City of
WILSONVILLE
in OREGON

2015

STORMWATER & SURFACE WATER DESIGN & CONSTRUCTION STANDARDS

SECTION 3 - PUBLIC WORKS STANDARDS

Community Development Department
29799 SW Town Center Loop E
Wilsonville, OR 97070

Revised December 2015

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CITY OF WILSONVILLE

PUBLIC WORKS STANDARDS - 2015

Community Development Department

Revised December 2015

These Standards were compiled by information obtained from, or input received from the following sources:

American Association of State Highway and Transportation Officials
American Public Works Association
American Water Works Association
Asphalt Institute
City of Beaverton Public Works Standards
City of Gresham Public Works Standards
City of Hillsboro Public Works Standards
City of Portland Public Works Standards
City of Tualatin Public Works Standards
CleanWater Services Agency of Washington County
King County, Washington
Oregon Department of Environmental Quality
Oregon Department of Fish and Wildlife
Oregon Department of Transportation
Oregon Health Division
Portland Cement Association
Portland General Electric
Stormwater Management Manual for Western Washington
Tualatin Valley Fire and Rescue
Tualatin Valley Water District Water System Standards
Washington County Department of Land Use and Transportation
Water Environment Services of Clackamas County

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STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

FOREWORD

The 2015 edition of the City of Wilsonville Public Works Standards will provide the technical engineering design and construction information standards for all Public Works transportation projects, storm system projects, sanitary sewer projects, and water distribution system projects in the interest of health, safety and welfare of the residents of the City of Wilsonville. These Public Works Standards – 2015 will supersede all previously issued Standard Specifications.

Interpretation and enforcement of these standards shall be the responsibility of the City of Wilsonville Engineering Division.

All federal, state, county (Clackamas or Washington) or local laws and ordinances are to be adhered to. If there is any conflict between the Standard Specifications and pertinent laws and ordinances, the laws and ordinances shall prevail.

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CITY OF WILSONVILLE

PUBLIC WORKS STANDARDS - 2015

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SECTION 3

STORMWATER & SURFACE WATER DESIGN AND CONSTRUCTION STANDARDS

301.1.00 ENGINEERING

301.1.01 Introduction

This section outlines design and construction requirements for stormwater and surface water management. The provisions and technical specifications herein set forth the requirements of the City of Wilsonville for constructing stormwater and surface water improvements. Interpretations of such provisions and their application in specific circumstances shall be made by the City's authorized representative, unless specifically stated otherwise. Refer to Section 1 of the "Public Works Standards" for general provisions and requirements.

Design guidelines established here are consistent with the City of Wilsonville Stormwater Master Plan. These provisions are intended to prevent or reduce adverse impacts to the drainage system and water resources of the Willamette River Basin. In combination with other federal, state, and local laws and ordinances, these requirements are intended to protect the beneficial uses of waters in the Willamette River Basin and inside the Wilsonville city limits.

301.1.02 Stormwater Management Thresholds

The site development thresholds and applicability of these standards are as follows:

a. All development that results in 5,000 square feet of new or replaced impervious surface, cumulative over a 5-year period, is subject to the requirements of these standards. Development includes new development, redevelopment, and/or partial redevelopment.

b. All development that results in 500 square feet of new or replaced impervious surface shall be subject to the erosion prevention and sediment control requirements outlined in Section 101.9.00.

c. Properties or development draining directly to and within 300 feet of the Willamette River or the Coffee Lake wetlands are exempt from the flow control standards. These projects are still subject to the water quality, conveyance and erosion prevention and sediment control provisions of these standards.

d. All site development that results in any new or replaced impervious surfaces and is categorized as high risk for increased pollutant loading in stormwater runoff is required to comply with Section 301.12, "Source Controls" in addition to all requirements within these standards. High-risk sites include, but are not limited to, the following site uses:

   1. Fuel Dispensing Facilities and Surrounding Traffic Areas

2. Above-Ground Storage of Liquid Materials
3. Solid Waste Storage Areas, Containers, and Trash Compactors
4. Exterior Storage of Bulk Materials
5. Material Transfer Areas/Loading Docks
6. Equipment and/or Vehicle Washing Facilities
7. Development on Land With Suspected or Known Contamination
8. Covered Vehicle Parking Areas
9. Industrial and Commercial High Traffic Areas
10. Land Uses Subject to Oregon Department of Environmental Quality (ODEQ) 1200-Z Industrial Stormwater Permit Requirements

301.1.03 Alternative Design and Construction Standards

If approved by the City Engineer, alternative design and/or construction standards may be substituted for the standards specified herein. Any requests for substitution must be in writing, stamped by a Professional Engineer registered in the State of Oregon at the time of submittal, and submitted at least three weeks prior to the Engineering Plan Review submittal process. The City Engineer may request submission of any additional information deemed necessary to properly evaluate alternative design and/or construction standards.

301.1.04 Exemptions from Stormwater Management Requirements

Projects in the following categories are generally exempt from the requirements of these standards:

a. Stream enhancement or restoration projects approved by the City unless required by other State or Federal agencies;

b. Farming practices as defined by Oregon Revised Statutes (ORS) 30.930 and farm use as defined in ORS 214.200; except that buildings associated with farm practices and farm use are subject to the requirements of these standards;

c. Actions by a public utility or any other governmental agency to remove or alleviate an emergency condition;

d. Road and parking area preservation/maintenance projects such as pothole and square cut patching, surface sealing, provided the preservation/maintenance activity does not expand the existing area of impervious coverage above the thresholds listed in Section 301.1.02.a, “Stormwater Management Thresholds”;

e. Maintenance activities, such as overlaying or repairing existing asphalt or concrete pavement without expanding the area of coverage above the thresholds listed in Section 301.1.02.a, “Stormwater Management Thresholds”;

f. Pedestrian and bicycle improvements (sidewalks, trails, pathways, and bicycle paths/lanes) where no other impervious surfaces are created or replaced, built to direct stormwater runoff to adjacent vegetated areas;

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

h. Operation and maintenance or repair of existing utilities.

301.1.05 Stormwater Systems Design Criteria

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

b. Stormwater systems shall strive to maintain the pre-development stormwater runoff characteristics to minimize effects on the drainageways such as sediment transport, erosion and degradation generally associated with urbanization. Stormwater management facilities shall be designed to maximize groundwater recharge through the process of infiltration of runoff into vegetated facilities and the use of what is referred to as Low Impact Development (LID) facilities and/or flow controls to address hydromodification.

c. In selecting a stormwater management approach, the designer shall consider site characteristics, anticipated land uses, runoff characteristics, and treatment objectives. Once the site analysis is complete, the designer shall incorporate the most effective stormwater management facilities into the stormwater management plan for the proposed development. See Section 301.2.00, "Site Assessment and Planning" for additional details on site assessment and planning, and Section 301.4.00, "Stormwater Management Facility Selection and Design" for design criteria, design methods and facility selection and sizing.

d. Developments shall accommodate existing off-site drainage entering a development site so as to not impact upstream property owners. Modifications to the existing on-site storm drainage facilities shall not restrict flows thereby creating backwater onto off-site property to levels greater than the existing situation, unless approved by the impacted off-site property owners and the City's authorized representative, and an inundation easement is provided.

e. Surface or subsurface drainage, caused or affected by development, shall not flow over adjacent public or private property in a volume 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. The City generally does not allow the diversion of stormwater from one drainage basin or watershed to be directed to another drainage basin or watershed.

f. Land use assumptions for 25- and 100-year flows for design of conveyance systems shall be based on full build-out of the upstream basin based upon the most recently approved City Comprehensive Land Use Plan and/or realistic estimates of development densities in areas included in recent additions to the Urban Growth Boundary or Urban Growth Reserve. Storm drainage facilities shall be designed and

constructed to accommodate all assumed future full build-out flows generated from upstream property within the basin based on the most recent approved comprehensive land-use plan.

g. Conveyance systems shall be designed and constructed to carry the 25-year 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.

h. Generally, the Santa Barbara Urban Hydrograph (SBUH) method for computing peak discharge is preferred by the City. Other acceptable methods include Technical Release 55 (TR-55), stormwater management model (SWMM), or other standard methods as approved by the City. For drainage basins 25 acres or less, the *Rational Method* is acceptable (Section 301.5.03, "Rational Method").

i. 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 (HEC-RAS) or equivalent computer modeling software.

j. Constructed channels shall be designed per Section 301.6, "Constructed Channel Design Standards."

k. Culverts shall be designed per Section 301.7, "Culvert Design Standards."

l. Stormwater manholes, pipes and catch basins shall be designed per Section 301.8, "Storm Manhole, Pipe and Catch Basin Design Standards."

m. Stormwater management facilities shall be designed per Section 301.4.00, "Stormwater Management Facility Selection and Design."

301.1.06 Offsite Stormwater Management Facilities

When a proposed development is unable to meet the flow control or water quality requirements of these standards, the City may allow applicants to build a stormwater management facility offsite or pay a fee in lieu of onsite improvements. In such a case, the City will determine whether the applicant shall construct the offsite stormwater management facilities or pay the City (or an adjacent property owner by agreement) for the construction of offsite facilities. The fee shall be based on the proportional cost for the construction of the stormwater management facilities to be used plus engineering design, contingency, project management and project inspection. Any development which is utilizing offsite facilities shall pay all applicable fees prior to approving, permitting, or recording of a plat for the development.

301.1.07 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 Basin Total Maximum Daily Load (TMDL) Program, the industrial NPDES permitting program, or any other applicable state or federal regulations or permit requirements.

All development within Federal Emergency Management Agency (FEMA)-regulated streams and floodplain overlay zones shall meet the FEMA floodplain permit approval process requirements through the local planning and building authority.

301.1.08 Easements

Piped storm systems shall generally be located in the right-of-way. When it is not possible or practical to install Public storm conveyance facilities in a dedicated public street the facilities shall be located within a storm drainage easement granted to the City. Storm drain easements shall typically be exclusive and conform to Section 101.8.14, "Easements."

301.1.09 Point of Discharge

a. Provide an acceptable point of discharge from the developed site. All conveyance system considerations and/or limitations will be evaluated prior to approving the point of discharge. Developments shall not materially increase or concentrate runoff onto adjacent properties, except when the runoff is contained in an existing drainage way. To prevent concentrated runoff, a development may be required to discharge stormwater via a flow spreader device approved by the City's authorized representative.

b. The applicant shall establish an acceptable point of discharge, as approved by the City's authorized representative.

c. Runoff from developed portions of the site drainage basin should be discharged at the existing natural drainage outlet or outlets.

d. Runoff must be discharged in a manner that will not cause adverse impacts to downstream properties or previously constructed stormwater systems.

e. The applicant will be responsible for acquiring approval from any other agency having jurisdiction or permitting authority related to the activity. City may require a copy of other jurisdictional approval(s) prior to approving the stormwater management plan.

f. If the point of discharge is an open drainageway then adequate velocity dissipation and/or additional channel protection shall be required to prevent erosion and/or alteration to the existing downstream drainageway.

g. Any connection to a public or private piped downstream stormwater conveyance system shall be approved by the City's authorized representative. The means and methods of connecting or extending a piped conveyance system will be consistent with City standards and/or other standards required by agencies having the authority to regulate the connection.

301.1.10 On-site Runoff Conveyance

The following on-site conveyance system requirements shall be incorporated into the design of the stormwater management plan:

a. The site shall be planned and designed so as to generally conform to on-site natural drainage patterns and discharge to natural drainage paths within a drainage basin. These natural drainage paths should be modified as necessary to contain and safely convey the peak flows generated by the development.

b. Open channel conveyance systems are preferred over closed conduits where feasible, especially where they might provide opportunities for water quality treatment, wildlife habitat improvement, or emergency overland flood relief routes.

c. In establishing the layout of stormwater networks, it is essential to ensure that flows will not discharge onto private property prior to the system design storm capacity.

d. It shall be the responsibility of the owner to provide a conveyance drainage system for all stormwater runoff and/or or surface water entering the property from off-site. Surface water, springs, and groundwater shall be incorporated into the drainage design.

e. An overland emergency flow path must be identified and/or designed that allows large flow events to discharge without risk of injury or property damage. The emergency flow path 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 stormwater conveyance system. Any emergency overflow structures shall be designed for the 100-year design storm.

f. It is important to ensure that the on-site conveyance 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.

301.1.11 Upstream Drainage Basin(s) Conveyance

Developments are required to convey upstream drainage through or around the development.

a. The upstream off-site stormwater or other surface water runoff will be conveyed through the development in a separate main line system and will not be mixed with the stormwater collected and treated with on-site stormwater BMPs unless the stormwater BMP facilities are designed to include the additional flows from the upstream drainage basin(s) assuming full development potential. Stormwater collected and treated on-site can be released to a main line system provided a natural point of discharge is not available.

b. Upstream drainage basin analysis shall assume ultimate build out and/or maximum zoning density in determining the size of the conveyance system required through the site.

c. Generally, land use zoning adopted by the City will be used to size the capacity of the bypass system. For areas within the upstream basin that currently have a rural zoning designation but have the potential to be incorporated into the Urban Growth Boundary or Reserve, the City will assign the appropriate zoning designation and/or

allowable maximum density to use in the upstream basin analysis for ultimate development potential and conveyance system sizing.

301.1.12 Extension of Public Storm Sewer Systems

a. The extension or upsizing of the public stormwater systems in excess of 12 inches in diameter (or equivalent flows) or as shown in the Wilsonville Stormwater Master Plan to serve the ultimate development density of the contributing area shall be done by the property owner or permit applicant and may be subject to applicable System Development Charge (SDC) credits.

b. The City reserves the right to perform the work or cause it to be performed and bill the owner for the cost of the work or to pursue special assessment proceedings.

c. The public storm sewer system shall extend to the most distant parcel boundary and be designed at a size and grade to facilitate future extension to serve development of the entire contributing area.

d. Where public infrastructure improvements paid for by the property owner or permit applicant directly benefit adjacent properties, the property owner or permit applicant may pursue establishment of a reimbursement district per Section 3.116 of the City Code.

e. The City's authorized representative may require a storm pipeline that serves or may serve more than one property to be a public system.

301.1.13 Conveyance System Hydraulic Standards

a. The conveyance system shall be designed to convey and contain at least the peak runoff for the 25-year design storm.

b. Structures for proposed pipe systems must be demonstrated to provide a minimum of 1 foot of freeboard between the hydraulic grade line and the top of the structure or finish grade above pipe for the 25-year post-development peak rate of runoff.

c. Design surcharge in new pipe systems shall not be allowed if it will cause flooding in a habitable structure, including below-floor crawl spaces.

d. The 25-year design shall be supplemented with an overland conveyance component demonstrating how a 100-year event will be accommodated. The overland component shall not be allowed to flow through or inundate an existing building.

e. Flows in streets during the 25-year event shall not run deeper than 4 inches against the curb or extend more than 2 feet into the travel lane.

f. Open channel systems shall be designed for minimum 1-foot freeboard from bank full, provided that no structures are impacted by the design water surface elevation.

