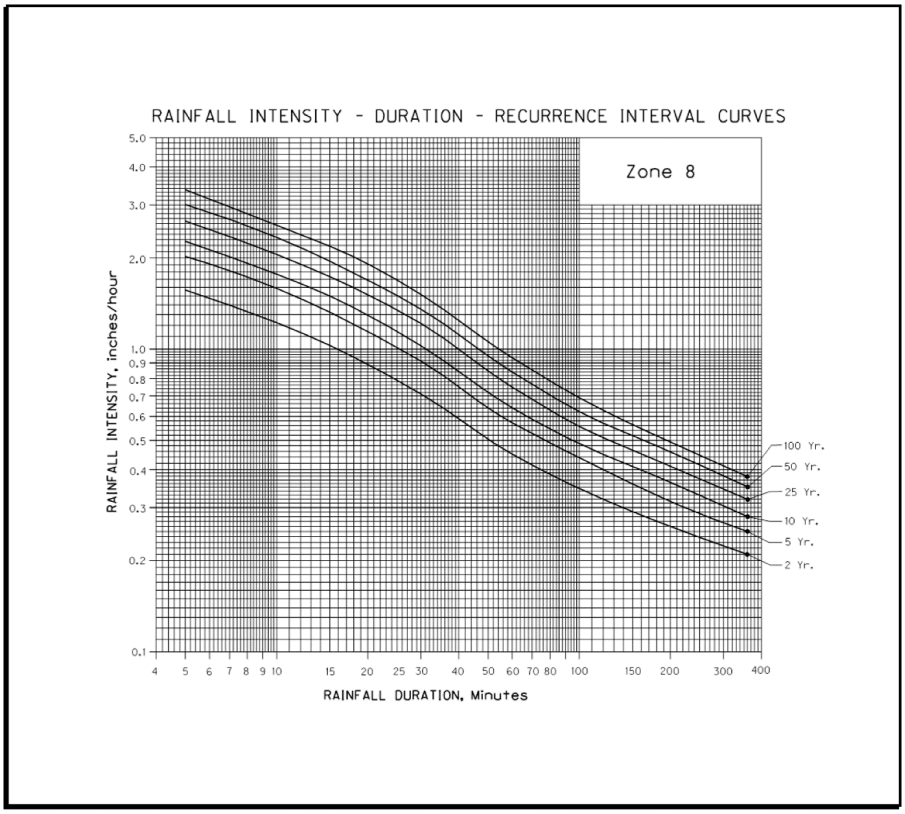


FIGURE E-5. RAINFALL INTENSITY RECURRENCE CURVES (ZONE 8)

APPENDIX F

Planting Guide for Vegetated Stormwater Facilities

CLACKAMAS
WATER
ENVIRONMENT
SERVICES

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F.1 Introduction

This appendix provides planting matrices categorized by stormwater management facility type. The matrices provide important information on plants approved for installation in each facility type and are intended to guide plant selection for planting plans.

All plants included in these matrices are intended to be drought tolerant but require irrigation temporarily during their establishment period. Even after the establishment period, native plants may require supplemental irrigation during periods of high heat or extended drought. The species listed are representative examples and are not to be considered exclusive or exhaustive for these facility types.

The City of Portland maintains a comprehensive Native Plant List for planting within the Portland metropolitan region that can be found on the City's website.

When a conflict exists between the representative species outlined within this publication and the Native Plant List, the Native Plant List will prevail.

An alternate plant selection may be proposed for review and approval by the District. No species adopted within the Portland Nuisance Plants List will be permitted.

F.2 Plant Type Information

A description of the type of information provided for each plant is provided below.

- *Plant Name*: Plants are listed by their botanical name first, in italics, followed by a generally accepted common name. Note that common names vary, so use of the botanical name is recommended to ensure proper plant selection
- *Zone*: As noted in the zone section of the compiled plant lists, zone denotes the planting moisture zone in which it is appropriate to locate each respective plant. Zone A refers to the highest point on the slope (dry/upland), Zone B refers to the mid-section of the slope (moist/dry) and Zone S refers to the lowest part of the slope (saturated/wet). Refer to Figure F-1 for zones by facility type. Some plants work in multiple moisture zones, and others only in a particular dry, moist, or wet condition.
- *Origin*: Plants approved for stormwater facilities can be grouped into three categories: NW Natives, NW Native Cultivars, and Non-Native Adaptive plants.
  - **NW Native**: These are plants that are indigenous to our specific region. They typically require minimal care once they are planted because they have evolved and adapted to the growing conditions and climate of the region. Because of their place in the local ecology, native plants also provide habitat value for birds and other local species. For these reasons, native plants are strongly recommended for stormwater facilities and should be used to the maximum extent practical. In designated vegetated buffers and sensitive areas only native plants are allowed in stormwater management facilities.
  - **NW Native Cultivar**: These species are cultivated varieties of native plants produced by horticultural techniques and are not normally found in wild populations. Cultivars are bred for certain desired characteristics that make them different from their native counterparts. Native cultivars may be selected over a native plant if it is more suitable for certain conditions, such as densely urbanized applications. For example, Kelsey dogwood (Cornus sericea 'Kelseyi) is a cultivar of the native red twig dogwood (Cornus sericea). Kelsey dogwood has been selectively bred to be much smaller at maturity than red twig dogwood, which can be advantageous in small scaled urban stormwater planters. In such instances, the native cultivar is preferred because it will not outgrow the facility or require frequent

pruning maintenance, while still offering the same vegetative advantages as its native counterpart.

- **Non-Native Adaptive**: These plants are not native to our region but have certain characteristics that make them very useful and well adapted to stormwater facilities. The non-native adapted plants included on the stormwater facility plant lists are considered non-invasive. WES prefers that native and native cultivars be used whenever practical but will allow non-native adapted plants where appropriate.
- **Type/Size:** The following factors provide guidance on individual plant characteristics:
  - (E)vergreen/(D)ecidious: Identifies the characteristic of a plant to keep or lose foliage during winter months. Evergreen plant materials are often preferred at the understory level for stormwater treatment through winter.
  - Potential Height: Identifies maximum size at maturity to use as a design guideline.
  - Typical On-Center Spacing: Identifies the optimum spacing for new plantings. This is to be used as a guideline and may vary slightly depending on site conditions.

F.3Context Factors

The following factors should be considered when selecting vegetation. Consult the appropriate Plant List for guidance.

- *Sun/Shade*: When developing planting plans, solar orientation is important to consider. This column identifies which plants are appropriate for full to part sun or shade.
- *Facility with underdrain:* In facilities with underdrains, it is important to select plants appropriate for faster draining soils.
- *Facility less than 3 feet wide*: Narrow conditions require plants that are not too large and will outgrow or have the potential for roots to be damaged in narrow planters. This column identifies which plants are appropriate for narrow planter widths.
- *Lined Facility/On Top of Utilities*: In lined facilities it is important to limit larger material or plants with aggressive and deep roots. This column identifies which plants are appropriate for this application.
- *Parking Areas*: This column identifies plants that are appropriate for facilities in most parking areas. Large shrubs selected for parking areas should have form and habit that are open and transparent.

  Note: For portions of parking areas that have line of sight requirements, plants should be selected from the “Streets/Line of Sight” column.
- *Streets/Line of Sight*: For street-side facilities and in parking areas where line of sight visibility is required, use plant materials that do not limit necessary lines of sight visibility. This column identifies which plants are appropriate for this application.
- *Adjacent to Buildings*: When planting adjacent to buildings, limit plant sizes for compatibility with building footings, windows, or other systems. This column identifies which plants are appropriate to use adjacent to buildings.
- *In Natural Resource Overlay District:* If the stormwater facility is within the Natural Resource Overlay District, all plants shall be indigenous to our specific region.
- *Public Maintenance:* For facilities that will be publicly maintained, plant palette shall be more limited and focused on lower maintenance plants. These facilities should also emphasize more hardy plants that can adapt to higher summer temperatures and extended drought.

- *Maintenance Legacy:* The designer should carefully consider the long-term vegetation management strategy for the stormwater facility, with an emphasis on the anticipated maintenance requirements for the future owners.
- *Native vs Blended Soils:* Designers should select plants after a careful analysis of the facility's growing medium matrix. Plant material selection should take into account the site-specific characteristics of both blended and underlying native soils, including infiltration rates.

F.4 Planting requirements

While planting sizes, densities, and irrigation requirements are not specified here, vegetation must be installed such that 100 percent vegetative cover is achieved through a mix of herbaceous, groundcover, and shrubs at the end of the warranty period, prior to acceptance. A dense vegetative cover at the ground level must be achieved for maximum water quality treatment.

Planter plant matrices and facility layout figures are provided in the following pages in Tables F-1 through F-6 and Figures F-1 through F-6.

Table F-1. Stormwater Planter Plant List

Plant Name	Zone	Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Herbaceous Plants														
Carex densa Dense sedge	x	x			E	24"	12"	Sun to Part Shade	x	x	x	x	x	x
Eleocharis ovata Ovate spike rush	x	x			E	30"	12"	Sun to Part Shade	x	x	x	x	x	x
Juncus ensifolius Dagger-leaf rush	x			x	D	10"	12"	Sun to Part Shade	x	x	x	x	x	
Juncus patens Spreading rush	x	x			E	36"	12"	Sun, Part Shade, Shade	x	x	x	x	x	x
Small Shrubs/Groundcover														
Cornus sericea 'Kelseyi' Kelsey dogwood	x		x		D	24"	24"	Sun to Part Shade	x	x	x	x	x	
Mahonia repens Creeping Oregon Grape	x	x			E	2'	3'	Sun, Part Shade, Shade		x	x	x	x	x
Fragaria chiloensis Coastal strawberry	x	x			E	6"	12"	Sun to Part Shade	x	x	x	x	x	x
Polystichum munitum Sword fern	x	x			E	2'	2'	Sun, Part Shade, Shade	x	x	x	x	x	x
Large Shrubs/Small Trees														
Rubus spectabilis Salmonberry	x	x			D	10'	4'	Sun to Part Shade		x			x	x
Salix purpurea nana Blue arctic willow	x			x	D	8'	6'	Sun to Part Shade			x			
Spirea douglasii Douglas spiraea	x	x			D	7'	4'	Sun to Part Shade		x			x	x
Viburnum edule Highbush cranberry	x	x			D	6'	4'	Sun to Part Shade		x	x	x		x
Trees*														
Acer circinatum Vine maple	x	x			D	15'	10'	Sun, Part Shade, Shade	x	x	x		x	x
Acer rubrum Red maple	x			x	D	40'	25'	Sun to Part Shade		x	x	x		
Malus fusca Pacific crabapple	x	x			D	30'	10'	Sun to Part Shade	x	x	x			

Table F-1. Stormwater Planter Plant List

Plant Name	Zone	Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Calocedrus decurrens Incense cedar	x	x			E	90'	15'	Sun to Part Shade			x			x

*Trees are not required, but allowed with adequate soil volume and root space for healthy growth and maturity. Provide minimum 2 cubic feet of soil volume per square foot of mature canopy size.