301.1.14 Storm Systems and Fish Passage

For pipe systems that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to

determine whether fish passage is required and to identify site-specific design criteria. All culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria*, or latest edition, unless exempted by ODFW and the City.

301.1.15 Surveying

a. The design engineer shall be responsible for establishing the location of the storm facilities by means of reference stakes offset along the centerline of the storm facilities. No construction shall be allowed to begin before construction staking. All staking shall be performed by or under the direction of a Professional Land Surveyor registered in the State of Oregon.

b. Stakes shall locate all public tees, cleanouts, manholes, catch basins, area drains, water quality stations, and pump stations. Maximum spacing for reference stakes is 50 feet. Stakes shall reference cuts or fills to all invert elevations and rim grades. The design engineer shall also be responsible for identifying and staking easements during construction.

301.2.00 SITE ASSESSMENT AND PLANNING

301.2.01 Introduction

The purpose of the site assessment and planning requirements is to ensure that the physical attributes of the development site are reviewed before placing man-made structures such as streets, parking lots, and buildings. This is meant to optimize site design of stormwater management techniques and protection of sensitive areas, and to reduce or eliminate potential conflicts between site development elements and required stormwater management systems. A layout that integrates site attributes to manage stormwater and protect habitat may reduce the number, size, and cost of stormwater management facilities required for the site.

301.2.02 Applicability

This section describes the process for preparing the Site Assessment and Planning submittal, the first step in meeting the City's stormwater management requirements. The *Site Assessment and Planning Checklist* shall be submitted with a development permit application. Refer to Section 301.3.00, "Submittal Requirements" for additional information. The Site Assessment and Planning submittal is required for all development which creates 5,000 square feet (SF) or more of new and/or modification of existing impervious surface area. A professional engineer registered in the State of Oregon shall prepare the plans and documentation required by this section.

301.2.03 Stormwater Site Assessment

As part of the applicant's development permit application submittal a Stormwater Site Assessment will be completed. The assessment will include the completed checklist, site assessment maps, preliminary site plan, proposed impervious surface area, preliminary stormwater facility sizing documentation, and supporting materials as required.

The following Table 3.1 and sections describe the process for completing the Stormwater Site Assessment and Planning checklist and associated mapping and supporting materials for submittal according to these standards.

TABLE 3.1 SITE ASSESSMENT AND PLANNING CHECKLIST

	Information Needed	Provide information as required; Attach supporting materials as needed
1 Site Information		
	Applicant Contact Information	Applicant name Business name Contact address, phone number, and e-mail
	Project Location	Site Address Site Description Major Drainage Basin Vicinity Map of the site (including location of property in relation to adjacent properties, roads, and pedestrian/bike facilities)
	Project Type	Identify types of development planned for the site such as commercial, industrial, single-family residential, multi-family residential, or other (describe)
	Size of site	Size of site (acres) and number of existing/ proposed tax lots
2 Site Assessment (attach engineered scale Site Assessment Map and documentation)		
	Topography Evaluate site and map slopes: Flat (0-10%), Moderate (10-20%), Steep (20%+)	Attach aerial based mapping with 2-foot intervals for slopes 0-20% slope, 10-foot intervals for steeper. Shade or mark areas of flat, moderate and steep slopes. If required, attach geologist/geotechnical report. Slope information may be available from the City.
	Soils and Groundwater Research and map site soil hydrologic group, depth to groundwater	Natural Resources Conservation Service (NRCS) Hydrologic Soil Type (show on map if more than one type present): Attach seasonal groundwater depth evaluation if available or required (site has floodplain and/or wetland). Groundwater depth information is available from the City.
	Infiltration Assessment Determine soil capacity for onsite infiltration	If an infiltration test is performed attach the documentation. Report the test type (Basic/Professional) performed and results. See Appendix B for the approved infiltration testing methods. Test Type:_____(inches/hour):_____

TABLE 3.1 SITE ASSESSMENT AND PLANNING CHECKLIST		
	Information Needed	**Provide information as required; Attach supporting materials as needed**
	Hydrology - Conditions and Natural Features Map site floodplains, wetlands, streams, and location of outfalls	Clearly label on map all streams, rivers and wetlands, FEMA floodplains, and existing drainage systems (pipes, ditches, outfalls). Check here if present on site: Sensitive Area(s) ____, Floodplain _____.
	Downstream Conveyance	Prepare and attach Preliminary Drainage Report with analysis of upstream drainage area and downstream conveyance capacity, as required by Section 301.3.02. Check here if analysis indicates adequate downstream capacity is NOT available: ____
	Existing Vegetation Map trees and vegetation	Using aerial photos or survey, map all trees and vegetation. Note all existing trees 6-inch caliper and greater (DBH) on map. Delineate and identify other areas and types of existing vegetation.
	Natural Resource Areas and Setbacks Assess and map buffers	Identify the Significant Resource Overlay Zone and other natural resource areas.
	Land Use and Zoning	Existing Land Use Zoning designation(s):
	Access and Parking	Delineate proposed access points for all transportation modes on map. Indicate amount and area of required parking onsite if applicable, attach documentation as needed:
	Utilities to Site and Surrounding Area	Map existing utilities including stormwater management facilities, storm conveyance, sewer, water, wells, drywells, on-site septic systems, electricity, phone/cable, gas, and any public storm system/facility downstream.
3 Site Planning Design Objectives (attach engineered scale Preliminary Site Plan)		
	1. Preserve Existing Natural Resources	**Required:** Show the Significant Resource Overlay Zone and other natural resource areas on the site plan. Show any proposed areas of encroachment and associated mitigation areas.
	2. Minimize Site Disturbance	**Required:** Delineate protection areas on site plan for areas to remain undisturbed during construction.
	3. Minimize Soil Compaction	**Required:** Delineate and note temporary fencing on site plan for proposed infiltration facilities, vegetated stormwater management facilities, and re-vegetation areas.
	4. Minimize Imperviousness	**Required:** Complete and attach *Impervious Area Threshold Determination Form*. Delineate impervious reduction methods on site plan.
4 Proposed Stormwater Management Strategy		
	Proposed Stormwater Management Strategy	___ LID facilities to the MEP ___ All onsite infiltration including retention of the 10-year storm event. ___ LID facilities and infiltration are limited by the following conditions (include a

TABLE 3.1 SITE ASSESSMENT AND PLANNING CHECKLIST		
	Information Needed	**Provide information as required; Attach supporting materials as needed**
		geotechnical analysis of the site and report): ___ Stormwater management facility to be located on fill ___ Steep slopes ___ High Groundwater ___ Contaminated Soils ___ Conflict with required Source Controls (Section 301.12.00)
	Check Minimum Facility Size Required	A. Calculate surface area of onsite LID facility, as determined by BMP Sizing Tool or Engineered Method: _____ SF; or B. Calculate MEP surface area of onsite LID facility for sites with limiting conditions: total new/redeveloped impervious area (SF) x 0.10 = _____ SF C. Required surface area of onsite LID facility: smaller of [A] or [B] _____ SF D. Proposed LID facility surface area: must be equal to or larger than [C] _____ SF
5	**Facility Selection/Sizing**	
	Proposed Facility Type(s)	Check all that apply, attach output from BMP Sizing Tool application, and show proposed facilities on Preliminary Site Plan. LID facilities: ___ Infiltration Stormwater Planter ___ Filtration Stormwater Planter ___ Infiltration Rain Garden ___ Filtration Rain Garden ___ Vegetated Filter Strip ___ Vegetated Swale ___ Detention Pond Other Stormwater Management Facilities as approved: ___ Infiltration Trench ___ Manufactured Treatment Technology ___ Underground Detention Tank ___ Other: _____

1. **Site Information**

   Provide the site information as stipulated in the checklist, with reference to supporting documentation and maps as appropriate for the site.

2. **Site Assessment**

   Applicants shall inventory conditions on and adjacent to the site. This information shall be presented on a Site Assessment Map at a standard engineer scale appropriate for analyzing the information. The goal is to learn how stormwater moves through the site and how natural hydrologic functions may be protected and preserved.

   The site assessment should follow the order depicted in Fig. 2-1. The required information is detailed below.

   (a) Topography

   Steep slopes greater than 20% should be avoided for clearing, grading and building. Infiltration is not allowed on steep slopes and slide prone areas. Infiltrating stormwater on moderate slopes of 10% or greater requires a geologist or geotechnical engineering analysis to determine the appropriate strategies.

   (b) Soils and Seasonal High Groundwater

   Use soil maps (NRCS Soil Survey) to determine the site hydrologic soil type (an indication of soil infiltration capacity). An assessment of the seasonal high water table may be required to ensure the functionality of the system.

   (c) Infiltration Assessment

   Stormwater management facility sizing is based on tested infiltration rates. See Appendix B for specific infiltration testing requirements and methods.

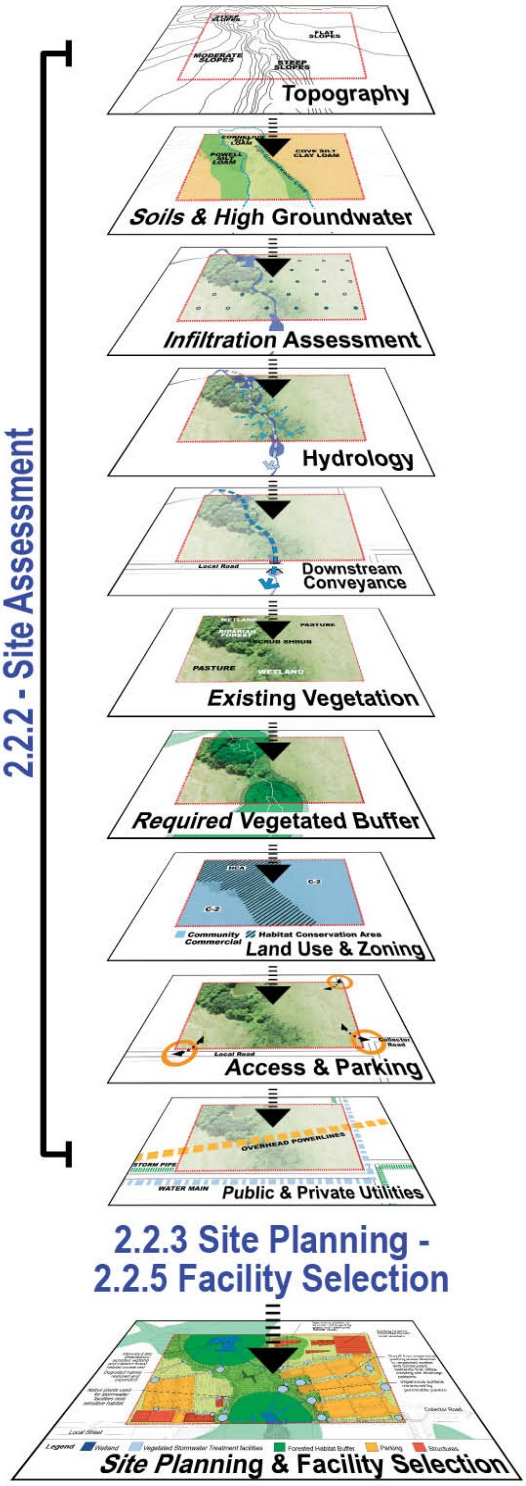

Fig. 3.1 Site Assessment Process

   (d) Hydrology – Site Conditions and Natural Features

   Show natural and manmade drainage features including channels, pipes, and outfalls. Identify jurisdictional wetland(s) (per Oregon Department of State Lands

[ODSL] and U.S. Army Corps or Engineers [USACE]) or 100-year floodplain (per FEMA mapping) present on the site.

(e) Downstream Conveyance

See Section 301.5.01, "System Design Considerations" for upstream and downstream analysis requirements, and attach the required Storm Drainage Report documentation to this submittal package.

(f) 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.

(g) Natural Resource Areas

If natural resources areas are present, show these areas on the Site Assessment Map.

(h) Land Use and Zoning

Document existing zoning, including any special overlay zones and/or special districts.

(i) Access and Parking

Map proposed access points for all modes of transportation.

(j) Private and Public Utilities – Site and Surrounding Area

Map existing public and private utilities.

3. **Site Planning and Objectives**

Prepare a Preliminary Site Plan at an engineer scale appropriate to review the information which includes proposed grading, clearing areas, stormwater management facilities, natural resource areas and required setbacks, buildings, parking areas, streets and other proposed impervious areas. The preliminary site plan must address the four objectives listed below to reduce the impact of stormwater runoff from development, which may reduce the size of stormwater management facilities required.

(a) Preserve Existing Resources

On the Preliminary Site Plan, show the Significant Resource Overlay Zone and any other natural resource areas. If encroachment into any natural resource area is proposed, show the area of encroachment on the site map and the required mitigation area. Check with the Planning Division to identify any other buffer or conservation requirements.

(b) Minimize Site Disturbance

Protecting undisturbed, uncompacted areas from construction activities provides more rainfall interception, evapo-transpiration 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.

(c) Minimize Soil Compaction

Avoid any construction activity that could cause soil compaction in areas designated for stormwater management facilities to preserve filtration and infiltration characteristics of the soil. Also avoid soil compaction in natural resource areas, and mitigation and/or re-vegetation areas. Delineate these areas on the Preliminary Site Plan and protect them during construction with orange construction fencing.

(d) Minimize Imperviousness

Complete and attach the Impervious Area Threshold Determination Form. The form allows for impervious area reduction credits for use of porous pavement, green roofs, tree preservation and tree planting (tree credits apply to non-single family developments only). Identify proposed impervious area reduction methods, and show them on the Preliminary Site Plan.

4. **Proposed Stormwater Management Strategy**

Given suitable site and soil conditions, the City requires that development shall incorporate LID facilities to infiltrate stormwater runoff to the Maximum Extent Practicable (MEP) to recharge groundwater and mimic pre-development hydrologic conditions. LID facilities will be designed and sized according to the soil classification and/or infiltration testing rate. Onsite soil characteristics may require a geotechnical report to address soil conditions, infiltration rates and groundwater to incorporate an infiltration strategy into the stormwater management plan to the MEP.

For the *Site Assessment and Planning Checklist*, the applicant must identify and select a proposed stormwater management strategy from the choices below.

(a) LID facilities to the MEP – Check this option if LID facilities will be utilized to the MEP to address the water quality and flow control requirements of the site. LID facilities must be sized according to the design requirements in Section 301.4.00, "Stormwater Management Facility Selection and Design" utilizing either the BMP Sizing Tool or the Engineered Method. MEP is defined as installing LID facilities with a surface area of at least 10% of the total new or redeveloped impervious area. Approved stormwater management facilities that qualify as LID facilities are defined in Section 301.4.00.