Table F-2. Rain Garden Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants																
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part to Full Shade		x	x	x	x	x
Carex stipata Sawbeak sedge	x	x	x	x			D	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x		x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x		x	x	x	x
Juncus balticus Baltic rush		x	x	x			E	24"	12"	Sun	x	x	x	x	x	x
Juncus patens Spreading rush	x	x	x			x	E	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Scirpus microcarpus Small Fruited Bulrush	x		x	x			E	24"	12"	Sun	x		x	x	x	x
Small Shrubs/Groundcover																
Athyrium filix-femina *Lady fern*	x	x		x			E	3'	2'	Part Shade to Shade	x		x	x	x	x
Arctostaphylos uva-ursi Kinnickinnick	x	x		x			E	5"	3'	Sun to Part Shade	x	x	x	x	x	x
Mahonia repens Creeping Oregon Grape	x	x		x			E	2'	3'	Part Shade to Shade	x	x	x	x	x	x
Philadelphus lewisii Mock orange	x		x	x			D	6'	4'	Sun to Part Shade			x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x		x	x	x	x
Symphoricarpos albus Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x	x

Table F-2. Rain Garden Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Large Shrubs/Small Trees																
Cornus sericea Red twig dogwood	x	x	x	x			D	6'	4'	Part Shade						
Physocarpus capitatus Pacific ninebark	x		x	x			D	9'	3'	Sun to Part Shade			x	x	x	x
Rosa nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x		x	
Ribes sanguineum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x	x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade						
Trees*																
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x		x	x	x	x
Rhanmus purshiana Cascara	x	x		x			D	30'	20'	Part Sun to Shade						
Calocedrus decurrens Incense cedar	x	x	x	x			E	90'	15'	Part Shade to Shade				x		

* Trees are not required, but allowed with adequate soil volume and root space for healthy growth and maturity. Provide minimum 2 cubic feet of soil volume per square foot of mature canopy size.

Table F-3. Swale Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants																
Carex obnupta Slough sedge	x		x	x			E	48 "	12 "	Part Shade		x	x	x	x	x
Carex stipata Sawbeak sedge	x		x	x			D	36 "	12 "	Sun to Part Shade	x	x	x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36 "	12 "	Part Shade	x		x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24 "	12 "	Part Shade	x		x	x	x	x
Juncus balticus Baltic rush		x	x	x			E	24 "	12 "	Sun	x		x	x	x	x
Juncus patens Spreading rush	x	x	x			x	E	36 "	12 "	Sun to Part Shade	x	x	x	x	x	x
Scirpus microcarpus Small fruited bulrush	x		x	x			E	24 "	12 "	Sun	x	x	x	x	x	x
Small Shrubs/Groundcover																
Athyrium filix-femina Lady fern	x	x		x			E	3'	2'	Sun to Part Shade	x		x	x	x	x
Arctostaphylos uva-ursi Kinnickinnick	x	x		x			E	5"	3'	Sun to Part Shade	x		x	x	x	x
Fragaria chiloenis Coastal strawberry	x	x		x			E	6"	12 "	Sun to Part Shade	x	x	x	x	x	x
Mahonia repens Creeping Oregon grape	x	x		x			E	2'	3'	Part Shade to Shade	x	x	x	x	x	x
Philadelphus lewisii Mock orange	x	x		x			D	6'	4'	Sun to Part Shade			x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x		x	x	x	x
Symphoricarpos alba Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x	x

Table F-3. Swale Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Large Shrubs/Small Trees																
Cornus sericea Red twig dogwood	x	x	x	x			D	8'	4'	Part Shade						
Physocarpus capitatus Pacific ninebark	x		x	x			D	6'	3'	Sun to Part Shade			x	x	x	x
Rosa nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x		x	
Ribes sanguineum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade						
Trees*																
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x		x	x	x	x
Rhamnus purshiana Cascara	x	x		x			D	30'	20'	Part Shade to Shade				x		
Calocedrus decurrens Incense cedar	x	x	x	x			E	90'	15'	Part Shade to Shade				x		

*Trees are not required, but allowed with adequate soil volume and root space for healthy growth and maturity. Provide minimum 2 cubic feet of soil volume per square foot of mature canopy size.

Table F-4. Wetland Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors					
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants															
Alisma plantago-aquatica Water plantain			x	x			D	24"	12"	Sun	x	x			
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part Shade		x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x	x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x	x	x	x	x
Juncus ensifolius Dagger-leaf rush	x		x			X	D	10"	12"	Sun to Part Shade	x	x	x	x	x
Juncus patens Spreading rush	x	x	x			X	E	36"	12"	Sun to Part Shade	x	x	x	x	x
Scirpus microcarpus Small fruited bulrush	x		x	x			E	24"	12"	Sun	x	x	x	x	x
Small Shrubs/Groundcover															
Mahonia repens Creeping Oregon grape	x	x		x			E	2'	3'	Part Shade to Shade	x	x	x	x	x
Rosa pisocarpa Swamp rose		x	x	x			D	6'	3'	Sun to Part Shade		x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x	x	x	x	x
Symphoricarpos albus Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x
Large Shrubs/Small Trees															
Cornus sericea Red twig dogwood	x	x	x	x			D	8'	4'	Part Shade					
Physocarpus capitatus Pacific ninebark	x		x	x			D	6'	3'	Sun to Part Shade		x	x	x	x
Rosa nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x		x	
Ribes sanguineum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x	x	x	x

Table F-4. Wetland Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors					
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Narrow facility	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade					
Ceanothus velutinus Snowbrush	x	x		x			E	6'	3'	Sun, Part Shade, Shade		x	x	x	x
Trees															
Acer circinatum Vine maple	x	x		x			D	15'	8'	Part Shade to Shade	x	x	x	x	x
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x	x	x	x	x
Fraxinus latifolia Oregon ash	x		x	x			D	30'	25'	Sun					
Calocedrus decurrens Incense cedar	x	x	x	x			E	90'	16'	Part Shade to Shade			x		

Table F-5. Pond Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Facility width	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants																
Alisma plantago-aquatica Water plantain	S		x	x			D	24"	12"	Sun	x		x			
Carex obnupta Slough sedge	x		x	x			E	48"	12"	Part Shade		x	x	x	x	x
Deschampsia cespitosa Tufted hair grass	x			x			D	36"	12"	Part Shade	x	x	x	x	x	x
Elymus glaucus Blue wild rye	x	x		x			E	24"	12"	Part Shade	x		x	x	x	x
Juncus ensifolius Dagger-leaf rush	x		x			x	D	10"	12"	Sun to Part Shade	x	x	x	x	x	x
Juncus patens Spreading rush	x	x	x			x	E	36"	12"	Sun to Part Shade	x	x	x	x	x	x
Scirpus microcarpus Small fruited bulrush	x		x	x			E	24"	12"	Sun	x	x	x	x	x	x
Small Shrubs/Groundcover																
Athyrium filix-femina Lady fern	x	x		x			E	3'	2'	Part Shade to Shade	x		x	x	x	x
Mahonia repens Creeping Oregon grape	x	x		x			E	2'	3'	Part Shade to Shade	x		x	x	x	x
Polystichum munitum Sword fern	x	x		x			E	2'	2'	Part Shade to Shade	x		x	x	x	x
Symphoricarpos albus Snowberry	x	x		x			D	3'	3'	Sun, Part Shade, Shade	x	x	x	x	x	x
Large Shrubs/Small Trees																
Cornus sericea Red twig dogwood	x	x	x	x			D	8'	4'	Part Shade		x				
Physocarpus capitatus Pacific ninebark	x		x	x			D	6'	3'	Sun to Part Shade		x	x	x	x	x

Table F-5. Pond Plant List

Plant Name	Zone			Origin			Type/Size			Context Factors						
Botanical Name Common Name	A	B	S	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade	Facility width	Publicly maintained	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Philadelphus lewisii Mock Orange	x	x		x			D	6'	4'	Sun to Part Shade		x	x	x	x	x
Rosa Nutkana Nootka rose	x	x		x			D	8'	4'	Sun, Part Shade, Shade			x		x	
Ribes sanguimeum Red flowering currant	x	x		x			D	8'	4'	Sun, Part Shade, Shade		x	x	x	x	x
Salix sitchensis Sitka willow	x		x	x			D	15'	5'	Sun, Part Shade, Shade						
Ceanothus velutinus Snowbrush	x	x		x			E	6'	3'	Sun, Part Shade, Shade		x	x	x	x	x
Trees																
Acer circinatum Vine maple	x	x		x			D	15'	8'	Part Shade to Shade	x		x	x	x	x
Cornus nuttalii Pacific dogwood	x	x		x			D	20'	10'	Sun, Part Shade, Shade	x		x	x	x	x
Rhamnus purshiana Cascara	x	x		x			D	30'	20'	Part Sun to Shade						
Calocedrus Incense cedar	x	x	x	x			E	90'	15'	Part Shade to Shade				x		

Table F-6. Greenroof Plant List

Plant Name	Zone		Origin			Type/Size			Context
Botanical Name Common Name	C	D	NW native	NW native cultivar	non-native adapted	(E)vergreen/(D)eciduous	Potential Height	Typical On Center Spacing	Sun/Shade
Sedums and Succulents									
Delosperma ssp. Ice plant	x	x			x	E	4"	6"-12"	Sun
Malephora crocea v. purpurea Coppery mesemb	x	x			x	E	10"	6"-12"	Sun to Part Shade
Sedum album White stonecrop	x				x	E	3"	6"-12"	Sun
Sedum oreganum Oregon stonecrop	x	x	x			E	4"	6"-12"	Sun to Part Shade
Sedum spathufolium Stonecrop	x	x			x	E	4"	6"-12"	Sun to Part Shade
Sedum spurium Two-row stonecrop	x	x			x	E	6"	6"-12"	Sun
Sempervivum tectorum Hens and chicks	x				x	E	3"	6"-12"	Sun to Part Shade
Herbaceous Plants									
Achillea millefolium Common yarrow	x	x			x	D	24"	24"	Sun to Part Shade
Artemesia 'Silver Mound' Silver mound artemesia	x	x			x	D	12"	12"	Sun to Part Shade
Castilleja foliosa Indian paintbrush	x	x	x			D	10"	12"	Sun
Festuca glauca 'Elijah's Blue' Elijah's blue fescue	x	x			x	E	12"	12"	Sun
Fragaria chiloensis Coastal strawberry	x	x	x			E	6"	12"	Sun to Part Shade
Polystichum munitum Sword fern	x	x	x			E	24"	24"	Sun, Part Shade, Shade
Thymus serpyllum Creeping thyme	x				x	D	3"	6"	Sun, Part Shade, Shade

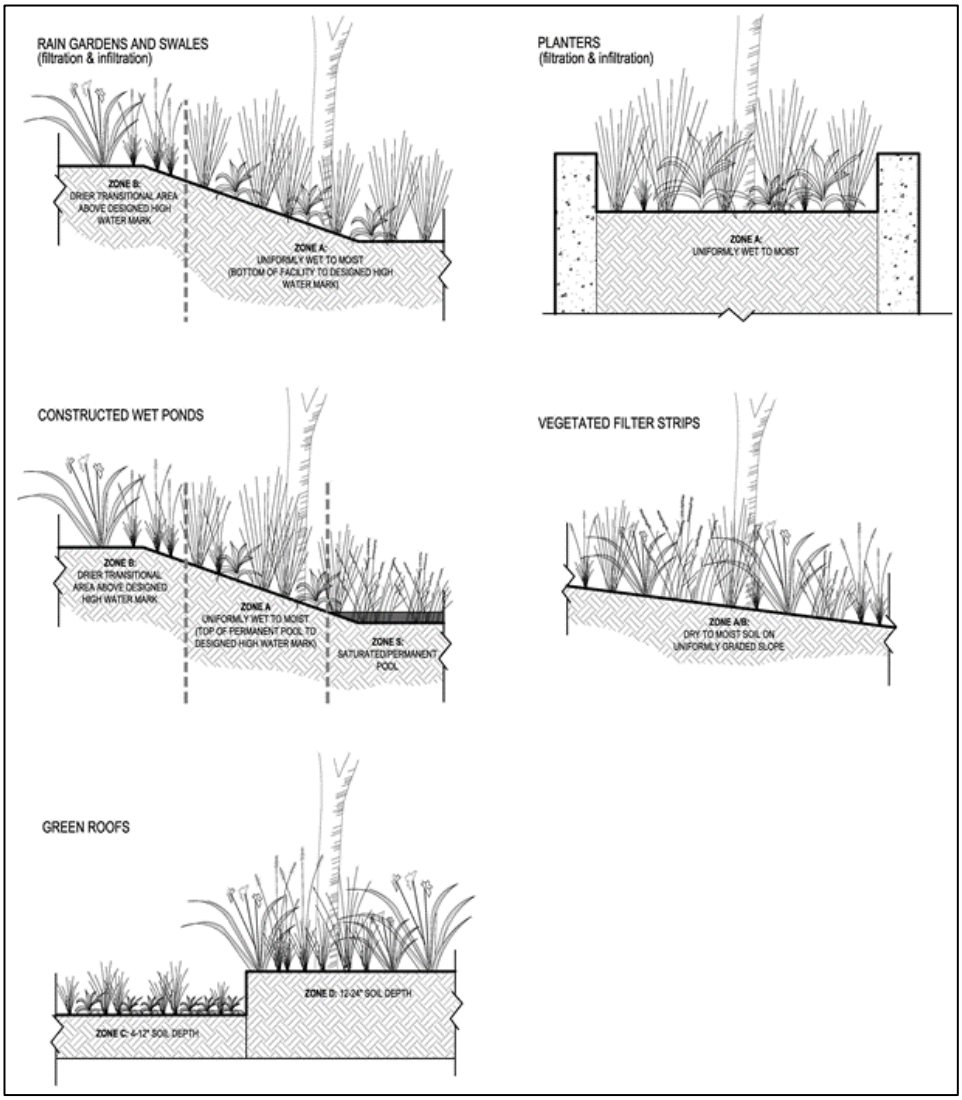
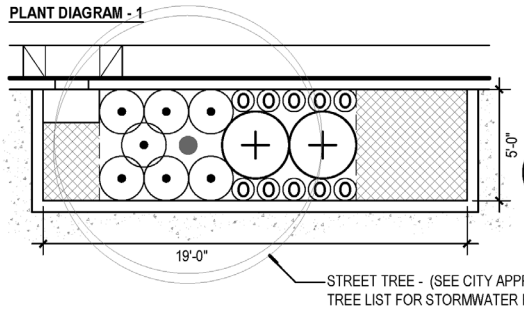


Figure F-1. Planting Zone by Facility Type

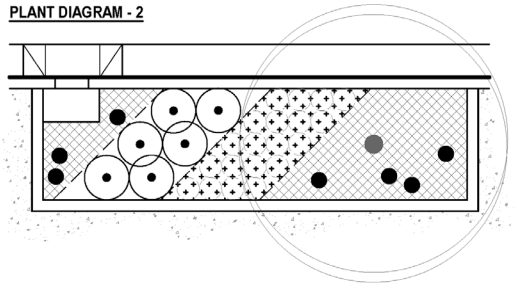
PLANT DIAGRAM - 1



PLANT LEGEND - 1

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Camas leichtlinii GREAT CAMAS	D	12"	10
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	7
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	39
	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	2

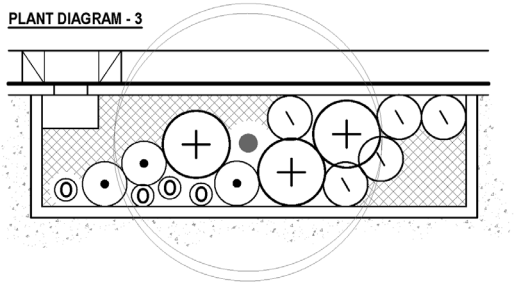
PLANT DIAGRAM - 2



PLANT LEGEND - 2

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Carex densa DENSE SEDGE	E	12"	20
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	6
	Iris Tenax OREGON IRIS	D	VAR	7
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	53

PLANT DIAGRAM - 3



PLANT LEGEND - 3

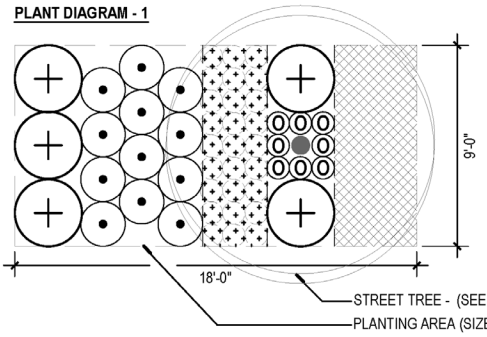
SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Camas leichtlinii GREAT CAMAS	D	12"	4
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	3
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	34
	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	3
	Polystichum munitum SWORD FERN	E	2'-0"	5

DESIGN GUIDELINES

1. THESE ARE EXAMPLE PLANTING DIAGRAMS APPROVED BY WES. CHOOSE A PLANTING DIAGRAM AND ALTER IT TO YOUR DESIGN. OTHER PLANTING DESIGNS MAY BE APPROVED.
2. SEE ENGINEERING DESIGN STANDARDS FOR SPECIFIC LANDSCAPE REQUIREMENTS.
3. SEE PLANT MATRIX FOR TYPICAL PLANT SPACING.
4. PLANTING TABLE REQUIRED PER ENGINEERING DESIGN STANDARDS. PLANTING LEGENDS SHOWN HERE DO NOT INCLUDE ALL REQUIRED INFORMATION FOR PLANTING TABLES.

Linear Planter **Figure F-2**		WES STORMWATER AND GRADING DESIGN STANDARDS

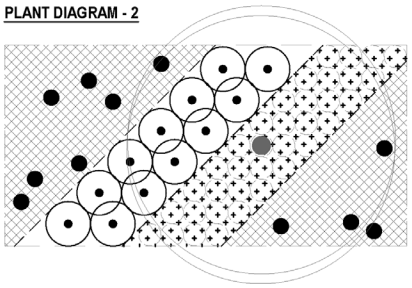
PLANT DIAGRAM - 1



PLANT LEGEND - 1

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Camas leichtlinii GREAT CAMAS	D	12"	8
	Carex densa DENSE SEDGE	E	12"	30
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	12
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	39
	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	5

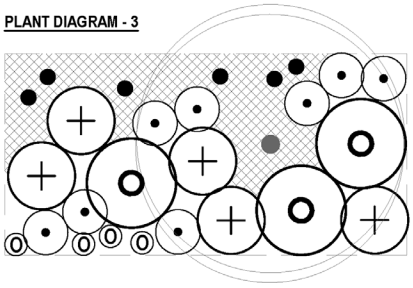
PLANT DIAGRAM - 2



PLANT LEGEND - 2

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Carex densa DENSE SEDGE	E	12"	36
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	12
	Iris Tenax OREGON IRIS	D	VAR	11
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	92

PLANT DIAGRAM - 3



PLANT LEGEND - 3

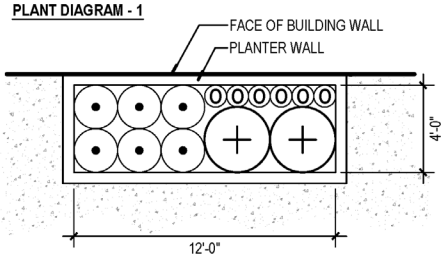
SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Camas leichtlinii GREAT CAMAS	D	12"	4
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	8
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	51
	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	5
	Spiraea Douglasii DOUGLAS SPIREA	E	2'-0"	5

DESIGN GUIDELINES

1. THESE ARE EXAMPLE PLANTING DIAGRAMS APPROVED BY WES. CHOOSE A PLANTING DIAGRAM AND ALTER IT TO YOUR DESIGN. OTHER PLANTING DESIGNS MAY BE APPROVED.
2. SEE ENGINEERING DESIGN STANDARDS FOR SPECIFIC LANDSCAPE REQUIREMENTS.
3. SEE PLANT MATRIX FOR TYPICAL PLANT SPACING.
4. PLANTING TABLE REQUIRED PER ENGINEERING DESIGN STANDARDS. PLANTING LEGENDS SHOWN HERE DO NOT INCLUDE ALL REQUIRED INFORMATION FOR PLANTING TABLES.

Rectangular Planter **Figure F-3**		WES STORMWATER AND GRADING DESIGN STANDARDS

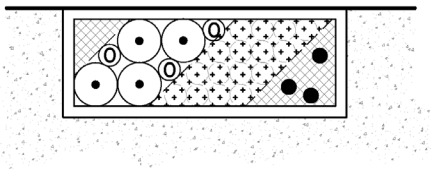
PLANT DIAGRAM - 1



PLANT LEGEND - 1

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
O	Camas leichtlinii GREAT CAMAS	D	12"	6
●	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	6
+	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	2

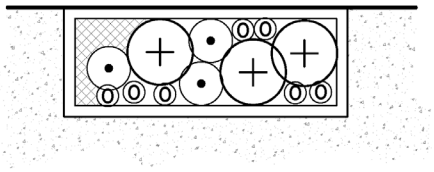
PLANT DIAGRAM - 2



PLANT LEGEND - 2

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
O	Camas leichtlinii GREAT CAMAS	D	12"	3
▭	Carex densa DENSE SEDGE	E	12"	16
●	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	4
●	Iris Tenax OREGON IRIS	D	VAR	3
▨	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	15

PLANT DIAGRAM - 3



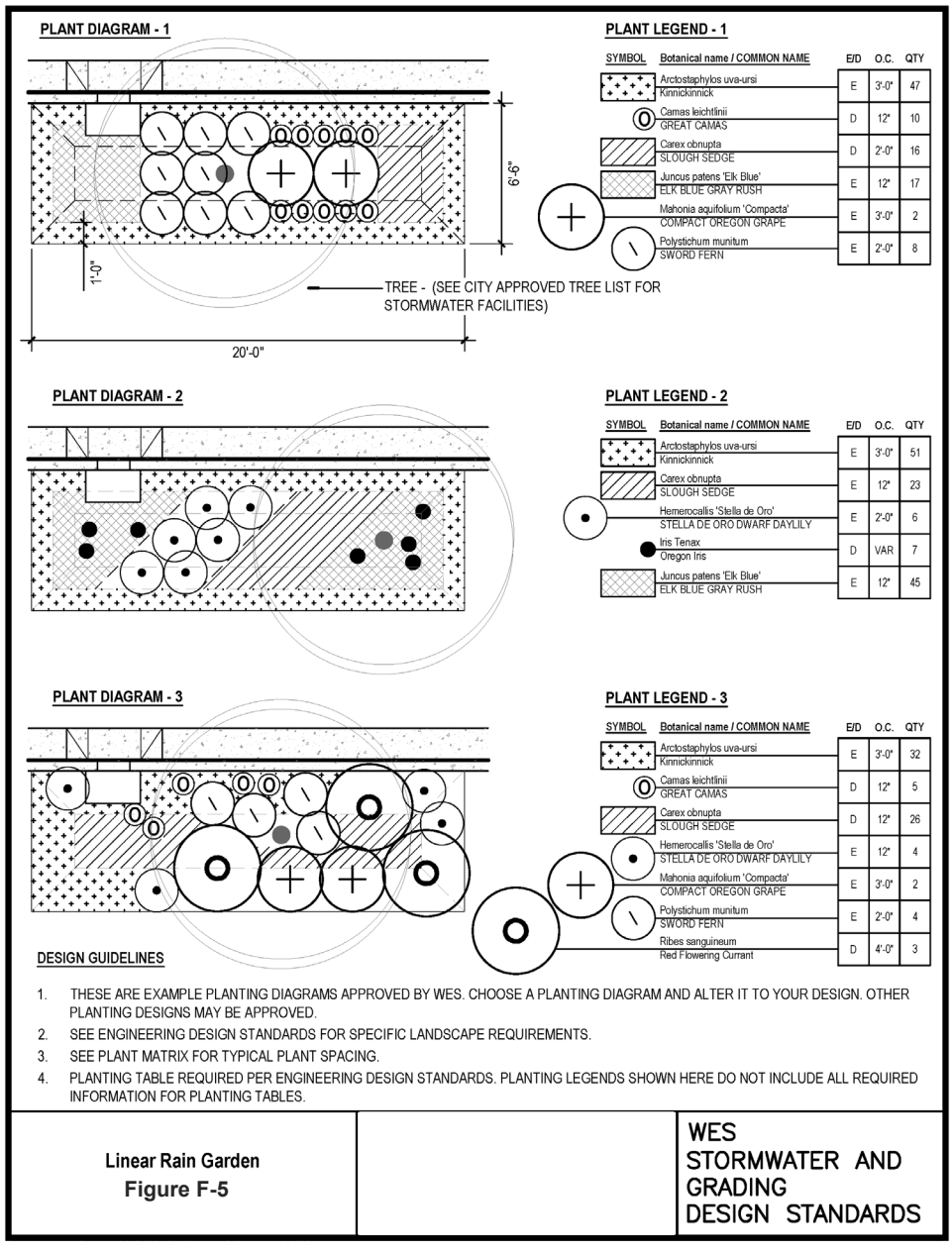
PLANT LEGEND - 3

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
O	Camas leichtlinii GREAT CAMAS	D	12"	7
●	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	3
▨	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	6
+	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	3