(b) Onsite retention of the 10-year design storm – Where possible, retain and infiltrate all stormwater runoff up to and including the 10-year storm onsite using LID facilities. Infiltration of the full 10-year design storm is assumed to satisfy both water quality and flow control requirements of Section 301.4.00, "Stormwater Management Facility Selection and Design".

(c) Limiting conditions for LID facilities - The following limiting conditions restrict the practicality of using onsite infiltration and may require the use of lined, non-infiltrating stormwater management facilities or underground facilities to meet stormwater management requirements. When sites have limiting conditions, a report is required to document one of the following:

(1) Stormwater management facilities will be located on fill.

(2) Site areas with steep slopes (≥20%) and/or slope stability concerns (geotechnical engineering or geologist report and City approval required for infiltration facilities on moderate slopes of 10-20%).

(3) Sites in areas of seasonal high groundwater table (for site planning submittal, sites with jurisdictional wetlands or FEMA floodplains may be required to perform a seasonal high groundwater table assessment and determine that the seasonal groundwater table is below the proposed bottom elevation of stormwater infiltration facilities).

(4) Sites with contaminated soils (sites that have contaminated soils conditions must be evaluated by the Oregon Department of Environmental Quality (ODEQ) and/or the Environmental Protection Agency 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 City at the time of application).

(5) There is a conflict with required source controls for high-risk sites (a geotechnical report is not required to document this limiting condition, but approval from the City is required to install lined and/or underground facilities in place of LID facilities).

5. **Facility Selection/Sizing**

After selecting a stormwater management strategy, applicants shall indicate which stormwater management facilities are proposed for the site based on the results of the site assessment and planning process. The BMP Sizing Tool shall be used to calculate the size of the facilities and the BMP Sizing Tool report shall be included as part of the application. All proposed impervious area reduction methods and proposed stormwater management facilities shall be shown on the Preliminary Site Plan.

301.3.00 SUBMITTAL REQUIREMENTS

The Developer's engineer shall submit sufficient supporting information as outlined below to justify the proposed stormwater management design meets all the provisions within these standards and the land use conditions of approval. It is the design engineer's responsibility to ensure that engineering plans are sufficiently clear and concise to construct the project in proper sequence, using specified methods and materials, with sufficient dimensions to fulfill the intent of these design standards. A Storm Drainage Report as outlined in Section 301.3.02, "Storm Drainage Report", is required to be prepared and submitted with the design plans.

301.3.01 Supporting Information

a. All elevation on design plans and record drawings shall be based on the applicable NAVD 88 Datum specified in Section 101.7.07.a, "NAVD 88 Datum."

b. Existing conditions and facilities on design plans and record drawings shall be shown in light, grey print. Proposed conditions and facilities on design plans and record drawings shall be shown in bold, black print.

c. All engineering drainage plans shall be stamped by a Professional Engineer registered in the State of Oregon. At a minimum, the drainage plans shall contain the following:

1. At least one sheet shall show a plan view of the entire project site. If the project site is sufficiently large that detailed drainage plans on any given sheet do not encompass the entire project site, then a sheet showing the plan view of the entire site must serve as an index to subsequent detailed plan sheets.

2. A topographic map showing existing conditions for the site, including:

(a) Existing conditions and topography for the site. Plan views showing existing features may be required for a distance of up to 100 feet (or further if warranted) beyond the proposed improvement in order to prevent future grade conflicts and will be determined on a case-by-case basis by the City's authorized representative.

(b) Adjacent streets, trails, multi-use paths, and rail lines, including the respective names.

(c) Existing utilities, including franchised utilities located above or below ground and drainage facilities that transport surface water onto, across, or from the project site. Existing drainage pipes, culverts, and channels shall include the invert or flowline elevations.

(d) Existing vegetation, including denoting the type, DBH, and canopy size of trees within the construction limits.

(e) Existing sensitive areas (e.g., ravines, swales, steep slopes, wells, springs, wetlands, creeks, lakes). For natural drainage features, show direction of flow, drainage hazard areas, and 100-year floodplain boundary (if applicable).

(f) Adjacent existing features that are within 25 feet outside of the site boundary, including but not limited to construction activities that will potentially compromise the structural stability or condition of off-site features, such as cultivated vegetation, landscaping, and trees, buildings, fences, decks, walls, slabs, and pavements. Denote the type, DBH, and canopy size of all trees.

3. Plans for proposed drainage improvements shall include the following:

(a) Grading and erosion control plan.

(b) Finished grades, showing the extent of cut and fill by existing and proposed contours, profiles, or other designations. Plan views showing finished grades

may be required for a distance of up to 100 feet (or further if warranted) beyond the proposed improvement in order to prevent future grade conflicts and will be determined on a case-by-case basis by the City's authorized representative.

(c) Horizontal stationing along centerline, showing points of tangency and curvature, including centerline stationing of all intersecting streets.

(d) Proposed structures, including roads and road improvements, parking surfaces, building footprints, walkways, landscaped areas, etc.

(e) Location, dimensions, slopes, and elevations of all existing and proposed drainage facilities, including pipes, open channels, culverts, stormwater management facilities, outfalls, riprap treatment, energy dissipaters, and all storm system structures and appurtenances, including but not limited to manholes, catch basins, area drains, inlet/outlet structures, clean outs, and service laterals. Notes shall be included for referencing details, cross-sections, profiles, etc.

(f) Existing and proposed utilities, showing exact line and grade of all utilities crossings with proposed drainage system.

(g) All proposed off-site improvements.

(h) Applicable detail drawings.

(i) Existing and proposed property lines, right-of-way lines, survey monuments, and easements.

(j) Setbacks from environmentally sensitive areas or resource areas protected within the Significant Resource Overlay Zone (SROZ).

(k) Maintenance access, as applicable (See Section 301.13.08. "Access and Safety").

(l) Show emergency overflow pathway(s).

(m) Any proposed phasing of construction. (Note: stormwater management facilities must be constructed before completion of any phased construction)

(n) Any additional information that the City's authorized representative deems necessary.

4. Profiles for proposed drainage improvements will be provided at the same horizontal scale as the plan sheets and a 1" = 5' vertical scale. Profile drawings shall be drawn below the plan view or immediately following the associated plan view sheets. Profile views showing existing features may be required for a distance of up to 100 feet (or further if warranted) beyond the proposed improvement in order to prevent future grade conflicts and will be determined on a case-by-case basis by the City's authorized representative. The profiles shall include the following:

(a) Existing and proposed ground along proposed storm facility alignments.

(b) Conveyance systems, including pipe, culvert, and channel sizes, types and materials, lengths, backfill material, and all drainage system structures and appurtenances, including but not limited to manholes, catch basins, area drains, inlet/outlet structures, fittings, and clean outs. Notes shall be included for referencing details, cross-sections, etc.

(c) Existing and proposed utilities, showing exact line and grade of all utilities crossing the proposed drainage system. The vertical separation from existing and proposed utilities shall be labeled for all proposed utility crossings.

(d) Any additional information that the City's authorized representative deems necessary.

5. A detailed grading plan shall be provided for all open stormwater management facilities. The plan shall include the following:

   (a) Existing ground contours (shaded) and proposed ground contours at a minimum 2-foot contour interval. Slopes steeper than 6H:1V shall be identified.

   (b) Location of top and toe of slope.

   (c) Limits of embankment designed to impound water.

   (d) Location of all drainage structures as well as any other piped utilities in vicinity (0.1-foot detail).

   (e) Flow route of the secondary/emergency overflow system (0.1-foot detail).

   (f) Maintenance access, as applicable (see Section 301.13.08. "Access and Safety").

6. A detailed landscape plan shall be provided for open stormwater management facilities. The plan shall include the following:

   (a) Final ground contours at a minimum 1-foot contour interval.

   (b) Location of top and toe of slope.

   (c) Maximum water surface elevations.

   (d) Location of all drainage structures as well as any other piped utilities in vicinity (screened) (0.1-foot detail).

   (e) Limits of areas to receive amended topsoil.

   (f) Irrigation plan to achieve the required plant survival rate.

   (g) Planting species, locations and densities in accordance with the landscape requirements in Appendix B.

7. Cross-sections shall be provided for at least the following:

   (a) Stormwater management facilities, including but not limited to ponds, swales, rain gardens, and stormwater planters. Cross-sections shall graphically illustrate the following:

      (1) Design maximum water surface.

      (2) Proposed dead storage water surface (as applicable).

      (3) Pavement section or amended soil section, as applicable.

   (b) Proposed ditches and swales, including vegetated swales.

8. Interference with City Drainage System Prohibited

   No person shall block, obstruct, or interfere with any portion of the City drainage system without a diversion plan being submitted and approved by the City's authorized representative. This prohibition includes, but is not limited to, the obstruction of the flow of storm water from, and to any point within, the City drainage system.

301.3.02 Storm Drainage Report

a. The drainage report shall be on 8½-by-11 paper. Maps shall be folded to 8½-by-11 size unless another format is approved before the report is submitted.

b. If Low Impact Development pervious features are being proposed with the project the Impervious Area Threshold Determination Form shall be included with the Storm Drainage Report.

c. The drainage report shall be prepared by and bear the seal and original signature of a Professional Engineer registered in the State of Oregon and shall contain the following information:

   1. Cover sheet, including the project name, project tracking number (Planning DB No.), applicant's name, address, and telephone number, design engineer's name, and date of submittal.

   2. Table of contents, with page numbers for each section of the report, including exhibits, appendices, and attachments.

   3. Vicinity Map.

   4. Project description, specifying type of permit(s) for which the applicant is applying, size and location of the project site, address or parcel number, legal description of the property, and property zoning. Also describe other permits required (e.g., Corps of Engineers 404 fill permit). Describe the project, including proposed land use, proposed site improvements, proposed construction of impervious surfaces, proposed landscaping, and special circumstances.

   5. Existing Conditions

(a) Describe existing site conditions and relevant hydrological conditions, including but not limited to the following:

(1) Project site topography.

(2) Land cover and land use.

(3) Abutting property land cover, land use, and ownership information.

(4) Off-site drainage to the property.

(5) Natural and constructed channels.

(6) Wetlands, creeks, ravines, gullies, steep slopes, springs, and other sensitive areas on or adjacent to the project site.

(b) General soil conditions in the project site, using SCS soil designations.

(c) Points of discharge for existing drainage from the project site.

(d) References to relevant reports, such as basin plans, flood studies, groundwater studies, wetland designations, watershed plans, subbasin master plans, sensitive area designation, environmental assessments, water quality reports, or other relevant documents. Where such reports impose additional conditions on the applicant, those conditions shall be included in the report.

(e) Soils report(s) and/or infiltration test results and seasonal groundwater depth evaluation, where applicable.

(f) Hydrologic analysis, pursuant to Section 301.4.01, "Hydrologic Analysis."

(g) Basin map(s), showing boundaries of project, any off-site contributing drainage basins, on-site drainage basins, approximate locations of all major drainage structures in the basins, and depicting the course of stormwater originating from the subject property and extending to the closest receiving body of water. Reference the source of the topographic base map (e.g., USGS), the scale of the map, and include a north arrow.

(h) Description of drainage basin(s) to which the project site contributes runoff, and identification of the receiving waters for each basin.

6. Developed Conditions

(a) Developed site drainage conditions: Describe the land cover resulting from the proposed project; describe the potential stormwater quantity and quality impacts resulting from the proposed project; describe the proposed methods for collection and conveyance of runoff from the project site, for the control of any increase in stormwater quantity resulting from the development, and for maintaining stormwater quality.

(b) Description of upstream and downstream basins, identifying any sources of runoff to the project site. Description shall be based on field investigation.

Any existing drainage or erosion issues upstream that may affect the proposed development shall be noted.

(c) Downstream analysis, pursuant to Section 301.5.01, "System Design Considerations".

(d) Hydraulic design computations, supporting the design of all proposed stormwater conveyance facilities, and verifying the capacity of existing conveyance facilities to remain in place. These computations may include capacity and backwater analysis as part of the proposed drainage design or as part of the downstream drainage investigation.

(e) BMP Sizing Tool report files to show the required size of stormwater management facilities or equivalent Engineered Method calculations to document how proposed stormwater management facilities meet the design standards of Section 301.4.04, "Design Criteria."

(f) Flood routing computations if required for wetland impact analysis, or for floodplain analysis.

(g) Description of how the stormwater system will function during the 100-year storm to protect public safety and property.

(h) Operation and maintenance manual, required for privately owned and maintained stormwater management facilities. The manual will be an attachment to the City's Stormwater Maintenance Covenant and Access Easement.

(i) Appendices shall include necessary technical information.

301.4.00 STORMWATER MANAGEMENT FACILITY SELECTION AND DESIGN

Each new development is responsible for mitigating its impacts on the public stormwater system. The City's authorized representative shall determine which of the following techniques may be used to satisfy this requirement. Stormwater management facilities shall be designed to mitigate post-development flows in conformance with this section. Mitigation requirements shall meet applicable federal, state, and local standards and regulations.

This section describes the methods and criteria for selecting and designing stormwater management facilities for projects that exceed the development thresholds in Section 301.1.02, Stormwater Management Thresholds". The pollutants of concern include, but are not limited to, sand, silt, and other suspended solids; metals such as copper, lead, and zinc; nutrients such as nitrogen and phosphorus; certain bacteria and viruses; and organics such as oil, grease, petroleum hydrocarbons, and pesticides. Methods of removing pollutants include sedimentation or settling, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Floatable pollutants such as oil, debris, and scum can be removed with separators. Additional water quality treatment is required for certain types of development categorized as high-risk for pollutants described in Section 301.12.00, "Source Controls".

301.4.01 Impervious Area Used in Design

a. Stormwater management facilities are required when proposed development establishes or increases the impervious surface area by more than 5,000 square feet. Development includes new development, redevelopment, and/or partial redevelopment.

b. For single-family and duplex residential subdivisions, stormwater management facilities shall be sized for all impervious areas created by the subdivision, including all residences on individual lots at the current rate of 2,750 square feet of impervious surface area per dwelling unit.

c. For all developments other than single-family and duplex dwellings, including row houses and condominiums, the sizing of stormwater management facilities shall be based on the impervious area to be created by the development, including structures and all roads and impervious areas. Impervious surfaces shall be based on building permits, construction plans, or other appropriate methods of measurement deemed reliable by the City's authorized representative.

d. The City encourages design initiatives that reduce the effective impervious area. For developments other than single-family and duplex dwellings, a smaller stormwater management facility may be possible.