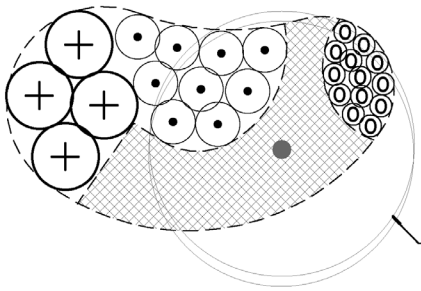
DESIGN GUIDELINES

1. THESE ARE EXAMPLE PLANTING DIAGRAMS APPROVED BY WES. CHOOSE A PLANTING DIAGRAM AND ALTER IT TO YOUR DESIGN. OTHER PLANTING DESIGNS MAY BE APPROVED.
2. SEE ENGINEERING DESIGN STANDARDS FOR SPECIFIC LANDSCAPE REQUIREMENTS.
3. SEE PLANT MATRIX FOR TYPICAL PLANT SPACING.
4. PLANTING TABLE REQUIRED PER ENGINEERING DESIGN STANDARDS. PLANTING LEGENDS SHOWN HERE DO NOT INCLUDE ALL REQUIRED INFORMATION FOR PLANTING TABLES.

Planter Box **Figure F-4**		WES STORMWATER AND GRADING DESIGN STANDARDS


PLANT DIAGRAM - 1
6'-6"
1'-0"
TREE - (SEE CITY APPROVED TREE LIST FOR STORMWATER FACILITIES)
20'-0"
PLANT LEGEND - 1
SYMBOL Botanical name / COMMON NAME E/D O.C. QTY
Arctostaphylos uva-ursi Kinnickinnick E 3'-0" 47
Camas leichtlinii GREAT CAMAS D 12" 10
Carex obnupta SLOUGH SEDGE D 2'-0" 16
Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH E 12" 17
Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE E 3'-0" 2
Polystichum munitum SWORD FERN E 2'-0" 8
PLANT DIAGRAM - 2
PLANT LEGEND - 2
SYMBOL Botanical name / COMMON NAME E/D O.C. QTY
Arctostaphylos uva-ursi Kinnickinnick E 3'-0" 51
Carex obnupta SLOUGH SEDGE E 12" 23
Hemerocallis 'Stella de Oro' STELLA DE ORO DWARF DAYLILY E 2'-0" 6
Iris Tenax Oregon Iris D VAR 7
Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH E 12" 45
PLANT DIAGRAM - 3
PLANT LEGEND - 3
SYMBOL Botanical name / COMMON NAME E/D O.C. QTY
Arctostaphylos uva-ursi Kinnickinnick E 3'-0" 32
Camas leichtlinii GREAT CAMAS D 12" 5
Carex obnupta SLOUGH SEDGE D 12" 26
Hemerocallis 'Stella de Oro' STELLA DE ORO DWARF DAYLILY E 12" 4
Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE E 3'-0" 2
Polystichum munitum SWORD FERN E 2'-0" 4
Ribes sanguineum Red Flowering Currant D 4'-0" 3
DESIGN GUIDELINES
1. THESE ARE EXAMPLE PLANTING DIAGRAMS APPROVED BY WES. CHOOSE A PLANTING DIAGRAM AND ALTER IT TO YOUR DESIGN. OTHER PLANTING DESIGNS MAY BE APPROVED.
2. SEE ENGINEERING DESIGN STANDARDS FOR SPECIFIC LANDSCAPE REQUIREMENTS.
3. SEE PLANT MATRIX FOR TYPICAL PLANT SPACING.
4. PLANTING TABLE REQUIRED PER ENGINEERING DESIGN STANDARDS. PLANTING LEGENDS SHOWN HERE DO NOT INCLUDE ALL REQUIRED INFORMATION FOR PLANTING TABLES.
Linear Rain Garden
Figure F-5
WES STORMWATER AND GRADING DESIGN STANDARDS

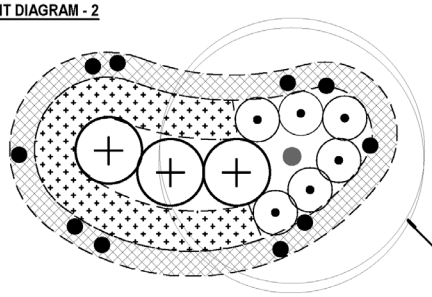
PLANT DIAGRAM - 1



PLANT LEGEND - 1

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Camas leichtlinii GREAT CAMAS	D	12"	10
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	7
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	39
	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	2

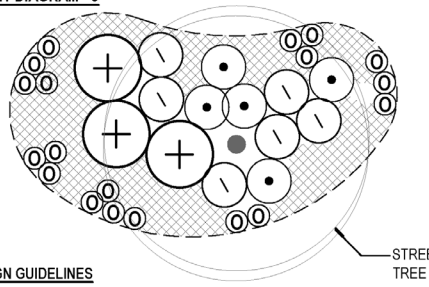
PLANT DIAGRAM - 2



PLANT LEGEND - 2

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Carex densa DENSE SEDGE	E	12"	20
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	6
	Iris Tenax OREGON IRIS	D	8"	7
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	53

PLANT DIAGRAM - 3



PLANT LEGEND - 3

SYMBOL	Botanical name / COMMON NAME	E/D	O.C.	QTY
	Camas leichtlinii GREAT CAMAS	D	12"	43
	Cornus sericea 'Kelseyi' KELSEY DOGWOOD	D	2'-0"	3
	Juncus patens 'Elk Blue' ELK BLUE GRAY RUSH	E	12"	34
	Mahonia aquifolium 'Compacta' COMPACT OREGON GRAPE	E	3'-0"	3
	Polystichum munitum SWORD FERN	E	2'-0"	5

DESIGN GUIDELINES

1. THESE ARE EXAMPLE PLANTING DIAGRAMS APPROVED BY WES. CHOOSE A PLANTING DIAGRAM AND ALTER IT TO YOUR DESIGN. OTHER PLANTING DESIGNS MAY BE APPROVED.
2. SEE ENGINEERING DESIGN STANDARDS FOR SPECIFIC LANDSCAPE REQUIREMENTS.
3. SEE PLANT MATRIX FOR TYPICAL PLANT SPACING.
4. PLANTING TABLE REQUIRED PER ENGINEERING DESIGN STANDARDS. PLANTING LEGENDS SHOWN HERE DO NOT INCLUDE ALL REQUIRED INFORMATION FOR PLANTING TABLES.

Oval Rain Garden **Figure F-6**		WES STORMWATER AND GRADING DESIGN STANDARDS

APPENDIX G

Biofiltration Soil Mix

(Blended Soil Specification for Vegetated Stormwater Systems)

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Blended Soil Specification for Vegetated Stormwater Systems

The following specification is taken from the *2010 City of Portland Standard Construction Specifications (SCS),* as amended or corrected, and is applicable to the requirements in the Stormwater Standards. Facilities include swales, planters, curb extensions, and basins.

01040.14(d) Stormwater Facility Blended Soil*

**NOTE: This specification is required for all public facilities. Private facilities must use blended soil that meets the General Composition requirements of 01040.14 (d) (1). Testing and submittals are not required for private facilities unless they are requested by the Agency permitting the work.*

01040.14 Topsoil. Furnish topsoil containing no substance detrimental to the growth of plants and that is free of Noxious Weeds and Nuisance Plants. Unsuitable topsoil, or topsoil placed without approval in areas to be planted, may be required to be replaced at no additional cost to the City.

(d) Stormwater Facility Blended Soil. Following the general provisions for topsoil, and incorporating the following requirements, furnish imported blended soil for all vegetated stormwater facilities conforming to the following:

(1) General Composition. Use a blended material incorporating loamy soil, sand, and compost that is 30-40% organic matter by volume and meets the other criteria in this specification. The blended soil must not contain contaminants such as weed seeds of plants designated by ODA as A or B weeds.

(2) Analysis Requirements for the Blended Material:

a. Particle Gradation. A sieve analysis of the blended sand and soil, not including compost, shall be conducted in conformance with ASTM C117/C136, AASHTO T11/T27, ASTM D7928/D1140, or ASTM D6913. The analysis shall include the following sieve sizes: 1 inch, 3/8 inch, #4, #10, #20, #40, #60, #100, #200. The gradation of the blend shall meet the following gradation criteria.

Sieve Size	Percent Passing
1 inch	100
# 4	85 -100
# 10	50-100
# 40	20-60
# 100	10-40
# 200	10-20

b. Acidity. The pH (Power of Hydrogen) of the blended material shall be tested and be between 6 and 8.

(3) General Requirements for the Blended Material:

a. The material shall be loose and easily broken into small pieces
b. It shall be well mixed and homogenous.
c. It shall be free of wood pieces, plastic, and other foreign matter.
d. It shall have no visible free water.

Source: City of Portland, SCS Special Provision,
Revision Date: 01-11-19

(4) Compost. The compost shall be derived from plant material and provided by a member of the US Composting Council Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.

The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions designed to promote aerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have no visible free water and produce no dust when handled. It shall meet the following criteria, as reported by the US Composting Council STA Compost Technical Data Sheet provided by the vendor.

- 100% of the material must pass through a 1/2-inch screen.
- The pH of the material shall be between 6 min. and 8.5 max.
- Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight.
- The organic matter content shall be between 30 and 70% (dry weight basis).
- Soluble salt content shall be less than 6.0 mmhos/cm.
- Maturity Indicator shall be greater than 80% for Germination and Vigor.
- Stability shall be 'Stable' to 'Very Stable'.
- Carbon/Nitrogen (C/N) ratio shall be less than 25:1.
- Trace metals test result = "Pass."

(5) Submittals - At least 14 working days in advance of construction, submit the following:

a. Documentation for the two analyses described in section 01040.14(d)(2) of this specification (particle gradation and pH) shall be performed by an accredited laboratory with current certification. The date of the analyses shall be no more than 90 calendar days prior to the date of the submittal. Include the following information in the report:

- Name and address of the laboratory.
- Phone contact and e-mail address for the laboratory.
- Test data, including the date and name of the test procedure.

b. For the compost component of the blended soil, a compost technical data sheet from the vendor. The analysis and report must conform to the sampling and reporting requirements of the US Composting Council Seal of Testing Assurance (STA) program. The analysis shall be performed and reported by an approved independent STA program laboratory and be no more than 90 calendar days prior to the date of the submittal.

c. Up to two 5-gallon buckets of the blended material, as requested.

d. The location/name of the source of the loamy soil.

(6) Stormwater Facility Blended Soil Installation - See 01040.43(e).

Source: City of Portland, SCS Special Provision,
Revision Date: 01-11-19

01040.43(e) Stormwater Facility Blended Soil:

(1) Protection of the Soil. The material shall be protected from all sources of contamination, including weed seeds, while at the supplier, in conveyance, and at the project site.

(2) Wet and Winter Conditions. Hauling and placement of the material will not be allowed when the weather is too wet, or the ground is frozen or saturated as determined by the Owner's Representative.

(3) Placement of the Soil. Place the material in loose lifts, not to exceed 8 inches each and each lift shall be compacted with a water-filled landscape roller. Do not otherwise mechanically compact the material.

(4) Timing of Plant Installation. Weather permitting and as approved, install plants as soon as possible after placing and grading the soil to minimize erosion and compaction.

(5) Erosion Control. Temporary erosion control measures are required until permanent stabilization measures are functional.

(6) Protection of the Installed Soil. In all cases, protect the installed material from foot or equipment traffic and surface water runoff. Install temporary fencing or walkways as needed to keep workers, pedestrians, and equipment out of the area. Under no circumstances should materials and equipment be stored on top of the installation area.

Source: City of Portland, SCS Special Provision,
Revision Date: 01-11-19

APPENDIX H

Facility Operation and Maintenance Guide

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Appendix H – Facility Operation and Maintenance Guide **Page**

Stormwater Facilities Inspection and Maintenance Log

CLACKAMAS WATER ENVIRONMENT SERVICES

OWNER:	**CONTACT INFO:**
FACILITY LOCATION/ADDRESS:	
FACILITY TYPE:	
ACCESS NOTES:	

Refer to the facility's quarterly inspection requirements in the O&M Plan before conducting inspections and maintenance actions.

INSPECTION YEAR:

WINTER INSPECTION LOG	*SPRING INSPECTION LOG*	*SUMMER INSPECTION LOG*	*FALL INSPECTION LOG*
DATE:	**DATE:**	**DATE:**	**DATE:**
INSPECTOR NAME:	**INSPECTOR NAME:**	**INSPECTOR NAME:**	**INSPECTOR NAME:**
COMPONENTS INSPECTED*:	**COMPONENTS INSPECTED*:**	**COMPONENTS INSPECTED*:**	**COMPONENTS INSPECTED*:**
STRUCTURAL: ☐	**STRUCTURAL:** ☐	**STRUCTURAL:** ☐	**STRUCTURAL:** ☐
PONDING AREA: ☐	**PONDING AREA:** ☐	**PONDING AREA:** ☐	**PONDING AREA:** ☐
VEGETATION: ☐	**VEGETATION:** ☐	**VEGETATION:** ☐	**VEGETATION:** ☐
MAINTENANCE ACTIONS PERFORMED:	**MAINTENANCE ACTIONS PERFORMED:**	**MAINTENANCE ACTIONS PERFORMED:**	**MAINTENANCE ACTIONS PERFORMED:**

* ***Structural Components*** *include all 'hard' elements of the facility (inlets, flow spreaders, liners, overflow caps, etc.).*
Ponding Area *includes areas on the surface or underground where stormwater accumulates. Inspect for blockages, sediment, and trash.*
Vegetation *includes maintaining vegetation, so the facility can function as designed (i.e., tree pruning, weed removal, mowing, grass management).*

Stormwater Planters

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Check overflow caps and replace if cracked or missing.	X		X		X
Check flow spreader, if present, and repair as necessary. Check inlet protection and replace or replenish rock, as necessary.	X		X		
Check liner, if present, and repair tears or holes, as necessary. Replace liner, as necessary.	X		X		
Patch concrete.		X	X		

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area, forebays, and inlets.	X		X		X
Repair any erosion around edges of concrete forebay if erosion is occurring.		X	X		X
Check trench drains discharging to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow in facility; fill in channels with soil and add plants to disperse flow.		X	X		X
Add 3" of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage at maturity. Do not add bark dust or bark chips; they will float and then clog the outlet or create bare spots.	X				
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs.	X			X	
If facility drains slowly, rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Rain Gardens

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Check overflow caps and replace if cracked or missing.	X		X		X
Check flow spreader, if present, and repair, as necessary. Check inlet protection and replace or replenish rock, as necessary.	X		X		

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area, forebays, and inlets.	X		X		X
Repair any erosion around edges of concrete forebay if erosion is occurring.		X	X		X
Check trench drains discharging to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow in facility; fill in channels with soil and add plants to disperse flow.		X	X		X
Add 3" of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage at maturity. Do not add bark dust or bark chips; they will float and then clog the outlet or create bare spots.	X				
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs and trees.	X			X	
If facility drains slowly, rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours.	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Vegetated Swales

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Check overflow caps or grates and repair, as necessary. Replace if they are missing.	X		X		X
Check flow spreader, if present, and repair, as necessary. Check inlet protection and replace or replenish rock, as necessary.	X		X		

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area, forebays, and inlets.	X		X		X
Repair any erosion around edges of concrete forebay if erosion is occurring.		X	X		X
Check trench drains discharging to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow in facility; fill in channels with soil and add plants to disperse flow.		X	X		X
Add 3" of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage at maturity. Do not add bark dust or bark chips; they will float and then clog the outlet or create bare spots.	X				
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs and trees.	X			X	
If facility drains slowly, rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours.	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Dry Wells

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Have drywell professionally cleaned and notify ODEQ. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.		X	X		
Remove sediment from catch basin.	X		X		X
Remove leaf litter/debris from gutters.	X		X		
Check trench drains leading to the facility and remove any soil or debris.	X	X	X	X	X
Remove inspection portal lid and check for spalling or cracking of walls and for root intrusions. Repair, as necessary.		X	X		
Remove inspection portal lid and check sediment depth. Have professionally cleaned when depth of sediment or debris is 6" or greater.		X	X		
Ponding should not occur for more than 48 hours.	X		X	X	X

Infiltration Trenches

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Have drywell professionally cleaned and notify ODEQ. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.		X	X		
Remove sediment from catch basin.	X		X		X
Remove leaf litter/debris from gutters.	X		X		
Check trench drains leading to the facility and remove any soil or debris.	X	X	X	X	X
Remove inspection portal lid. Check for cracking of walls and root intrusion. Remove roots and repair walls, as necessary. Have professionally cleaned when depth of sediment or debris is 3" or greater.		X	X		X
Ponding should not occur for more than 48 hours.	X		X	X	X

Pavers and Pervious Pavement

***NO** pesticide, herbicide, fungicide, or moss inhibitor use is allowed.*

NO sand or deicer should be used on paver area.

Clean up spills immediately. Call Metro to determine proper disposal requirements of spill response materials. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Check for moss growth. Use baking soda to kill moss and then scrape dead moss off and throw in yard waste bin.	X			X	
Sweep leaf litter and debris off pavement. Use a professional pavement sweeper or wet/dry vacuum, as necessary. **NO** pressure washing; it clogs the pavement.	X		X		X
Remove overhanging plants or grass near pavers.		X	X		
During rainstorms, check for water running onto surface and divert water away from pavement.			X	X	X
Repair cracks and settling, as necessary.	X	X			
No ponding or runoff should occur on the pavement.	X		X	X	X

Filter Strips or Landscaped Areas Receiving Sheetflow from Impervious Areas

NO pesticide, herbicide, or fungicide use is allowed.

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Maintenance Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove accumulated sediment.	X		X		X
Replace or replenish rock bordering filter strip or sheet flow area, as necessary.		X	X		X
Check flow spreader, if present, and repair, as necessary. Check inlet protection and replace or replenish rock, as necessary.	X			X	X
Check trench drains leading to the facility and remove any soil or debris.	X	X	X	X	X
Check for channeled flow; fill in channels with soil and add plants to disperse flow.	X		X		X
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth.	X				
Prune shrubs and trees.	X			X	
If moss is present, aerate the area or add 1/2-inch of 3/4-inch clean (no fines) rock.	X		X		
If facility drains slowly, aerate grasses or rake soil to stop crusting. Replace or amend soil if ponding occurs more than 24 hours.	X		X	X	X
Ponding should not occur for more than 48 hours.	X		X	X	X

Constructed Wetlands

NO pesticide, herbicide, or fungicide use is allowed.

Clean up spills immediately. Remove and replace contaminated soil. Call Metro to determine proper disposal requirements of spill response materials and contaminated soil. Record the date and spill response measures in the inspection log.

Structural Repairs	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Remove sediment in catch basins discharging to pond.	X		X		
Inspect outlet structure. Clean clogged orifices. Repair cracked or broken shear gate and handles.		X	X		
Check spillway and berms. Add erosion control matting to areas of slight or moderate erosion.		X	X		X
Check spillway and berms. Contact WES at 503.742.4567) if the erosion is severe or there is evidence of concrete cracking or spalling.		X	X		X

Ponding Area	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Remove trash.	X	X	X	X	X
Remove sediment from ponding area and inlets.		X	X		X
Replace or replenish rock at inlets if erosion is occurring.		X	X		X
Check flow dissipaters. Repair or replace diffuser, as necessary. Replace or replenish rock, as necessary.		X	X		
Add 3" of mulch or topsoil to bare areas and reseed or replant to achieve 100% coverage. Do not add bark dust or bark chips; they will float as the wetland refills and either clog the outlet or create bare spots in the ponding area.	X	X	X		
Remove weeds, invasive plants, and dead plants. Replant or reseed to achieve 100% coverage at maturity	X	X	X		
Thin grasses (remove dead blades) or remove top third of previous year's growth if desired.	X				
Prune shrubs and trees.	X			X	
Check depth or high-water mark in several areas. If depth is less than 50% of design depth, dredge area and replant. If depth is more than 150% of the design depth, add soil and replant in channeled area.	X		X		

Structural Detention

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Call Metro to determine proper disposal requirements of spill response materials. Record the date and spill response measures in the inspection log.

Structural Component	Spring	Summer	Fall	Winter	24-hr Precip > 1"
Replace or repair inlets if they are cracked or broken. Reseal inlet pipes if they are not watertight.	X		X		
Remove sediment in catch basins discharging to tank or vault.	X		X		X
Remove inspection portal lid, check for root intrusion, and remove roots and repair facility, as necessary. Check sediment depth and have professionally cleaned when depth of sediment and debris is > 15% of diameter at any point or > 6" below pipe invert.		X	X		X

Green Roofs

***NO** pesticide, herbicide, or fungicide use is allowed.*

Clean up spills immediately. Call Metro to determine proper disposal requirements of spill response materials. Record the date and spill response measures in the inspection log.

Maintain system per manufacturer's requirements.