301.4.02 Criteria for Requiring a Stormwater Management Facility

A stormwater management facility shall be constructed on site unless, in the judgment of the City's authorized representative, any of the following conditions exist:

a. The site location, size, gradient, topography, soils, or presence of an SROZ make it impractical or ineffective to construct an on-site facility.

b. The subbasin has a more effective, existing regional site designed to incorporate the development or which has the capacity to treat the site stormwater.

c. The development is for construction of one- or two-family (duplex) dwellings on existing lots of record which will establish or create less than 5,000 square feet of impervious surface.

301.4.03 Facility Selection

LID facilities 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. Impervious area reduction techniques, such as preservation of existing trees, 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.

a. The following types of stormwater management facilities can be used to meet these standards:

    1. Impervious Area Reduction Methods:

(a) Porous pavement

(b) Green roof

(c) Planting and preservation of trees (subject to limitations)

2. Stormwater Management Facilities:

(a) Stormwater planters

(b) Rain gardens

(c) Vegetated filter strips

(d) Vegetated swales

(e) Detention ponds

(f) Manufactured treatment technologies (various types, subject to limitations)

(g) Underground detention facilities (for flow control)

b. To select the most appropriate facilities applicants may use **Table 3.10** as a quick reference to match stormwater management facility types with common design objectives and site constraints.

TABLE 3.10. FACILITY SELECTION

Facility can be used for:	Porous Pavement	Green Roof	Tree	Stormwater Planter	Rain Garden	Filter Strip	Vegetated Swale	Detention Pond	Manufactured Treatment	Detention Tank
Impervious Area Reduction	●	●	●							
LID Facility Requirements*	●	●		●	●	●	●	●		
Flow Control	●	●		●	●		●	●		●
Water Quality Treatment	●	●		●	●	●	●	●	●	
Private Property	●	●	●	●	●	●	●	●	●	●
Public Right-of-Way (ROW)	●	●	●	●	●	●	●	●		●
Steep Slopes		●	●						●	●

*Facilities that include impermeable liners to prevent infiltration do not meet the LID requirements.

c. Alternate Facilities - Applicants may propose stormwater management facilities that are not listed in **Table 3.10**. Such a proposal will require the applicant to submit a request for a modification to these standards. Alternate facilities must be sized using the Engineered Method as described in this section. An example of an alternate facility would be for the use of a drywell, infiltration trench, or other underground injection control (UIC) facility on private property. To propose a UIC on private property, the applicant would need to prepare appropriate registration information to ODEQ and submit a modification request to the City.

301.4.04 Design Criteria

Stormwater management facility design is based on meeting the City's design criteria to address LID requirements, water quality treatment standards, and flow control requirements.

a. **LID to the MEP:** The goal is to prioritize the use of LID facilities to the MEP to mimic the natural stormwater runoff conditions of the pre-developed site and recharge the groundwater. The City's strategy to meet this goal is to incorporate LID principles in site planning and facility design.

   Either one of the following two options may be used to meet the LID requirement:

   1. LID facilities to the MEP – Utilize LID facilities to the MEP to address the water quality and flow control requirements of the site. LID facilities shall be sized according to the design requirements of this section, utilizing either the BMP Sizing Tool or the Engineered Method. When site constraints limit the surface area available for stormwater management facilities, MEP is defined as installing LID facilities with a surface area of at least 10% of the total new plus replaced impervious area.

   2. Onsite Retention – Retain and fully infiltrate the 10-year design storm on site using LID facilities. This is equivalent to retaining and infiltrating runoff from new impervious surface for the 3.4-inch storm over 24 hours. The facility shall fully infiltrate within 72 hours following the beginning of the storm event. Infiltration of the full 10-year design storm is assumed to satisfy both water quality and flow control requirements.

b. **Limited Infiltration:** For sites with conditions that limit the use of infiltration (fill, steep slopes, high groundwater table, well-head protection areas, and/or contaminated soils), utilizing LID facilities may not be practicable and the applicant may use lined, non-infiltrating or underground stormwater management facilities. In such cases, the applicant shall submit documentation of limiting conditions from a geotechnical engineer or engineering geologist registered in the State of Oregon, or documentation from ODEQ.

c. **Water Quality Requirement:** Water quality facilities shall be designed to capture and treat 80% of the average annual runoff volume to the MEP with the goal of 70% total suspended soils (TSS) removal. In this context, MEP means less effective treatment may not be substituted when it is practicable to provide more effective treatment. The treatment volume equates to a design storm of 1.0 inch over 24 hours.

The BMP Sizing Tool addresses these water quality requirements to size stormwater management facilities.

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

d. **Flow Control Requirement:** 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% of the 2-year storm peak flow rate[1] up to the 10-year peak flow rate. A hydrologic/hydraulic analytical model capable of performing a continuous simulation of flows from local long-term rainfall data shall be used to determine the peak flow rates, recurrence intervals and durations. The BMP Sizing Tool incorporates these flow control requirements to size stormwater management facilities.

301.4.05 Design Methods

This section explains the two methods accepted by the City for designing stormwater management facilities: the BMP Sizing Tool Method and the Engineered Method. To use a different method for sizing a treatment facility type not covered in these standards, applicants shall obtain approval from the City's authorized representative prior to submitting permit applications for review.

a. BMP Sizing Tool Method:

1. A BMP Sizing Tool application is available from the City to assist with the sizing of stormwater management facilities that meet the requirements of these standards. The following facilities can be sized using the tool:

   (a) Rain Garden – Infiltration and Filtration

   (b) Stormwater Planter – Infiltration and Filtration

   (c) Vegetated Swale - Infiltration and Filtration

   (d) Infiltrator

   (e) Detention Pond

2. The detention pond option will allow credit for the utilization of upstream LID facilities.

3. The report generated by the BMP Sizing Tool shall be included with permit application submittals. The BMP Sizing Tool can be used during the initial site

[1] The lower threshold of 42% 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.

planning and during final design. The soil infiltration rates used during final design shall meet the criteria outlined in these standards.

4. Pre-developed Hydrology

   For the purposes of hydrologic modeling, the pre-developed conditions of the site will be modeled as the historical vegetation which existed at the site prior to urban settlement. In many areas of the City, the pre-developed vegetation included Oak Savannah, which should be modeled in the sizing tool as grass. Areas of the City that were cultivated for agriculture prior to urban development also may be modeled as grass under the pre-developed condition requirements. The applicant may use historic photos, reports, or other available sources to document the condition of the site prior to urban settlement.

5. Facility Design Specifications

   (a) The BMP Sizing Tool was developed based on specific design requirements for each facility type. Facilities sized using the 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). Applicants who wish to propose alternate facility specifications may use **Table 3-11** to adjust the size of the stormwater management facility calculated from the BMP Sizing Tool.

   (b) Applicants considering design adjustments beyond those included in Table 3.12 should utilize the Engineered Method to show how the proposed facility size and design specifications will meet the flow control and water quality requirements of these standards.

TABLE 3.11. FACILITY SIZING ADJUSTMENTS

Facility Types	Design Modification	Facility Size Adjustment
Stormwater Planter Rain Garden Vegetated Swale	Increase growing media depth by 12 inches or more	Reduce required facility surface area by 25%

b. **Engineered Method:**

1. As an alternative to the BMP Sizing Tool, the Engineered Method may be used to calculate the required size of stormwater management facilities for any size or type of development. The Engineered Method provides the developer with flexibility to factor in a wider variety of site data and facility design parameters to determine the size and configuration of stormwater management facilities.

2. The Engineered Method may be used to do the following:

   (a) Address unique site conditions

   (b) Apply a new or emerging design technology

   (c) Propose alternate facility design specifications

3. The Engineered Method requires the development of a hydrologic/hydraulic analytical model capable of performing a continuous simulation of peak flows from long-term local rainfall records. The City must pre-approve the hydrologic/hydraulic analytical model prior to submittal or development of any plans and/or calculations. Regardless of how the stormwater calculations are performed, the report submitted to the City must show how the proposed stormwater management facilities meet the design criteria for LID, water quality, flow control, and conveyance provided in this section.

301.4.06 Infiltration Rate and Testing

To size stormwater management facilities, it is necessary to know the infiltration rate of the soil at the actual facility location. Infiltration testing is not required on development projects which create less than 5,000 square feet of new or replaced impervious surface.

The City has approved three methods for performing an infiltration test: Open pit falling head, Encased falling head, and Double-ring infiltrometer. Specifications for the test procedures are included in Appendix B.

301.4.07 UIC Registration

Subsurface discharging infiltration facilities that are defined by ODEQ as UICs (e.g., private soakage trenches or dry wells) shall be designed with approved pretreatment devices and registered with ODEQ as required. The City will not allow new UIC devices which accept stormwater runoff from a public ROW or for public ownership or maintenance.

The ODEQ identifies drywells and piped soakage trenches as "Class V Injection Wells" under the federal UIC Program.

The City will accept ODEQ approved and permitted UIC devices on private property, but will not accept UIC devices that the City will maintain, or private UIC devices which accept drainage from publicly owned or maintained improvements.

301.4.08 Planting and Irrigation Requirements

a. Stormwater management facilities with vegetative plantings shall meet the following requirements:

   1. Stormwater management facilities shall be planted and functional prior to impervious surfaces being installed.

   2. Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement,

shall be implemented for the two-year landscape maintenance assurance period (Section 101.8.18.c) to ensure plant survival.

3. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions (See Appendix A).

4. The design for plantings and planting medium 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.

5. Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.

6. Certified weed-free native grass or native wildflower seed shall be applied at the rates specified by the suppliers. If plant establishment cannot be achieved with seeding prior to installation of impervious surfaces, the contractor shall plant the area with approved sod, plugs, container plants, or other means to complete the specified plantings and protect against erosion before water is allowed to enter the facility.

7. Side slopes of planted areas shall not exceed 3 feet horizontal to 1 foot vertical.

b. Soil Mixes for Use in Facilities: Vegetated facilities require a soil/landscape system that simultaneously supports plant growth, soil microbes, water infiltration, nutrient and pollutant adsorption, and pollutant filtration and decomposition. Therefore, the soil mix selected for a facility is critical to its success. See the specific facility design details, and also refer to Appendix A for growing medium specifications for vegetated facilities.

c. Irrigation: The applicant is allowed to choose the method to irrigate, such as by truck or irrigation system. Plant survival rates shall be in compliance with Section 101.8.18.c. “Landscape Maintenance Assurance”, as such the City recommends on-site irrigation to maintain the plant survivability. Temporary irrigation systems must be fully removed before the City releases the Landscape Maintenance Assurance bond.

301.4.09 General Facility Design Requirements

The following general facility design requirements apply to all stormwater management facilities.

a. Facility Location

1. No stormwater management facility shall be built in a public easement unless approved by the City’s authorized representative. Stormwater management facilities are allowed to be located in the landscape areas of the public right-of-way when approved by the City’s authorized representative and maintained by the Applicant.

2. Stormwater management facilities may be allowed in the public right-of-way if approved by the City’s authorized representative and maintained by the development.

3. Stormwater management facilities shall not be located in an area designed or used for vehicular parking.

b. The average, wet-season groundwater elevation shall be determined for the proposed stormwater management facility. Groundwater elevation may be established through measurements at existing wells, installation of piezometer(s), or other methods approved by the City's authorized representative. The facility shall be designed to exclude detention/retention capacity below the established wet-season groundwater elevation.

c. Safety

1. Stormwater management facilities shall include a vegetated buffer or a safety bench.

2. Side slopes in stormwater management facilities shall not exceed 4H:1V up to the maximum design water elevation.

3. Stormwater management facilities shall be posted with warning signs that prohibit swimming or wading.

4. Where fencing is required by federal, state, and local laws and ordinances for public safety considerations or security reasons, the fencing shall be aesthetically designed. No barbed wire fencing shall be used.

d. Side Slopes

1. Interior side slopes up to the maximum water surface = 4H:1V.

2. Maximum exterior side slopes = 2H:1V, unless analyzed for stability by a Professional Engineer registered in the State of Oregon whose area of expertise is geotechnical engineering.

3. If slopes need to be mowed, maximum side slope = 4H:1V

e. Walls in Stormwater Management Facilities

1. Retaining walls may serve as pond walls if the design is prepared and stamped by a Professional Engineer registered in the State of Oregon and a fence is provided along the top of the wall.

2. At least 25% of the pond perimeter will be vegetated to a maximum side slope of 3:1.

3. Walls that are 4 feet or higher must meet all of the following criteria:

i. Be approved by a Professional Engineer registered in the State of Oregon whose area of expertise is structural or geotechnical engineering.

ii. The City shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the water management facility

tract or easement shall be clearly documented in the City's Stormwater Maintenance Covenant and Access Easement.

f. Maximum water storage depth in stormwater management facilities for the 100-year storm event shall not exceed 4 feet in depth, unless otherwise approved by the City's authorized representative.

g. The nearest upstream manhole from a stormwater management facility or any point of discharge shall be a stormwater pretreatment manhole conforming to Section 301.4.11.

h. Stormwater management facilities shall be designed to prevent scouring at the inflow structure(s) by use of an engineered energy-dissipating device such as a Swale Inflow Spreader (see Detail No. S-2225 of these standards) or other method approved by the City's authorized representative.

i. A pond overflow system shall provide for discharge of the design storm event without overtopping the pond embankment or exceeding the capacity of the emergency spillway. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. The emergency spillway shall be located in existing soils when feasible and armored with riprap embedded in concrete, or other approved erosion protection extending to the toe of the embankment (see Detail No. S-2275 of these standards).

j. Where an underground detention pipe system is used each pipe shall be provided with a clean out and a manhole access located at either end of the pipe structure

k. Stormwater management facilities shall be operational prior to installation of any impervious surface or hardscape designed to drain to the facility.

301.4.10 Access Road

Access roads are for maintenance and inspection purposes. All-weather access shall be provided for the entire perimeter of the stormwater management facility, unless otherwise approved by the City's authorized representative. At a minimum, access shall be provided for maintenance and inspection of the inflow and outflow structures of the facility. The following criteria are the minimum City requirements:

a. Three inches of Class C AC; over 8 inches of ¾"-0"compacted crushed aggregate; over firm subgrade. Crushed aggregate and subgrade shall be compacted to 95% of maximum dry density, as determined by AASHTO T-180.

or

The design engineer may submit a certified road design capable of supporting a 30-ton maintenance vehicle in all weather conditions.

b. The plan shall include design of strengthened sidewalk sections where maintenance vehicles will cross.

c. Maximum grade: 15% with a maximum 3% cross-slope.

d. Minimum width: 15 feet on straight runs and curves. Curves shall be designed with a minimum 40-foot interior radius.

e. A 2-foot wide gravel shoulder shall be provided on the facility side of the access road.

f. Access shall extend to within 10 feet of all control structures, unless otherwise approved by the City's authorized representative.

g. If fencing is required for public safety or security reasons (see Section 301.4.09), the fence shall include a 12-foot-wide lockable gate for maintenance access.