APPENDIX I

NOAA Isopluvial Maps

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Source: Precipitation Frequency Atlas of the Western United States
DOC/NOAA/NWS > National Weather Service, NOAA, U.S. Department of Commerce
DOC/NOAA/NESDIS/NCEI > National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce

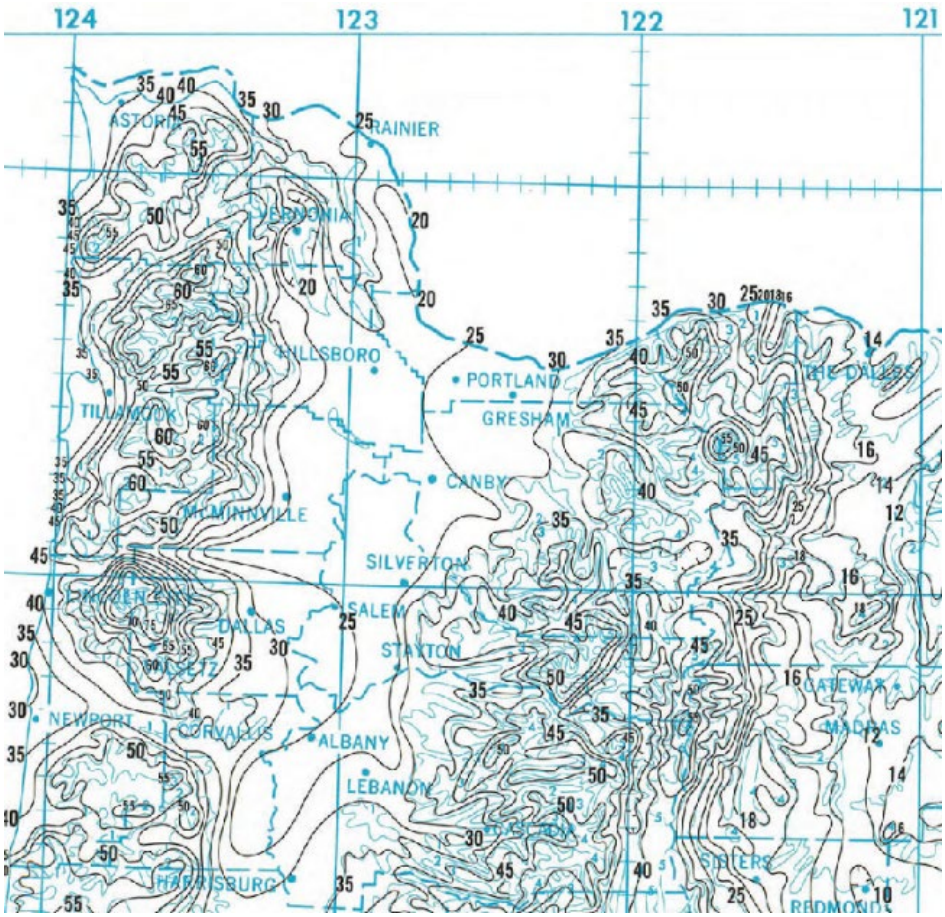

Figure I-1. ISOPLUVIALS OF 2-YR, 24-HR PRECIPITATION IN TENTHS OF AN INCH

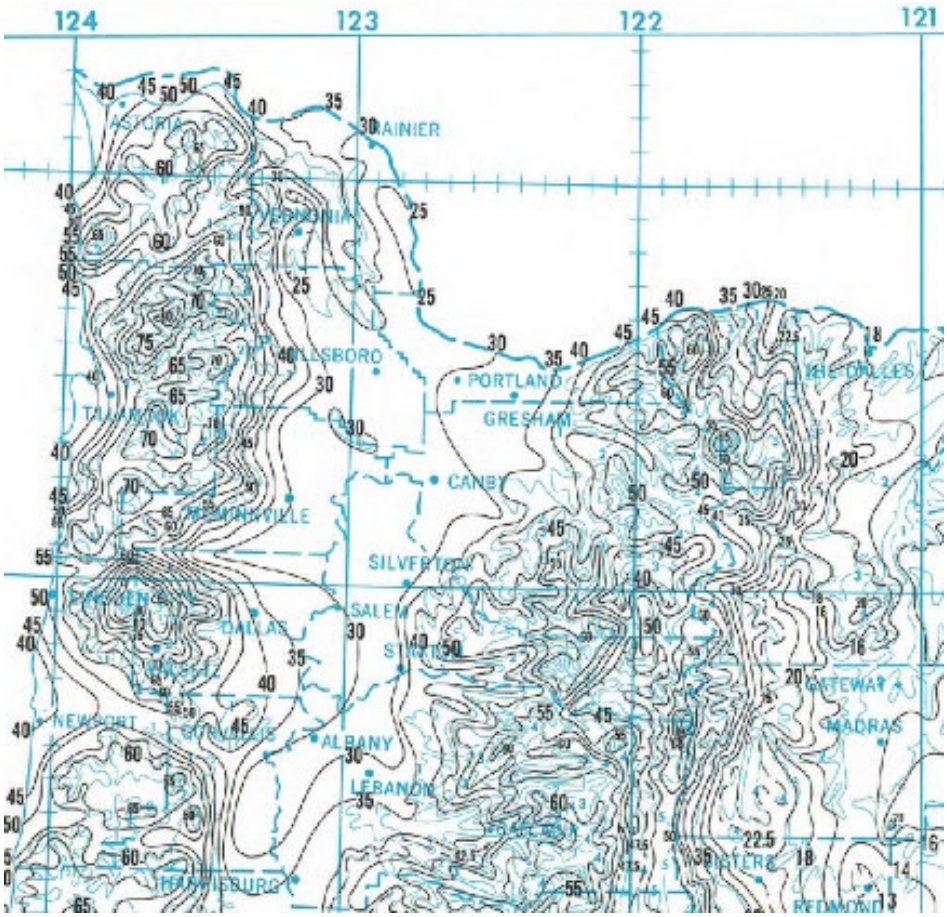

Figure I-2. ISOPLUVIALS OF 5-YR, 24-HR PRECIPITATION IN TENTHS OF AN INCH

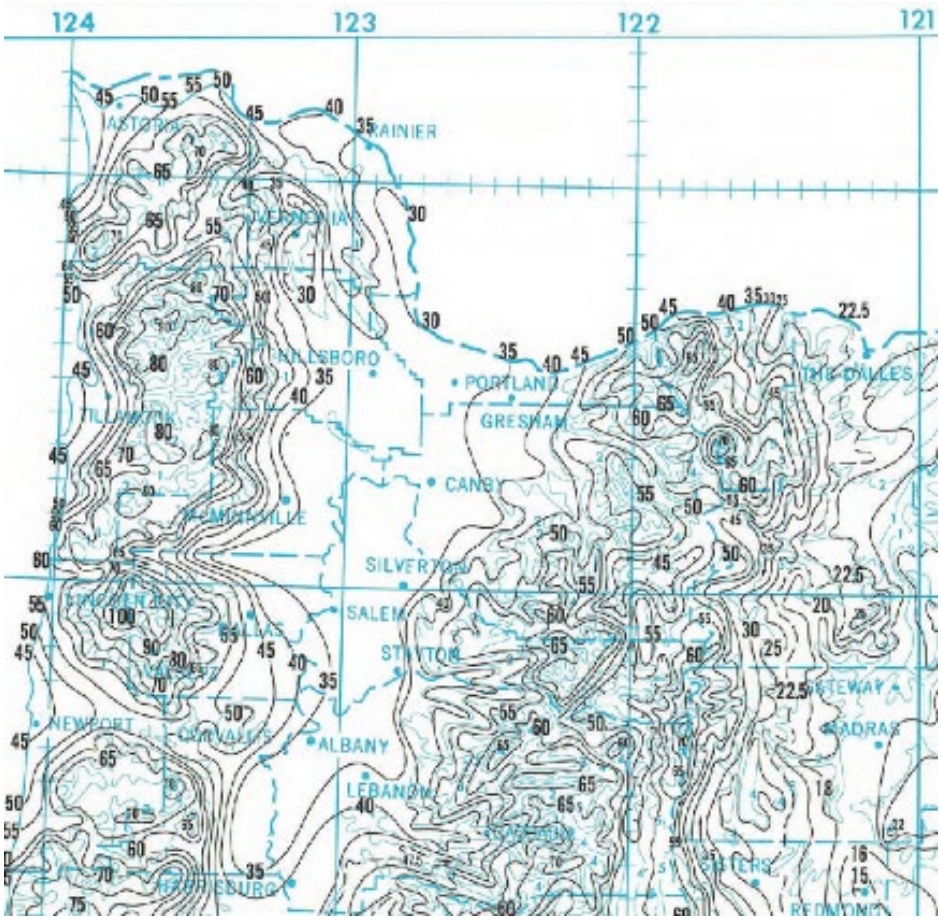

Figure I-3. ISOPLUVIALS OF 10-YR, 24-HR PRECIPITATION IN TENTHS OF AN INCH

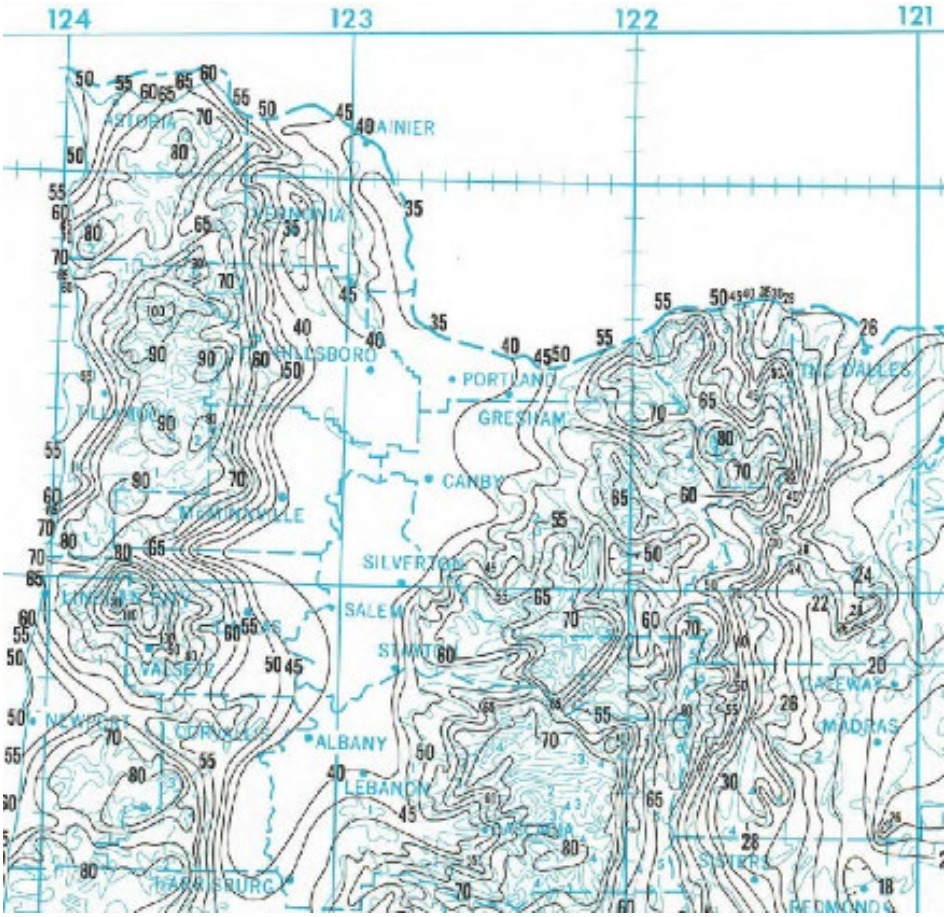

Figure I-4. ISOPLUVIALS OF 25-YR, 24-HR PRECIPITATION IN TENTHS OF AN INCH

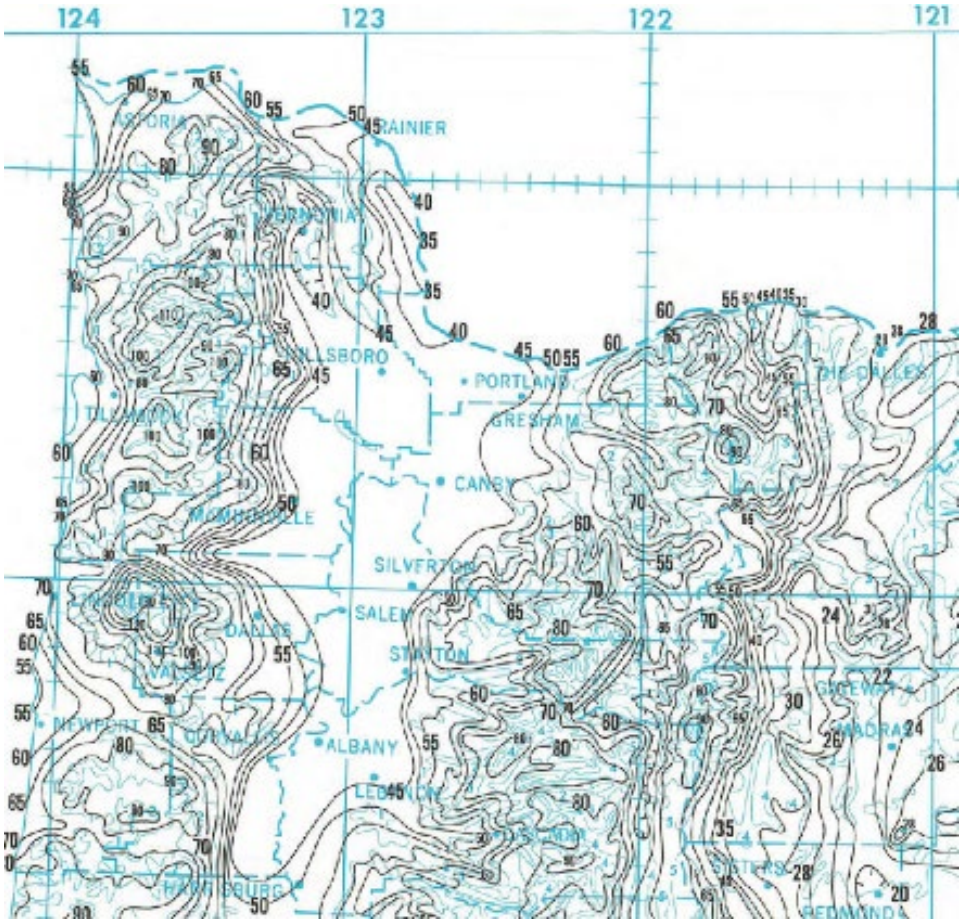

Figure I-5. ISOPLUVIALS OF 50-YR, 24-HR PRECIPITATION IN TENTHS OF AN INCH

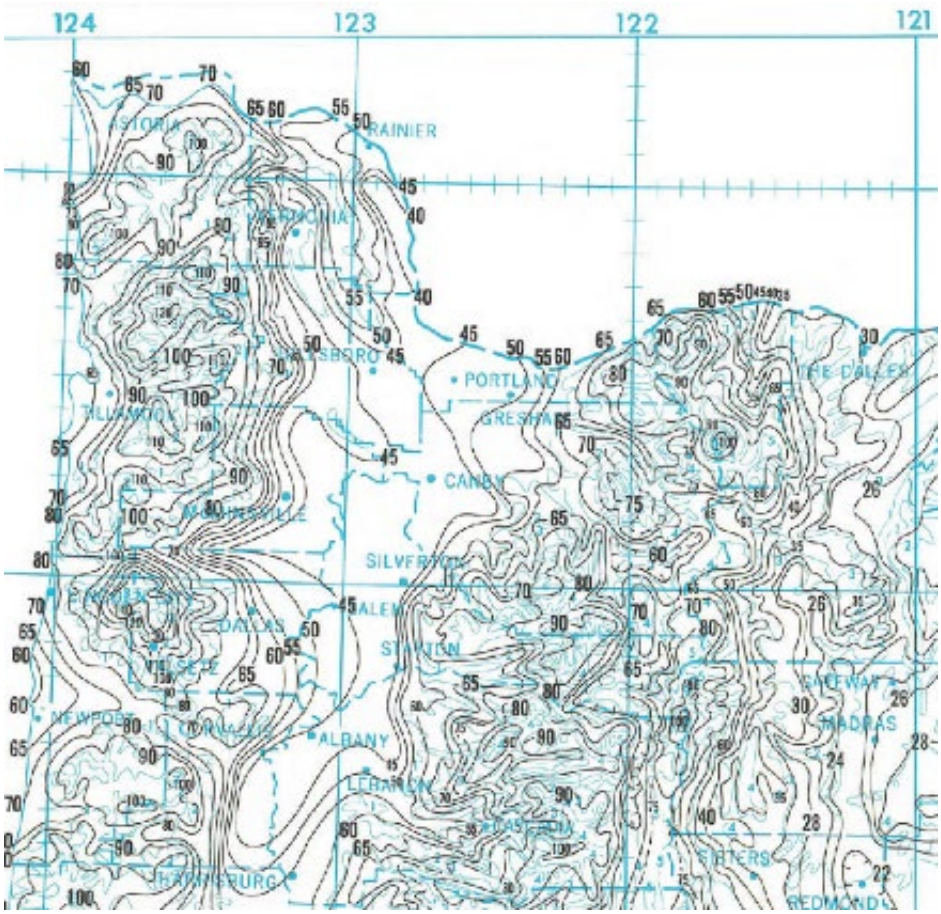

Figure I-6. ISOPLUVIALS OF 100-YR, 24-HR PRECIPITATION IN TENTHS OF AN INCH

APPENDIX J

Proprietary Stormwater Treatment Technology Policy

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PROPRIETARY STORMWATER TREATMENT TECHNOLOGY POLICY

J.1 General

The District accepts the limited use of proprietary stormwater treatment technologies (devices) approved by the Washington Department of Ecology. The District only allows Stormwater Treatment Technologies with the designation of General Use Level Designation (GULD - General Use Level Designation). ~~The approved proprietary stormwater treatment technologies (devices) can be found on the Washington Department of Ecology website link listed below in Section F.5.~~

J.2 Acceptable Water Quality Devices

Approved Basic Treatment Technologies

Basic Treatment Proprietary Water Quality Technologies (devices) approved by the Washington Department of Ecology with General Use Level Designation and classified as Basic Treatment may be utilized to satisfy the stormwater water quality treatment requirements when sized to capture and treat;

a. the first 1-inch of stormwater runoff within a 24- hour period; and
b. sized as specified in the Washington Department of Ecology General Use Level Designation.

J.3 Privately Maintained Facilities

The use of proprietary stormwater treatment technologies (devices) approved by the Washington Department of Ecology is allowed for use on privately maintained facilities.

J.4 Publicly Maintained Facilities