301.4.11 Stormwater Pretreatment Manholes

a. Hydraulic criteria

1. Minimum design flow = water quality flow.

2. An upstream flow splitter manhole may be used to bypass conveyance flows in excess of the Water Quality flow.

b. Design criteria

1. Shall be required immediately upstream of all stormwater management facilities, or any release point to a natural drainage.

2. Shall conform to Detail No.S-2050, "Stormwater Pretreatment Manhole," or an equivalent detail approved by the City's authorized representative.

3. Minimum manhole diameter shall be 60 inches.

4. Sump depth shall be no deeper than 5 feet from invert to bottom of sump, unless approved by City's authorized representative.

5. Volume of sump shall be 20 cubic feet per 1.0 cfs of flow into the water quality manhole, up to the 25-year flow. Flow calculations shall include the effect of an upstream flow splitter.

6. Maintain a 3-foot clear access zone between the inside structure wall and the interior outlet structure.

7. Orient access to structure in a clear zone.

301.4.12 Proprietary Stormwater Management Facilities

a. Proprietary stormwater management facilities are permitted on a case-by-case basis, with approval of the City's authorized representative.

b. The devices shall be sized in accordance with the manufacturer's recommendations. However, the facilities shall comply with the stormwater management facility design requirements in this section.

c. Technical submittals from the manufacturer are required, including hydraulic design criteria, particulate removal efficiency, and maintenance requirements and schedule.

d. When a proprietary stormwater system is used, prior to City acceptance of the project the applicant shall provide a letter from the system manufacturer stating that the system was installed per specifications and is functioning as designed.

301.5.00 CONVEYANCE SYSTEM ANALYSIS

301.5.01 System Design Considerations

a. **On-site and Off-site Drainage Concerns:** Site development improvement projects shall address on-site and off-site drainage concerns, both upstream and downstream of a project, including but not limited to the following:

1. Modifications to the existing on-site storm drainage facilities shall not restrict flows creating backwater onto off-site property to levels greater than the existing situation, unless approved by the impacted off-site property owners and the City's authorized representative. The off-site property owner(s) shall agree to and sign a permanent easement legally describing the location of the backwater storage and authorizing the use of their property for stormwater drainage and detention/retention purposes. The easement shall be in a form approved by the City.

2. Stormwater runoff will be discharged in a manner to not adversely affect the safety and/or flooding potential of adjacent or downstream property owners. The design of storm drainage facilities shall analyze the impact of restrictions downstream of the project site, in accordance with Section 301.5.01, "System Design Considerations." Downstream restrictions that create on-site backwater may be required to be removed by the applicant, at the discretion of the City's authorized representative, or the on-site backwater shall be addressed in the design of the development's storm system. The removal of downstream obstructions shall not be allowed if removal would create downstream capacity problems.

3. If the projected increase in the surface water runoff from a proposed development will cause or contribute to damage from flooding to existing buildings or dwellings, the downstream stormwater system shall be enlarged to relieve the identified flooding condition before development, or the applicant shall construct an on-site detention/retention facility.

b. **Review of Downstream System:** The design engineer must perform an analysis of the drainage system downstream of the development, verifying that the downstream system has the capacity to convey the 25-year design storm.

1. Downstream system capacity analysis is the responsibility of the applicant for new development. Based on the information submitted, the City will determine the adequacy of the downstream system. This determination will be based on the analysis submitted but may also be based upon existing information indicating current or past drainage problems downstream from the project.

2. The analysis shall extend downstream to a point in the drainage system where the proposed development site constitutes 10% or less of the total tributary drainage flow (for example, the analysis point for a 10-acre site would be analyzed to the nearest downstream point with a drainage area of 100 acres).

3. If the proposed development area is less than 10% of the total tributary drainage area at the approved point of discharge, the analysis will continue for one-quarter mile downstream of the approved point of discharge.

c. **Limited Downstream Conveyance:** If the downstream capacity is undersized, or when, in the opinion of the City, property or properties may be adversely affected by the existing and/or proposed stormwater release rates the following design requirements shall be considered.

1. Additional stormwater flow control measures may be required to reduce flow contributions to the downstream system. This additional flow control requirement may still require downstream conveyance system improvements in order to safely convey all existing and proposed stormwater runoff generated from the upstream and onsite drainage basins.

2. The applicant may have the option to correct and/or improve downstream drainage conditions so that the proposed stormwater release rates do not have to be further restricted.

3. The applicant is responsible to replace, repair, upsize, construct, or reconstruct the downstream conveyance system in order to provide the capacity necessary to develop the property. The downstream conveyance system may include any open or closed public or private stormwater conveyance system.

4. The applicant is required to identify all off-site downstream conveyance restrictions and the cost of upsizing/improving these conveyance systems to meet the minimum conveyance requirements established in this section.

5. Any off-site improvements will be the requirement and responsibility of the applicant to obtain easements, design approval, and authorization from all owners of any property and/or agency having the authority to regulate the activity. All agreements, easements, authorization and approvals shall be acquired prior to stormwater management plan approval.

d. **Severely Limited or No Downstream Conveyance System**

1. Where no conveyance system exists at the adjacent down gradient property line and the discharge was previously un-concentrated or significantly lower concentrated flow, measures must be taken to prevent adverse downstream impacts.

2. Drainage easements from downstream property owners may be needed and shall be obtained in addition to the construction of an adequate conveyance system prior to the City approving the stormwater management plan and/or issuing a Public Works Permit.

301.5.02 Computational Methods

This section describes acceptable methods of estimating the quantity and characteristics of surface water runoff, as well as the assumptions and data required as input to the methods. These methods shall be used to analyze existing, and to design proposed drainage systems and related facilities.

a. The method of hydraulic calculations shall be subject to approval from the City's authorized representative. The design engineer may use various computer models, methods or formulas for the hydrograph analysis, but the City's authorized representative may verify the design flows and volumes based on InfoSWMM® modeling software, or as alternatively identified in this section.

b. Unless an alternative method is approved by the City in writing, calculation of storm runoff used for conveyance design shall be based on SBUH, TR-55 or the SWMM methods with the following limitations.

   1. The rainfall distribution to be used within the City is the design storm of 24-hour duration based on the standard National Resources Conservation Service's (NRCS) Type 1A rainfall distribution using the 24-hour precipitation isopluvials in the National Oceanic and Atmospheric Administration Atlas 2, Volume 10, *Precipitation-Frequency Atlas of the Western United States*.

   2. Curve numbers shall be derived from the NRCS runoff curve numbers contained in TR-55 *Urban Hydrology for Small Watersheds*.

   3. Soil types shall be derived from the NRCS Soil Survey for Clackamas County.

   4. The maximum overland distance for sheet flow used in calculations shall be 300 feet.

301.5.03 Rational Method

The Rational Method is most accurate for runoff estimates from small drainages with large amounts of impervious area and is approved for analyzing drainage basins of less than 25 acres with the following limitations:

a. Use it only in predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.

b. Drainage subbasin area cannot exceed 25 acres for a single calculation without approval from the City's authorized representative.

c. The time of concentration shall be 5 minutes if computed to be less than 5 minutes.

d. Rainfall intensities shall be from **Table 3.2,** or an alternative approved by the City's authorized representative.

e. Rational formula: Q=C*I*A Where: Q = Flow in cubic feet per second
   C = Runoff coefficient (0.9 for paved surfaces)
   I = Intensity
   A = Area in acres

TABLE 3.2. RATIONAL METHOD FOR DERIVING RAINFALL INTENSITIES1

Time of Concentration (minutes)	Storm Event (storm event, probability, inches per hour)					
	2 (50%)	5 (20%)	10 (10%)	25 (4%)	50 (2%)	100 (1%)
0	1.90	2.50	3.00	3.40	4.00	4.50
5	1.90	2.50	3.00	3.40	4.00	4.50
10	1.30	1.70	2.20	2.50	3.00	3.50
15	1.10	1.40	1.80	2.10	2.50	2.90
20	0.90	1.20	1.50	1.80	2.10	2.40
30	0.75	0.95	1.20	1.40	1.65	1.90
40	0.60	0.75	1.00	1.15	1.30	1.60
50	0.55	0.70	0.85	1.00	1.15	1.35
70	0.45	0.55	0.70	0.82	0.95	1.10
100	0.40	0.45	0.55	0.67	0.75	0.90
180 or more	0.35	0.40	0.50	0.60	0.70	0.85

1. Data for east Washington County; data from CleanWater Services.

301.5.04 Unit Hydrograph Methods

To obtain a realistic and consistent hydrologic analysis for each development site, all developments shall use the hydrograph analysis method for drainage planning and design unless otherwise approved in advance by the City's authorized representative. The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume, and duration of the runoff hydrograph. The Santa Barbara Urban Hydrograph (SBUH) will be the primary acceptable unit hydrograph method.

a. **Design Storm:** Return frequency and duration specify the design storm event. The design storms shall be based on two parameters:

   1. Total rainfall (depth in inches).

   2. Rainfall distribution (dimensionless).

b. **Design Storm Distribution:** The total depth of rainfall for storms of 24-hour duration is shown in **Table 3.3.** The rainfall distribution to be used in the City is the design storm of 24-hour duration based on the standard National Resource Conservation Service (NRCS), formerly known as the Soil Conservation Service (SCS), type 1A rainfall distribution using **Table 3.4**.

TABLE 3.3. RAINFALL DISTRIBUTION

Recurrence Interval (years)	Total Precipitation Depth (inches)
2	2.50
5	3.00
10	3.45
25	3.90
50	4.25
100	4.50

TABLE 3.4. DESIGN STORM DISTRIBUTION CHART1

Hour	Percent Rainfall		Rainfall Depth (inches)					
			2-Year Storm	5-Year Storm	10-Year Storm	25-Year Storm	50-Year Storm	100-Year Storm
	Incremental	Cumulative	2.50	3.00	3.45	3.90	4.25	4.50
1	2.40	2.40	0.06	0.07	0.08	0.09	0.10	0.11
2	2.60	5.00	0.07	0.08	0.09	0.10	0.11	0.12
3	3.20	8.20	0.80	0.10	0.11	0.12	0.13	0.14
4	3.80	12.00	0.10	0.12	0.13	0.15	0.16	0.17
5	4.44	16.44	0.11	0.14	0.15	0.17	0.19	0.20
6	5.18	21.62	0.13	0.16	0.18	0.20	0.22	0.23
7	6.48	28.10	0.16	0.20	0.22	0.25	0.27	0.29
8	16.44	44.54	0.41	0.51	0.57	0.64	0.69	0.74
9	7.58	52.12	0.19	0.23	0.26	0.30	0.32	0.34
10	5.28	57.40	0.13	0.16	0.18	0.21	0.22	0.24
11	4.96	62.36	0.12	0.15	0.17	0.19	0.21	0.22
12	4.32	66.68	0.11	0.13	0.15	0.17	0.18	0.19
13	4.02	70.70	0.10	0.12	0.14	0.16	0.17	0.18
14	3.42	74.12	0.09	0.11	0.12	0.13	0.14	0.15
15	3.28	77.40	0.08	0.10	0.11	0.13	0.14	0.15
16	3.00	80.40	0.08	0.09	0.10	0.12	0.13	0.14
17	2.80	83.20	0.07	0.09	0.10	0.11	0.12	0.13
18	2.40	85.60	0.06	0.07	0.08	0.09	0.10	0.11
19	2.40	88.00	0.06	0.07	0.08	0.09	0.10	0.11
20	2.40	90.40	0.06	0.07	0.08	0.09	0.10	0.11
21	2.40	92.80	0.06	0.07	0.08	0.09	0.40	0.11
22	2.40	95.20	0.06	0.07	0.08	0.09	0.10	0.11
23	2.40	97.60	0.06	0.07	0.08	0.09	0.10	0.11
24	2.40	100.00	0.06	0.07	0.08	0.09	0.10	0.11

1. Source: *Subbasin Hydrologic Modeling Criteria*, Kramer, Chin, & Mayo, Inc. 1991.

c. **Runoff Parameters:** The physical drainage basin characteristics listed below shall be used to develop the runoff hydrograph.

1. **Area**

(a) To obtain the highest degree of accuracy in hydrograph analysis requires the proper selection of homogeneous basin areas. Significant differences in land use in a given basin must be addressed by dividing the basin area into subbasin areas of similar land use or runoff characteristics. Hydrographs shall be computed for each subbasin area and superimposed to form the total runoff hydrograph for the basin.

(b) All pervious and impervious areas within a given basin or subbasin shall be analyzed separately. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately, the cumulative errors associated with averaging these areas are avoided, and the true shape of the runoff hydrograph is better approximated.

2. **Selection of Curve Number**

(a) The NRCS has developed CN values based on soil type and land use. The combination of these two factors is called the "soil-cover complex." Storm water modeling shall be based on these NRCS CN values; alternate methods subject to approval by the City's authorized representative.

(b) Soil-cover complexes have been assigned to one of four hydrologic soil groups, according to their runoff characteristics. Soil hydrologic groups may be found on-line on the NRCS website.

(1) Many factors can affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.

(2) CN values can be area-weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas shall not be combined with low CN areas (unless the low CN areas are less than 15% of the subbasin).

(3) Antecedent soil moisture values shall be considered. Soil shall be considered to be saturated before the start of a precipitation event.

3. **NRCS Curve Number Equations**

(a) The rainfall-runoff equations of the NRCS curve number method relate a land area's runoff depth (precipitation excess) to the precipitation it receives and to its natural storage capacity, as follows:

$$Q_d = (P_R - 0.2S)^2 / (P_R + 0.8S), \text{ for } P_R > 0.2S$$

and

$Q_d = 0$, for $P_R < 0.2S$

where Q_d = runoff depth in inches over the area.

P_R = precipitation depth in inches over the area.

S = potential maximum natural detention/retention, in inches over the area, due to infiltration, storage, etc.

The area's potential maximum detention/retention, S, is related to its curve number, CN:

$$S = (1000/CN) - 10$$

The computed runoff represents inches over the tributary area. Therefore, the total volume of runoff is found by multiplying Q_d by the area (with necessary conversions):

Total runoff volume (cf) = Q_d (in) × A (ac) x 3,630 (ft^3/(ac-in))

(b) **Time of Concentration:** Time of concentration (T_c) is the time for runoff to travel from the hydraulically most distant point of the watershed to the point where the hydrograph is to be calculated. Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of T_c. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system. T_c influences the shape and peak of the runoff hydrograph.

(1) **Sheet Flow:** Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. For sheet flow up to 300 feet, use the kinematics solution below to directly compute T_t :

$$T_t = (0.93L^{0.6} \times n^{0.3}) / (I^{0.4} \times S^{0.3})$$

where T_t = travel time (minutes).

n = Manning's effective roughness coefficient for sheet flow.

L = flow length (feet).

I = rainfall intensity (inches per hour).

S = slope of hydraulic grade line (feet per foot [ft/ft])

Sheet flow shall not be used for distances over 300 feet.

(2) **Shallow Concentrated Flow:** For slopes less than 0.005 ft/ft (0.5%), the following equations can be used:

For unpaved surfaces: $V=16.1345\ (S)^{0.5}$

For paved surfaces: $V=20.3282\ (S)^{0.5}$

where V = velocity (feet per second)

S = slope (ft/ft).

(3) **Channel Flow:** A commonly used method of computing average velocity of flow, once it has measurable depth, is the following equation:

$$V = (1.486 / n) \times R^{0.6} \times S^{0.5}$$

where V = velocity (ft/s)
n = Manning's roughness coefficient.
S = slope of flow path (ft/ft)
R = area/perimeter.

301.6.00 CONSTRUCTED CHANNEL DESIGN STANDARDS

301.6.01 Application

This section applies to open channels constructed to convey runoff to the existing public stormwater and surface water conveyance system. For work in existing stream channels, applicant shall follow the recommendation and requirements set forth in ODFW's *Fish Passage Criteria,* or latest edition, or an equivalent study or guideline approved by the City's authorized representative. The applicant shall comply with all applicable requirements of the Army Corps of Engineers and Oregon Department of State Lands for construction activities that may impact wetlands or waterways. Development that regrades existing roadside ditches or constructs new roadside ditches shall meet applicable City codes and standards.

301.6.02 Channel Design

a. Open channels shall be designed and constructed to carry the 25-year design flow in accordance with Section 301.5.00, "Conveyance System Analysis and Design."

b. Manning's Roughness Coefficient ("n") shall generally comply with the ODOT "Hydraulics Manual."

c. Open channels shall be designed to prevent scouring of the channel and shall be sized to pass the required flows without causing erosion and have side slopes no steeper than 2H:1V.

d. Vegetation-lined channels shall be used whenever practicable, as determined by the City's authorized representative. Rock-lined channels shall be used only where a vegetative lining will not provide adequate protection from erosion. Channels shall be protected in accordance with Section 301.6.03, "Channel protection."

e. Where riprap protection is specified, riprap shall be placed over a woven geo-textile fabric.

f. Constructed open channels shall be sized to pass the required flows and have side slopes no steeper than 3H:1V. In areas where 3H:1V side slopes are impracticable because of existing natural features or other limitations obstructing the channel, the bank slope shall be no steeper than 2H:1V. Any proposed constructed channel

improvement that does not meet these requirements shall be piped, unless an exception is approved by the City's authorized representative.

g. The flow-line slope is generally dictated by the natural contours. The minimum flow-line slope is 1% where practicable, but in no case shall the design flow velocity be less than 2 fps except as approved by the City's authorized representative.

h. Banks shall be designed with a minimum 1 foot of freeboard above the design storm provided no structures are impacted by the design water surface elevation. The surface configuration at the top of bank should provide adequate accessibility for maintenance as determined by the City.

i. Roadside ditches shall be constructed in conformance with ODOT SSC Section 00330, "Earthwork." Normal maximum depth for open channels constructed adjacent to roadways shall be 2 feet.

j. No protruding pipes, culverts, utilities, or other structures will be allowed that reduce or hinder the flow characteristics of the channel. All pipe connections shall match side slopes, incorporate a headwall, and be designed with an energy dissipater device (see Sections 301.6.03, "Channel Protection," and 301.6.05, "Outfall Protection").

k. Bank Stabilization: Open channel designs shall be based on the minimum level or protection shown in **Table 3.5**.

    1. Open channel waterways shall be designed and constructed with temporary and permanent bank stabilization measures in all locations. Specialized bank stabilization shall be considered as follows:

        (a) Natural bank stabilization measures (i.e., slope pull-back, willow mats, rock barbs, or revegetation with localized native plant species) shall be used.

        (b) Areas of extreme curvature, changes in channel cross-section, or low-flow channels with design flow velocities exceeding 3 fps shall be designed and constructed with bank stabilization to consider additional potential for scouring from turbulent flows.

        (c) Post-construction bank stabilization shall minimize the potential for erosion or sedimentation.

        (d) In areas of waterway convergence or other points of disposal, bank stabilization shall meet these requirements.

301.6.03 Channel Protection

Open channels shall be designed to prevent long-term scouring of the channel. Where rip rap protection is specified, rip rap protection shall be placed over a filter fabric base or a minimum 6-inch thick gravel base. **Table 3.5** provides additional design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

TABLE 3.5. CHANNEL PROTECTION, NEW CHANNEL CONSTRUCTION

Velocity at Design Flow (fps)				
Greater than	**Less than or equal to**	**Required protection**	**Thickness (ft)**	**Minimum height above design water surface (ft)**
0	5	Vegetation lining	Not applicable	.05
5	8	Bioengineered lining[1] ODOT Class 50 riprap[2]	Not applicable 1.5	1.0
8	12	ODOT Class 200 riprap[2]	2.5	2.0
12	20	Slope mattress, etc.[3]	Varies	2.0
20		Engineer designed[3]		

[1]Bioengineered lining allowed for flows between 5 and 8 feet per second.
[2]ODOT riprap class in English units
[3]For high-velocity channels, engineering calculations are to be submitted to the City's authorized representative for review and approval.

301.6.04 Outfalls to Open Channel Waterways

The outlets of pipes and lined channels are points of critical erosion potential. Stormwater that is transported through man-made conveyance systems at design capacity generally reaches a velocity that exceeds the capacity of the receiving channel or area to resist erosion. To prevent scour at stormwater outlets, protect the outlet structure and minimize the potential for downstream erosion, a flow transition structure is needed to absorb the initial impact of flow and reduce the speed of the flow to a non-erosive velocity.

a. Outfalls to waterways may require ODSL and USACE permits. The applicant is responsible for obtaining necessary State and Federal permits and providing proof of approval to the City.

b. Direct outfalls greater than 4 inches in diameter to open channel waterways shall typically be designed by a licensed engineer. Outfalls shall be constructed to minimize the potential for erosion and other potential damage to the waterway banks. Outfall designs shall address erosion and scouring within the waterway upstream and downstream of the outfall structure.

c. Bank stabilization shall not reduce the carrying capacity of the water course. Bank stabilization designs shall consider the 25-year flow velocities of pipe outlets and 25-year flow velocities of open channel waterways. Where stones are placed within existing bank slopes, the bank shall typically be excavated a minimum of 18 inches or 1.5 times the size of the largest stone being used, whichever is greater

d. Flow from the outfall structure shall be directed downstream, typically no less than 30 degrees from perpendicular to the waterway flow.

e. Outfalls shall be located at a higher elevation than the downstream mean low water level. The mean low water level is defined as the average height of the low waters of a 10-year period. The area between the mean low water and the outfall discharge location shall be stabilized with material to dissipate energy.

f. Engineered energy dissipaters, including stilling basins, drop pools, hydraulic jump basins, baffled aprons, and bucket aprons, are required for outfalls with velocity at design flow greater than 10 fps. These shall be designed by a professional engineer using published references such as Hydraulic Design of Energy Dissipaters for Culverts and Channels (U.S. Department of Transportation, Federal Highway Administration) and other references. The construction plan submittal shall identify the design reference.

g. Outfalls shall be inter-planted with willow stakes or other approved plantings, every 2 feet on-center, to increase stability, reduce erosion, provide shading, and improve aesthetics. The direct flow path between the natural water body and the outfall shall be clear of trees.

301.6.05 Outfall Protection

Storm system outfalls shall be designed to prevent scouring at, or in association with, the outfall discharge and provide velocity reduction before discharge to the receiving channel. With hillside locations, storm pipes will be extended to the bottom of slope wherever possible and the energy dissipater installed at the end of pipe. Outfalls shall be at or just above the mean low water level unless an exception is approved by the City.

Engineered energy-dissipaters, including but not limited to, stilling basins, drop pools, and hydraulic jump basins shall be required for outfalls with design flow discharge velocities greater than 3 feet per second (fps). All outfalls shall be provided with a rock splash pad or other approved erosion control measure. **Table 3.6** provides design guidance for the design engineer; however, the design engineer is, as always, responsible for the final design.

TABLE 3.6. ROCK PROTECTION

Discharge Velocity at Design Flow (fps)	Required Protection (Minimum Dimension)				
	Type	Thickness[2]	Width	Length	Height
0 to 5	ODOT Class 50 riprap[1]	1.5 ft	Diameter + 6 ft	8 ft or 4 x diameter, whichever greater	Crown + 1 ft
5 to 10	ODOT Class 200 riprap[1]	2.5 ft	Diameter + 6 ft or 3 x diameter, whichever greater	12 ft or 4 x diameter, whichever greater	Crown + 1 ft
Greater than 10	Designed system[3]	As required	As required	As required	Crown + 1 ft

[1]ODOT riprap class in English units.

[2]Riprap shall be grouted in place (see Detail No. S-2225 or S-2275 of these standards). In environmentally sensitive areas a woven geo-textile fabric may be specified by the City.

[3]For high-velocity outfalls, engineering calculations are to be submitted to the City's authorized representative for review and approval.

301.7.00 CULVERT DESIGN STANDARDS

301.7.01 Application

a. Culverts provide for passage of water under or through obstructions placed across streams and drainageways. Culverts shall be designed to pass the required flows without compromising public safety or causing new or additional flooding.

b. For pipe systems or culverts that convey flows from a stream or through sensitive areas, a local representative of ODFW or other applicable state or federal agency shall be contacted to determine whether fish passage is required and to identify site-specific design criteria. Additionally, ODFW may require fish passage accommodations on any stream that has a history or the potential for fish production.

c. All culverts shall be designed for fish passage in accordance with ODFW's *Fish Passage Criteria,* or latest edition, unless otherwise exempted by ODFW and the City.

d. Culverts within Federal Emergency Management Agency (FEMA) floodplains shall be reviewed and approved by the local FEMA-designated floodplain permitting authority.

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

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

301.7.02 Hydraulic Design

Culverts shall be designed to safely pass the 100-year design storm flow.

301.7.03 Headwater

a. 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 City's authorized representative.

b. 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 City's authorized representative.

c. 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 subgrade

301.7.04 Inlet

The embankment around the culvert inlet shall be protected from erosion by lining around the inlet with rock, bioengineering, or other protection approved by the City's authorized representative. The lining shall extend upstream of the culvert a minimum of 10 feet, be designed to provide a smooth transition for water flow into the culvert, and shall be as high as the designed headwater elevation. Trash racks or debris barriers shall follow the design requirements of Section 301.8.09, "Trash Racks or Debris Barriers."

301.7.05 Outlets

The receiving channel of the outlet shall be protected from erosion by rock lining, bioengineering, or other energy dissipating devices (Section 301.6.03, "Channel Protection," and Section 301.6.05, "Outfall Protection") as approved by the City's authorized representative. Runoff exiting a development site shall be discharged with adequate energy dissipaters to prevent downstream damage.

301.7.06 Inlet Control Analysis

The headwater depth for pipes under inlet control shall be determined using the nomographs as provided in Detail No. S-2205 and S-2210 of these standards, the ODOT "Hydraulics Manual," or a modeling method consistent with FHWA's HY8 software.

301.7.07 Outlet Control Analysis

The headwater depth for pipes under outlet control shall be determined using the nomographs as provided in Detail No. S-2220 of these standards, the ODOT "Hydraulics Manual", or a modeling method consistent with FHWA's HY8 software.

301.7.08 Outfall Design Standards

a. Outfalls shall be above the mean low-water level, unless an exception is approved by the City's authorized representative. All outfalls shall be provided with a rock splash

pad or other approved erosion-control measure. Erosion protection at outfalls shall be designed in accordance with the guidelines in Section 301.6.05, "Outfall Protection," unless exceptions are approved by the City's authorized representative.

b. Mechanisms that reduce velocity before water discharges from an outfall are required. The dissipaters shall be designed using published references such as FHWA's "Hydraulic Design of Energy Dissipaters for Culverts and Channels," the ODOT "Hydraulics Manual", and others. Design references shall be cited in the construction plan submittal.

c. Non-erosive stormwater flow velocities shall be maintained for the entire overland flow from the energy dissipating device to the receiving public waterway. The City's authorized representative shall approve structures and/or methods to maintain non-erosive flow velocities prior to construction or installation.

301.8.00 STORM MANHOLE, PIPE AND CATCH BASIN DESIGN STANDARDS

The following design standards are intended only for the design of storm sewer improvements.

301.8.01 Manhole Design

a. Manholes shall be provided at least every 400 feet, unless otherwise approved by the City's authorized representative. Manholes shall be located at every grade change, change in pipe size, change in alignment, pipe connection greater than 6" in diameter, and at the end of main lines not to be extended in the future. Manhole lids shall be located as indicated in the street detail drawings of these standards unless an exception is approved by the City's authorized representative).

b. A shallow manhole with precast grooves shall be provided for manholes 4 feet deep from crown of pipe and less. The shallow manhole top shall consist of a short eccentric cone as shown in **Detail No. S-2025** of these standards. Where the short eccentric cone top is not feasible as determined by the City's authorized representative, a flat slab top may be permitted as shown in **Detail No. S-2030** of these standards..

c. Flat-top manholes shall be designed to be installed at an elevation to permit construction of the full street section, allowing for the design gradients; if this is not possible, additional construction measures may be required to prevent premature failure of the road surface.

d. Manholes shall be designed such that the manhole cover is flush with the surrounding grade in paved areas, set 1-foot above grade in landscape areas unless otherwise directed by the City's authorized representative.

e. Manhole grade rings shall be concrete, key-lock joint designed to withstand AASHTO H-20 loadings. Grade rings shall not exceed 12 inches in height.

f. The minimum manhole size shall be as follows:

1. 48-inch diameter manhole for pipe equal to or less than 24 inch diameter

2. 60-inch diameter manhole for pipe between 27-inch and 36-inch diameter

3. 72-inch diameter manhole for pipe equal to or greater than 42-inch diameter.

g. Suburban style manholes frames shall not be used in PCC streets.

h. There shall be a maximum of 4 pipes entering/exiting a manhole unless otherwise approved by City's authorized representative.

i. Detail(s) 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. The manufacturer or design engineer shall provide the City's authorized representative with supporting calculations, stamped by a Professional Engineer registered in the State of Oregon, documenting the structural integrity of the manhole.

j. A storm service lateral entering a manhole within a public conveyance system shall be designed so that the invert of the lateral is 6 inches above the invert of the outlet pipe and enters the manhole at an angle of 60 to 90 degrees from the mainline sewer.

k. Connections to an existing manhole, elevation of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted with the plans.

l. All precast manhole bases and sections shall be manufactured with smooth, clean openings at the design inlet and outlet points for the size of pipe specified. Manholes shall be core drilled to field adjust the design connection joints. Openings shall not be sawcut or broken out.

m. Where a connection is proposed to an existing manhole the connection shall be core drilled and elevations of the existing ledge, location of steps, and elevations of existing inlets and outlets shall be submitted as a detail on the plans.

n. A minimum of 8 inches shall separate connections, measured from the outside diameter of the core holes.

o. All manhole bases shall be properly channelized.

p. All manholes shall have inlets at a minimum 90-degree angle in relation to the outlet, as measured from the center of the manhole base.

q. The crowns of all incoming pipes shall be at least as high as the crown of the outgoing pipe.

r. Manholes shall have a minimum free drop of 0.20 feet. Any drop greater than 0.20 feet shall only be allowed when existing utilities or physical obstructions prevent a connection from being made within this specification as determined by the City's authorized representative. Where allowed, the maximum free-drop shall be 1.5 feet.

s. When the free-drop exceeds 1.5 feet an inside drop shall be installed in the manhole per Detail S-2041 of these standards. Outside drop manholes are not allowed.

t. An oversize curb inlet manhole as shown in Detail No. S-2090 of these standards may be used in lieu of a manhole, as required by Section 301.8.04, "Catch Basin Design", when approved as part of a flow-through system. Oversized gutter or curb and gutter catch basins will be allowed in lieu of manholes, with approval of the City's authorized representative.

u. Stormwater pretreatment manholes shall be installed where required and in conformance with Section 301.4.11, "Stormwater Pretreatment Manholes."