The use of proprietary stormwater water quality treatment technologies (devices) which will be maintained by a public agency shall be approved by the District. Any device requiring the replacement of specific manufacture filter cartridges and/or media will not be allowed without the specific approval of the District for facilities which will be publicly maintained and/or accepts stormwater runoff from public improvements.

J.5 List of Approved Stormwater Treatment Technologies

The list of approved proprietary stormwater treatment technologies (devices) can be found on the Washington Department of Ecology website.

APPENDIX K

Areas with Limited Downstream Conveyance Capacity

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Areas with Limited Downstream Conveyance Capacity

K.1. General

Within these designated basins, flow control shall be designed to reduce the 25-year, 24-hour, post-developed runoff rate to the 2-year, 24-hour pre-developed discharge rate. If there are segments of the downstream conveyance system that can be upgraded, this additional flow control requirement may still require downstream stormwater conveyance system improvements in order to safely convey all existing and proposed stormwater runoff generated from the upstream and onsite drainage basins. Appendix G only addresses areas requiring additional flow control requirements, and all other aspects of the Stormwater Standards shall apply, including a downstream conveyance analysis.

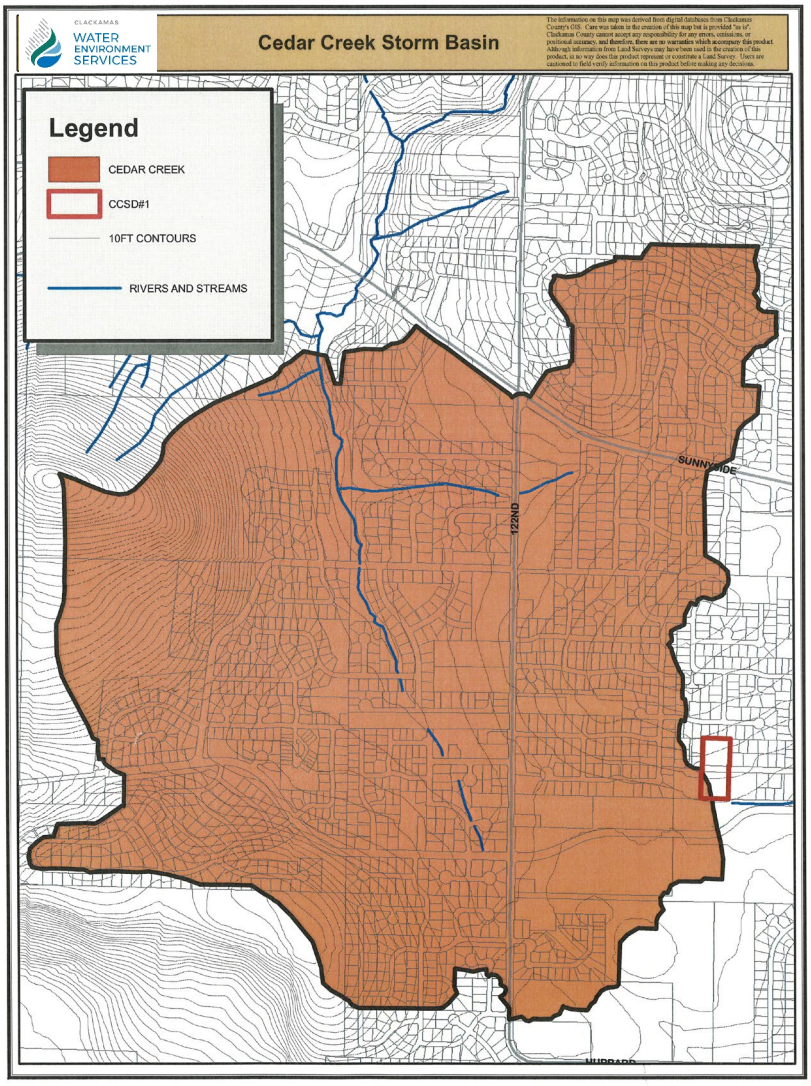
K.2. Limited Conveyance Capacity Designated by WES

Any drainage system with a limited or inadequate stormwater conveyance system designated by WES or other governing jurisdictions will be required, if feasible, to improve the downstream conveyance system capacity. If improving the system is not feasible, the District will determine if additional flow control requirements are an option to develop the property without increasing the potential for downstream flooding during a 25-year storm event. The District or other jurisdiction may designate an area or stormwater conveyance system as having “limited downstream capacity” based on local knowledge, drainage complaints, engineering study or other information indicating the need for additional flow control requirements for larger storm events. In all cases, a safe overflow pathway from the developed site to an acceptable point of discharge must be maintained.