301.8.02 Storm Pipe Design

a. Manning's equation shall be used to calculate pipe capacity for the 25-year design storm, in accordance with Section 301.1.13 "Conveyance System Hydraulic Standards."

b. **Pipe size:** The design size shall be based on hydraulic calculations provided by the design engineer. The minimum diameter of public storm pipe is identified below:

1. Pipe from the catch basin to the mainline in the public right-of-way shall be nominal 10-inch-diameter pipe.

2. Mainline pipe shall be nominal 12-inch-diameter pipe.

3. Storm pipes located out of a public street right-of-way, with no reasonable need to be extended, and with roof drains or area drains connected, shall be a minimum 10-inch-diameter pipe.

c. **Materials:**

1. Generally, storm sewer mains and laterlas shall be Polyvinyl Chloride (PVC) pipe, ASTM D-303, SDR 35 or lower, unless otherwise recommended by the Engineer of Record and directed by the City's authorized representative.

2. Pipe materials shall conform to the specifications in Section 301.9.03.b, "Materials" unless otherwise approved by the City's authorized representative.

3. Pipe and fittings shall consist of one type of material throughout and no interchanging of pipe and fitting material is allowed.

d. **Location:** Storm sewers located within the public right-of-way shall generally be installed at or near the street centerline as indicated in the street detail drawings of these standards. All storm sewer locations shall be approved by the City's authorized representative. Storm drain inlets shall be designed as per Section 301.8.05, "Drain Inlet Design Standards".

e. **Easements:** Easements shall be provided as specified in Section 301.1.08, "Easements".

f. **Alignment:** Public storm pipe shall be laid on a straight alignment and at uniform grade. Where storm drains are located parallel with other utility pipe or conduit lines, the vertical and horizontal alignment should 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.

g. **Horizontal separation:** The minimum separation distance between parallel storm sewers and other utilities shall be 5 feet measured from the edge of each pipe.

h. **Vertical separation:** Utility crossings shall be constructed as near 90 degrees as practicable. Utility crossings of storm pipes with other utilities shall have a minimum 6 inches of vertical separation measured from the edge of each pipe.

i. **Curb Marking:** Newly constructed curbs or replaced curbs shall be stamped with the capitol letters "SD" on the outer edge of the gutter pan at the location of each storm lateral crossing. Letters shall be 3 inches in height and embossed a minimum of ⅛-inch deep.

j. **Locating Wire, Tape, and Marker:** Storm laterals and mains shall have tracer wire installed beside the pipe and plastic caution tape installed 1-foot above the pipe crown as shown in Detail No. S-2175 of these standards. Tracer wire shall be connected at all junctions, including service laterals, using a solderless connection kit suitable for direct burial that joins wires mechanically and electrically and seals out moisture, GelCap or approved equal. Tracer wire shall be 12-guage stranded or solid copper insulated High Molecular Weight Polyethylene (HMW-PE) with a white insultated cover a minimum 45 mil in thickness and the wire UL rated for 140°F. A 2 x 4 wood marker shall be installed at the end of the storm lateral extending from the invert of the pipe to 3 feet above the ground surface. The stake shall painted white in color to identify the storm lateral. Locating wire and tape shall be tied off to the 2 x 4 marker. A cleanout installed on the lateral located on the private side of the right-of-way boundary is an acceptable permanent marker.

k. **Grade:** Storm sewers shall be laid on a grade that maximizes the serviceable area to facilitate future extension of the storm sewer system as determined by the City's authorized representative. The maximum serviceable area shall be based on the future development within the contributing area as identified by the Wilsonville Stormwater Master Plan. The use of drop manholes in the design of new storm sewers shall be restricted as necessary to maximize the serviceable area.

   All storm lines shall have sufficient slope to maintain a minimum flow velocity of 3 feet per second when flowing full.

l. **Steep Slopes:** Where soil conditions warrant it, storm pipes on slopes in excess of 20% gradient shall be secured with approved anchor walls as shown in Detail No. S-2195 of these standards or other approved anchor systems as approved by the City's authorized representative. Spacing for anchors shall be as shown in **Table 3.7**.

TABLE 3.7. SECURING STORM SEWERS ON SLOPES

Minimum Anchor Spacing Storm Sewer Gradient >20%	
Grade (%)	**Center to Center (feet)**
<35	35
35-50	25
>50	15 (or concrete encasement)

m. **Pipe Cover:** All storm sewer pipes shall be laid at a depth sufficient to drain building storm sewers. Minimum pipe cover shall be in compliance with this section, unless an exception is approved by the City's authorized representative. In paved areas, pipe cover shall be measured from the finished grade to the upper surface of the pipe barrel; the pipe bell shall not intrude into the base rock. In areas without pavement, the pipe cover shall be measured from the finish grade to the upper surface of the pipe barrel. Minimum cover requirements are shown in **Table 3.8.**

TABLE 3.8. MINIMUM PIPE COVER

Type of Pipe	Cover (inches)
Other Pipe Materials	36
Nonreinforced	36
RCP Class III	36
RCP Class IV	24
RCP Class V	12
AWWA C-900	12
AWWA C-905	12
Ductile Iron	12

301.8.03 Storm Service Connection Laterals Design

The specifications contained herein, together with the Oregon Uniform Plumbing Code and all other requirements of Federal, State, and local law shall govern the installation of laterals.

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

b. Minimum diameter for storm service laterals shall be 6 inches.

c. Lateral connections to the mainline sewer on new construction work shall be done using manufactured tees installed at surveyed locations. Lateral connections to existing storm lines may be done using either saddle tees as per Section

401.4.02.b.5(a), or by using Inserta Tee® as per Section 401.4.02.b.5(c). Laterals shall be of same material as main.

d. Laterals connections to a manhole shall be in accordance with Section 301.8.03, "Storm Service Connection Laterals Design".

e. Laterals shall contain no bends from the mainline to the edge of right- of-way.

f. A minimum grade of 2% is required for service laterals, unless a lesser grade is approved by the City's authorized representative.

301.8.04 Catch Basin Design

Design of catch basins shall follow the specifications provided in Section 301.8.05, "Drain Inlet Design Standards."

a. **Standard Catch Basin System:** All catch basins shall be sumped. The main storm line shall not pass through any catch basins or sumped manholes unless approved by the City's authorized representative. No more than three catch basins may be connected in a series before connecting to the main storm line. A ditch inlet or field inlet may be connected directly to the end of the main storm line.

b. **Series Catch Basin System:** Unsumped catch basins are allowed, provided that a sumped manhole is constructed below the unsumped catch basins before the flow enters the main storm line. No more than three unsumped catch basins may be constructed above a water quality or stormwater pretreatment manhole. The main storm line may not pass through the catch basins or sumped manholes. No ditch inlet or field inlet may be part of a series of unsumped catch basins.

c. **Flow-through Catch Basin System:** This system is allowed within an arterial or collector road, provided that the mainline storm pipe has a design velocity of at least 3 feet per second. Unsumped catch basins, ditch inlets, and field inlets are allowed to connect directly to the main storm line. An adequately sized water quality manhole is required at the downstream end of the flow-through system.

301.8.05 Drain Inlet Design Standards

All curb inlets and catch basins shall be designed to accept a 10-year storm event. Grates shall be designed, as far as practical, to avoid failure due to accumulation of debris.

a. Design Criteria

1. The following sources shall be used to locate catch basins and inlets:

(a) ODOT "Hydraulics Manual."

(b) Hydraulic Engineering Circular 12 (Federal Highway Administration, FHWA-84-202), "Drainage of Highway Pavements."

2. Precast and poured-in-place-catch basins and curb inlets are allowed.

3. All curb inlets shall be constructed with an 18-inch minimum sump unless they are part of a series or a flow-through curb inlet system, and approved by the City's authorized representative.

4. A main storm line shall not pass through a sumped curb inlet.

5. Avoid placing curb inlets along curb radius at street intersections. Grated catch basin inlets shall not be placed in front of ADA access ramps.

6. Spacing of curb inlets shall be determined by the capacity of each to pass a 10-year storm event. In addition, curb inlets shall be installed just before the upstream curb radius at all intersections.

7. Curb inlets, except for CG-48, shall be a maximum depth of 6 feet from the top of grate to the flowline of the lowest pipe invert. When depth from top of grate to flowline is greater than 5 feet, curb inlets shall be oversized and have steps installed.

8. Between the inlet and the mainline or mainline structure, the maximum length of pipeline shall be 40 feet for 10-inch pipe and 60 feet for 12-inch pipe, unless additional length is required to cross the street right-of-way.

9. Tee connections may be used in street right-of-way only with approval of the City's authorized representative. The lateral shall be no larger than 50% the diameter of the main line, unless otherwise approved by the City's authorized representative. The connecting curb inlet shall be oversized.

b. Area Drains and Ditch Inlets

1. The standard area drain shall be as shown in Detail No. S-2105 or S-2110 and S-2115 of these standards, and the ditch inlet shall be as shown in Detail No. S-2120 and S-2125 of these standards, unless an exception is approved by the City's authorized representative.

2. Area drains in rear or sideyards shall not be sumped. Ditch inlets shall be equipped with an 18-inch sump unless the inlets are part of a flow-through system.

3. A main storm line shall not pass through an area drain or a ditch inlet.

4. Area drains or ditch inlets may be located at the upper terminus of a main storm line, may connect to the main storm line at a manhole, or may connect to the main storm line through a tee when the lateral is no larger than 50% of the diameter of the main line.

5. The maximum acceptable intake flow rates for area drains and ditch inlets with a grate angle of 30 degrees are shown in **Table 3.9** 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 3.9.. MAXIMUM INTAKE FLOW RATES

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

301.8.06 Distance Between Structures

The maximum distance between structures, such as manholes, area drains, and catch basins, but excluding cleanouts, for 10-inch and larger pipe shall be 400 feet.

301.8.07 Access

Access roads are for maintenance and inspection purposes. All-weather access shall be provided to every manhole. Access roads shall be constructed as per Section 301.04.10, "Access Road."

301.8.08 Headwalls and Endwalls

Pipe 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 stabilize a slope. Details of all headwalls and end protection shall be included in the construction drawings.

301.8.09 Trash Racks or Debris Barriers

Trash racks or debris barriers are required by the City on inlets for pipe or culvert systems greater than 18 inches in diameter. The design engineer shall submit the trash rack/debris barrier system design to the City's authorized representative for approval.

301.9.00 MATERIAL AND TECHNICAL SPECIFICATIONS

301.9.01 Manholes and Structures

a. **General**

Manholes shall be constructed at locations shown on the plans and in compliance with the design requirements of Section 301.8.01, "Manhole Design", or as required by the City's authorized representative.

b. **Materials**

1. **Aggregate and Cement:** Aggregate shall meet the standards set forth in ODOT SSC Section 02690, "PCC Aggregates"; Portland cement shall meet the standards set forth in ODOT SSC Section 02010, "Portland Cement."

2. **Concrete:** PCC for poured in place manholes and structures shall conform to ODOT Class 3000 – 1½, Commercial Grade Concrete. Slump shall be between 2 and 4 inches.

3. **Manhole Frames and Covers:**

   (a) Casting shall be of new material, tough, close-grained gray iron conforming to ASTM A-48, Class 30B and AASHTO M 105, Class 30B. Where the ASTM and AASHTO specifications differ, the more stringent shall apply. Castings shall be smooth and clean, free of blisters, blowholes, and all defects. Bearing surfaces shall be planed or ground to ensure flat, true surfaces. Covers shall be true and set within rings at all points.

   (b) Rings shall be grouted in place and made watertight with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. Rings shall not be brought to grade with lumber.

   (c) Frames and covers shall be standard or suburban, depending on the manhole location and as approved by the City's authorized representative. Suburban style manhole frames shall not be installed in PCC streets or arterial roadways.

   (d) Manholes installed outside of paved street or sidewalk areas shall be installed with a tamperproof frame and cover as shown in Detail No. S-2060 of these standards.

4. **Manhole Types:** Manholes shall conform to the following.

   (a) **Precast 48-Inch-Diameter Manholes:** Materials shall conform to the requirements of ASTM C-478. Minimum wall thickness shall be 5 inches.

   (b) **Precast Large-Diameter (60-inch or larger) Manholes:** Materials shall conform to the requirements of ASTM C-478. The manufacturer or design engineer shall submit supporting calculations, stamped by a Professional Engineer registered in the State of Oregon, documenting the structural integrity of the manhole.

   (c) **Precast Manhole Tops:** Standard eccentric cone, short eccentric cone, and flat slab tops shall be provided in accordance with Section 301.8.01, "Manhole Design." Eccentric cones shall conform to all requirements of ASTM C-478, with the exception of the steel reinforcement requirement. Precast manhole tops shall be designed to withstand AASHTO H-20 loadings.

   (d) **Permeability Testing:** Before precast manhole sections of any size are delivered to the job site, the sections shall meet the permeability test requirements of ASTM C-14 and ASTM C-497.

   (e) **Precast Bases:** Precast manhole bases shall be used, except when placing a manhole over existing pipe. Precast bases shall conform to the requirements of ASTM C-478. The base riser section shall be integral with the base slab.

(f) **Poured-in-place Bases:** Poured-in-place manhole bases may only be used when placing a manhole over an existing pipe.