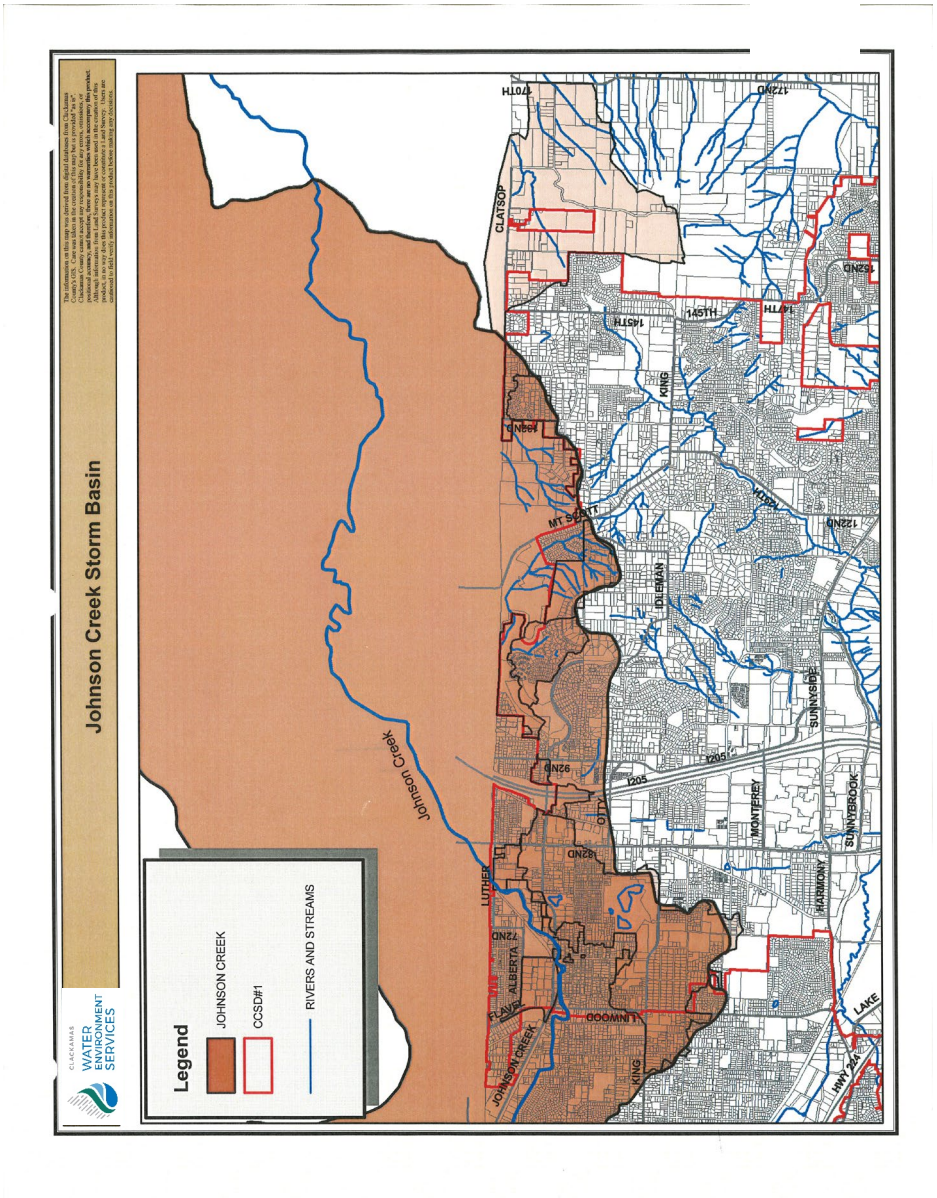
K.3. Drainage Basin Areas with Limited Capacity

The following drainage basin area maps within the District have been identified as having limited downstream capacity within portions of the existing associated stormwater conveyance system:

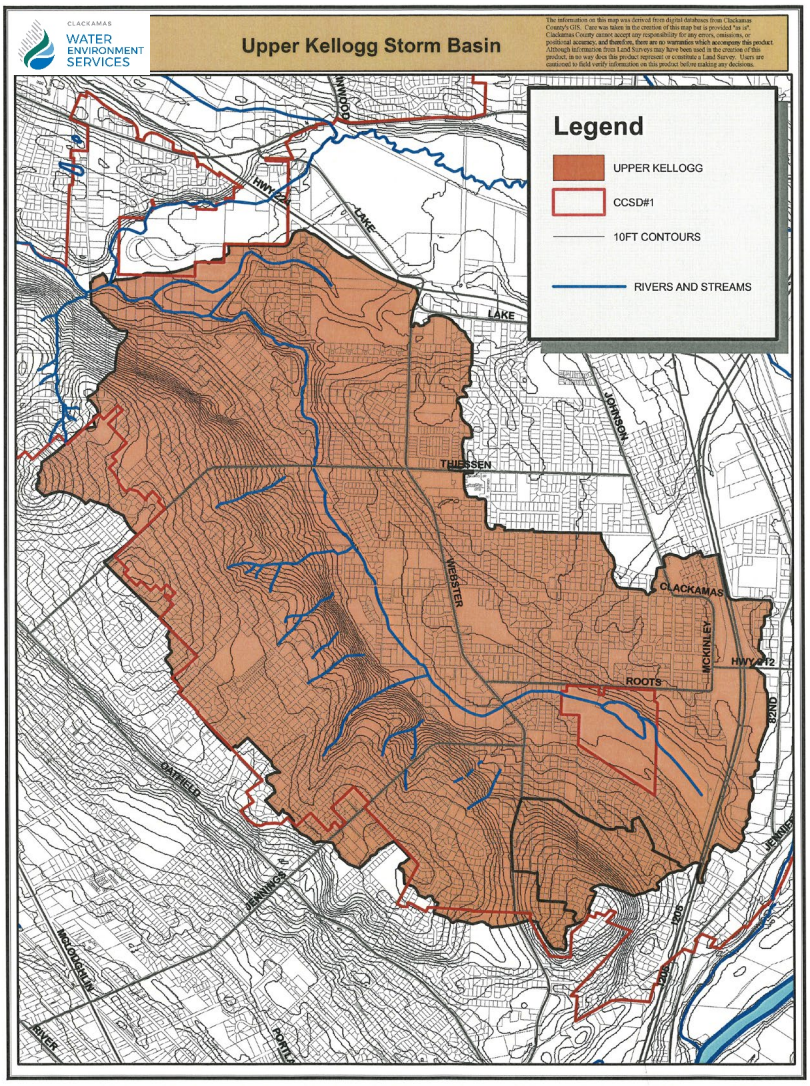
K.4. Cedar Creek Basin



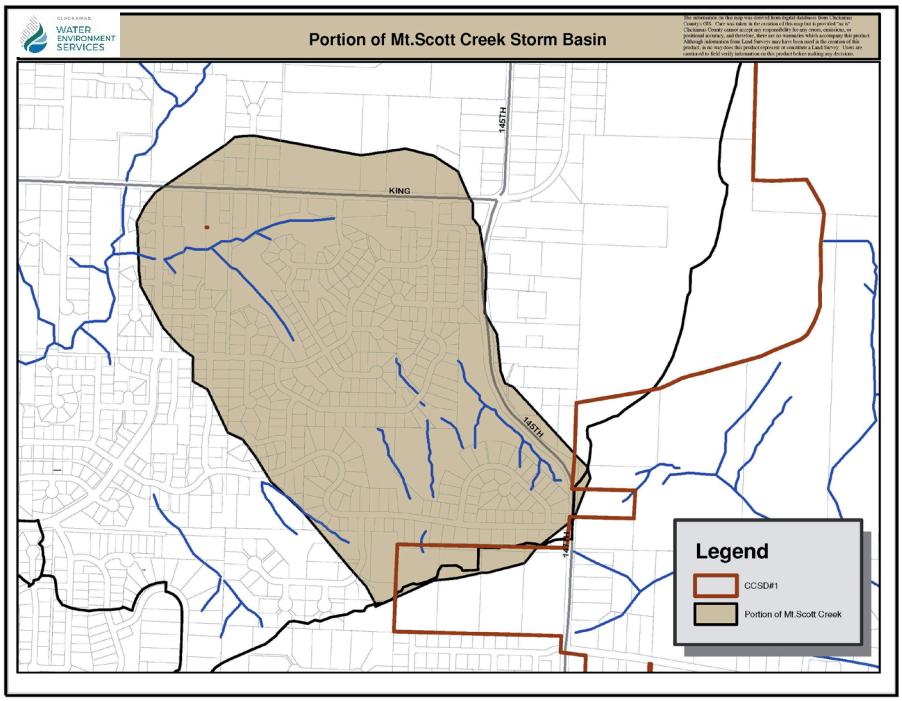
K.5. Johnson Creek Basin



K.6. Kellogg Basin (Upper)



K.7. Portion of Mt. Scott Creek Basin (tributary)



APPENDIX L

Detention Access Standards For Publicly Maintained Facility

CLACKAMAS
WATER
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SERVICES

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DETENTION ACCESS STANDARDS FOR PUBLICLY MAINTAINED FACILITY

Introduction

Access roads ~~are~~ must be provided to maintain stormwater infrastructure~~for maintenance purposes~~. The following criteria are considered to be the minimum required by Water Environment Services to provide access to public maintained infrastructure. Other permitting jurisdictions may have more restrictive requirements.

Specification Table

SLOPE	WIDTH		SURFACE MATERIAL	ACCESS 80,000 LB	STRUCTURAL
	EASMT.	GRVL.	MINIMUM		
SL < 8%	15-ft	12-ft	GRAVEL	N/A	8-INCH GRAVEL FILTER FABRIC
SLOPE	**TRACT**	**PVMT.**	**SURFACE MATERIAL**	**ACCESS 80,000 LB**	**STRUCTURAL**
SL >8% < 12%	15	12	GRAVEL	W/ TURNAROUND	8-INCH GRAVEL FILTER FABRIC
SL >8% < 12%	15	12	2-INCH A.C.	W/O TURNAROUND	8-INCH GRAVEL FILTER FABRIC
SL >12% <15%	20	15	2-INCH A.C.	W/ TURNAROUND W/ LANDING	8-INCH GRAVEL FILTER FABRIC
CONTACT DISTRICT					
SLOPE	**TRACT**	**PVMT.**	**SURFACE MATERIAL**	**ACCESS 80,000 LB**	**STRUCTURAL**
SL >15% <20%	20	13	3-INCH A.C.	W/ TURNAROUND W/ LANDING	8-INCH GRAVEL FILTER FABRIC

General Requirements

A Profile of the access road is required.

Maximum grade:

- **15-percent with a maximum 3-percent cross-slope.**
- **Special permission is required for grades over 15-percent.**

Minimum width of surface:

- **12-feet on straight runs and 15-feet on curves.**
- **Curves will be designed with a minimum 40-foot interior radius.**
- **Access will extend to within 10-feet of all Pollution control structures unless otherwise approved by the District.**
- **Access roads in excess of 150-ft in length is required to have a turnaround.**
- **Turnaround is required when access is taken from a collector or arterial roadway.**

Provide a minimum 12’ wide double opening gate at the entrance of the stormwater facility maintenance access.

Access Road Contained Within a Tract of Land

All publicly maintained stormwater facilities must provide an access road in accordance with the standards and this appendix, and must be contained within a ~~s shall be placed in a~~ Tract of Land that has a WES storm drainage easement, ~~unless prior permission is received from the District. The applicant shall provide additional protection for the access roads, including fencing, signs and access when an Easement is granted.~~

Design

Access Road:

a) Horizontal curves a) Minimum Radius for (inside) = 40-feet
   i. Vertical Curves a) Crest maximum K = 4
b) Vertical Curves
   i. Crest maximum K = 4
   ii. Sag maximum K = 6
      a. Where K = L/A
         L= algebraic difference in grades percent
         A= length of vertical curve (feet)

Landing:

c) Maximum slope = 4%
d) Minimum length of 40-ft

Turnaround:

e) Design per Clackamas County Roadway Standards – Detail C350
f) Maximum cross slope = 4%
g) Minimum width of the access road 12-ft
   i. Minimum radius for (inside) = 30-ft

Typical Surface:

h) Three 3-inches of class "B" asphaltic concrete and 2-inches of ¾"-0" compacted crushed rock; over 8-inches of 1½"-0" compacted crushed rock; over subgrade compacted to 95-percent AASHTO T-99.
i) The design engineer may submit a certified road design capable of supporting a 30-tons maintenance vehicle in all weather conditions.

Driveway Access:

j) All access roads shall have a standard driveway with 6" of concrete over 2" of gravel. The plan will include design of strengthened sidewalk sections (6-inches of Concrete minimum) where maintenance vehicles will cross. (See D600 Clackamas County Department of Transportation).

Driveway Access:

k) The final plan will have to show how maintenance equipment will safely access the pond. At least one side of the detention pond is required to have an access suitable for maintenance equipment (backhoe etc.). We require direct access to the pond of 15-feet wide and slopes of 4:1 or flatter.