5. **Manhole Pipe Connectors:** Connections to manholes shall be made with an approved flexible connector specifically manufactured for the intended use, conforming to ASTM C923, and in accordance with Detail No. S-2005 of these standards. Field fabricated waterstops or improvised adapters, such as gaskets stretched over the pipe, will not be allowed.

   Connections to existing manholes may be made with a sand collar fabricated of the same material as the connecting pipe by an approved manufacturer in accordance with Detail No. S-2005 of these standards. Sand collars shall be constructed with a gasketed joint located within 12" or half the pipe diameter, whichever is greaer, from the manhole wall. Sand collars shall not be fabricated in the field.

6. **Pipe Stubouts for Future Sewer Connections:** Pipe stubouts shall be the same type as approved for use in the lateral, main, or trunk sewer construction. Strength classifications shall be the same class as in adjacent trenches. Where two or more different classes of pipe exist at a manhole, the City's authorized representative shall determine the strength classification. Connect stubouts to manholes as specified in Section 301.8.01.d.2, "Connection to Existing Manholes." Rubber-gasketed, watertight plugs shall be furnished with each stubout and shall be adequately braced against air test pressures.

7. **Gaskets:** Manhole sections shall be installed with either preformed rubber gaskets or preformed flexible joint sealant or plastic gaskets. Rubber gaskets shall conform to AASHTO M 315 and ASTM C-443. Preformed flexible joint sealant and plastic gaskets shall meet all requirements of AASHTO M 198 and ASTM C-990.

8. **Manhole Steps**: Steps shall be required and shall be constructed as specified and shown in Detail No. S-2080 of these standards, unless otherwise approved by the City's authorized representative. When pipe is 24 inches in diameter or smaller, steps shall be located as indicated in Detail No. S-2065 of these standards. For pipe larger than 24 inches in diameter, steps shall be located over a bench as coordinated with the City's authorized representative.

c. **Workmanship**

1. **Foundation Stabilization:** If, in the opinion of the geotechnical engineer or the City's authorized representative, unstable subgrade material exists that will not support the manhole or other structure, the contractor shall excavate below grade and backfill with foundation-stabilization material in accordance with the standards of Section 601.3.02.d, "Trench Foundation."

2. **Pipe Connections:** All rigid pipes, such as concrete, entering or leaving the manhole shall be provided with flexible joints within 1 foot or half the pipe diameter, whichever is greater, of the manhole structure and shall be placed on firmly compacted bedding. All flexible pipe, such as PVC, shall connect to manholes using connectors as specified in Section 301.8.01.b.5, "Manhole Pipe

Connectors." Special care shall be taken to see that the openings through which pipes enter the structure are completely watertight.

3. **Flexible Joints:** At rigid pipe connections, such as concrete,, where a flexible joint cannot be provided within the greater of 1 foot or half the pipe diameter from the manhole, a 6-inch concrete encasement shall be constructed around the entire pipe, from the manhole base to within 1 foot of the pipe joint, at the discretion of the City's authorized representative. The pipe encasement shall be constructed integrally with the manhole base. Pipes laid out of the manhole shall be shortened to ensure that the first flexible joint is no more than 1 foot from the manhole base.

4. **Manhole Connections:** The contractor shall connect sewer pipe to manholes as specified in Section 301.9.01.d, "Types of Connections."

5. **Concrete Bases (Poured-in-Place):** Poured-in-place bases shall be used over existing pipelines in accordance with Detail No. S-2010 of these standards for 48" diameter manholes. For manholes greater than 48" in diameter, poured-in-place bases shall be provided in accordance with Detail No. S-2045 of these standards. The contractor shall remove water from the excavated area, place the compacted aggregate base, construct the concrete base, and set the first precast manhole section before the concrete has set. The first precast manhole section shall be properly located and plumb and have a uniform bearing throughout the full circumference. The contractor shall deposit sufficient concrete on the base to assure a watertight seal between base and manhole wall. Twenty-four hours shall be allowed to elapse before the remaining manhole sections are placed on the base, unless otherwise approved by the City's authorized representative. Where poured-in-place concrete bases are used to construct manholes over existing storm lines, comply with Section 301.9.01.d.3, "Manholes Over Existing Sewers."

6. **Drop Manholes**

   (a) The maximum free drop in a manhole shall be 18 inches. See Section 301.9.01.d.4, "Shallow Inside Drop Manhole," for construction of this connection.

   (b) When more than 18 inches feet of drop exists, a drop manhole shall be provided in accordance with Section 301.8.01, "Manhole Design."

7. **Placing Manhole Section:** The contractor shall clean the end of each sections of foreign material. Manholes shall be installed with either watertight rubber O-rings, preformed flexible joint sealant or preformed plastic gaskets per Section 301.9.01.b.7, "Gaskets" and in conformance with the manufacturers' recommendations. If plastic gaskets are used, the inside seams shall be grouted with a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal. Unused grout shall be discarded after 20 minutes and shall not be used. All grouted joints and pick holes shall be troweled smooth. Manholes will be visually inspected for water leakage by the City's authorized representative. Any leakage observed shall be repaired at the contractor's expense, and the manhole re-inspected.

8. **Manhole Inverts:** The contractor shall construct manhole inverts in conformance with Detail No. S-2005 or Detail No. S-2010 of these standards. Inverts shall have smooth transitions to ensure an unobstructed flow through the manhole. The contractor shall remove all sharp edges or rough sections that tend to obstruct flow.

9. **Manhole Stubouts:** The contractor shall install stubouts from manholes for sewer extensions, as shown in these standards or as required by the City's authorized representative. A watertight flexible connection shall be provided in all new manholes. The contractor shall construct invert channels in accordance with Detail No. S-2005 or Detail No. S-2010 of these standards. The minimum length of stubouts in existing manholes shall be 12 inches outside the manhole wall. Pipes shall be grouted in precast walls or the manhole base to create a watertight seal around the pipes. The contractor shall add compacted base rock, as specified in these standards, over undisturbed earth under all stubouts.

10. **Manhole Extensions, Rings, and Covers:** The contractor shall install rings and covers on top of manholes to positively prevent all infiltration of surface water or groundwater into manholes. Rings shall be set in a bed of high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, with the grout carried over the flange of the ring, and shall be set so that tops of covers are flush with the surface of the adjoining pavement, or 1 foot above natural ground, unless otherwise directed by the City's authorized representative. Unused grout shall be discarded after 20 minutes and shall not be used. Grouted surfaces shall be troweled smooth. Total thickness of grade rings shall not exceed 12 inches; rings shall be grouted watertight. Drop from rim to first manhole step shall not exceed 27 inches. In designated floodplain areas, all manholes shall be at an elevation of at least 2 feet greater than the 100-year storm event.

d. **Types of Connections**

1. **Connections to New Manholes:** The contractor shall connect storm sewers to new manholes at the locations shown on the plans. All pipes entering or exiting the manhole shall be water tight. Connection shall be done using a rubberized, core-seal boot. The connection shall be grouted smooth on both the interior and exterior of the manhole..

2. **Connection to Existing Manholes:** The contractor shall connect storm sewers to existing manholes at the locations shown on the plans. Contractor shall submit a plan for diversion control and receive written approval from the City's authorized representative before proceeding with construction. The contractor shall provide all diversion facilities, and shall perform all work necessary to maintain sewage flow in existing sewers while connections are being made to the manholes. Connections to existing manholes shall be core-drilled, and the bases shall be grouted as necessary to allow a smooth flow into and through the existing manholes.

3. **Manholes Over Existing Sewers:**

   (a) The contractor shall construct manholes over existing operating storm sewer lines at the locations shown on the plans.

   (b) Manholes constructed over existing storm sewers shall have all portions of the pipe to be in contact with the manhole cleaned and:

      (1) Concrete Pipe Connections: An approved commercial concrete bonding agent shall be applied to the pipe prior to placement of concrete.

      (2) PVC Pipe Connections: A dense coating of clean mortar sand shall be applied to the pipe using PVC solvent cement. After the cement has cured, an approved commercial concrete bonding agent shall be applied to the sand prior to placement of concrete. Water as a substitute for commercial bonding agent will not be allowed.

   (c) The contractor shall construct a poured-in place base under the existing sewer and the precast sections as specified.

   (d) The contractor shall not cut into any existing lines until the new manhole(s) are grouted and the new lines are balled, cleaned, and deflection tested and all portions of the storm line have been approved and accepted by the City's authorized representative.

   (e) After acceptance, the contractor shall sawcut into the existing line; cut edges of concrete pipe shall be covered with grout and troweled smooth; with ductile iron or plastic pipe, grout shall be applied up to cutout and troweled smooth.

4. **Shallow Inside Drop Manhole:** Where the invert of the connecting pipe is above the manhole shelf and less that 18 inches above the outlet, an inside drop shall be constructed utilizing Portland cement concrete. The stormwater entering the manhole shall follow a smooth concrete channel transitioning evenly from the invert of the inlet pipe into the main channel. Stormwater shall not be allowed to fall freely to the manhole base.

301.9.02 Catch Basins and Inlets

a. Materials

1. Aggregate, Cement, and Concrete: These materials shall meet the requirements of Section 301.9.01.b, "Manholes and Structures, Materials."

2. Frames, Grates, and Covers: All materials shall be flat bar steel (standard grade), cast iron or ductile iron complying with the requirements of ASTM A-36, A-663, or A-709.

3. Forms: All exterior surfaces shall be formed with steel or plywood. Other surfaces shall be formed with matched boards, plywood, or other approved material. Trench walls, rock, or earth will not be acceptable as form material.

4. Metal Reinforcement: All metal reinforcement shall conform to the requirements of ASTM A-615, Grade 60, deformed bars.

5. Precast Concrete Units: All precast units shall conform to the same requirements as manholes (ASTM C-478).

b. Workmanship

1. Excavation and backfill shall conform to the requirements of Section 301.9.01.c, "Workmanship."

2. **Bedding:** The contractor shall remove all water and debris from the excavation area, and shall install an 8-inch-minimum layer of compacted ¾"-0" crushed aggregate for a base.

3. **Cast-in-Place:** Cast-in-place catch basins shall have a minimum of 6 inches of concrete between the compacted crushed aggregate and the lowest invert. The forms used for cast-in-place catch basins shall be tight and well-braced. The storm pipe material shall extend into the poured concrete of the catch basin. All corners shall be chamfered. Immediately after placement, the concrete shall be consolidated with an approved vibrator. The top surface shall be screed, and exposed surfaces shall be troweled to a smooth finish, free from marks or irregularities. After forms are removed, the contractor shall patch any defects in the concrete with approved material.

4. **Precast:** After the base is prepared, the contractor shall set the precast catch basin to the proper line and grade. The storm pipe material being used shall connect to the precast catch basin.

5. **Inverts, Stubouts, and Sections:** Contractor shall clean the ends of all pipes and sections that contact the catch basin. All inverts, stubouts, and sections shall be installed according to Detail No. S-2085, S-2090, S-2095, or S-2120 of these standards, using a high-strength, non-shrink grout meeting ODOT SSC Section 02440.50(b), "Non-Shrink Grout," such as Alcrete Twenty Minute Fast Setting Grout®, or approved equal, making sure all sharp edges or rough sections are removed, to prevent obstruction of the flow. Unused grout shall be discarded after 20 minutes and shall not be used.

6. **Catch Basin Steps:** All catch basins deeper than 5 feet, measured from the top of the frame to the flowline, shall be oversized and have steps.

301.9.03 Stormwater Pipe and Fittings

a. General

1. It is not intended that the materials listed herein are to be considered equal or to be generally interchangeable for all applications. The material suitable for project conditions shall be determined by the Engineer of Record and approved by the City's authorized representative.

2. The materials used shall be adequate to carry anticipated dead and live loads within the deflection limits specified by the manufacturer. All pipe and culverts

shall have a minimum design service life of 75 years. Joints shall be gasketed, unless otherwise approved by the City's authorized representative.

3. Each piece of pipe and fitting shall be clearly identified as to strength, class, and date of manufacture.

b. Materials

Storm sewer pipe installed by open trenching shall have a minimum pipe stiffness at 5% deflection of at least 45 psi. Materials shall be the following types or approved equal:

1. **Reinforced Concrete Pipe**

(a) Reinforced concrete, nonpressure pipe shall conform to the requirements of ASTM C-76 and shall be of the class specified. Unless otherwise specified, pipe shall meet the design requirements of Wall B.

(b) Gaskets shall conform to the requirements of ASTM C-443.

(c) All steam-cured concrete pipe must be at least seven days old before it can be used. If the pipe has not been steam-cured, it must not be used before it has cured for 28 days.

(d) Fittings shall be manufactured integrally and be of a class at least equal to that of the adjacent pipe. Field taps shall be machine-drilled.

(e) Mortar used shall be standard nonshrink premixed mortar conforming to ASTM C-387 or in a proportion of one part Type II Portland cement to two parts clean, well-graded sand that will pass a ⅛-inch screen. Mortar mixed for longer than 30 minutes shall not be used.

2. **Ductile Iron Pipe (D.I.P.)**

(a) Ductile iron pipe shall be cement mortar lined with push-on joints conforming to the requirements of AWWA C-151/ANSI A21.51 and AWWA C-104/ANSI A21.4. The minimum thickness class shall be Class 50 (up through 12-inch diameter pipe) and Class 51 (for 14-inch diameter and larger pipe).

(b) Fittings shall be mechanical or push-on and be of a class at least equal to that of the adjacent pipe. Mechanical joint ductile iron fittings shall conform to AWWA C-110/ANSI A21.10. Push-on joint fittings shall be gray iron, with body thickness and radii of curvature conforming to ANSI A-21.10. Rubber gasket joints shall conform to AWWA C-111/ANSI A-21.11.

3. **Polyvinyl Chloride Pipe (PVC)**

(a) PVC pipe and fittings shall conform to ASTM D-3034 (SDR 35 or lower) and ASTM F-679. Where added pipe strength is required, PVC pipe shall conform to AWWA C-900and AWWA C-905.

(b) A2000 (PVC): All A2000 PVC pipe and fittings shall conform to ASTM F-949 specifications.

(c) PVC rib: PVC rib pipe and fittings shall be made of PVC, as defined in ASTM D-1784. The pipe stiffness shall correspond with the series, in accordance with ASTM D-2412. Series 46 and 28 are allowed. Gaskets shall conform to ASTM F-477.

4. **Corrugated polyethylene (CPP):** Corrugated polyethylene pipe, double wall, and fittings shall be made of polyethylene compounds that conform with the physical requirements of Type III, Category 3, 4 or 5, P23, P33, P34, Class C, with the applicable requirements defined in ASTM D-1248. CPP installed by open trenching shall have minimum pipe stiffness at 5% deflection of at least 45 psi. Spiral pipe is not acceptable. Corrugated polyethylene pipe shall conform to AASHTO M-294 specifications.

5. **Fittings**

(a) General

(1) Manufactured tee fittings shall be provided in the sewer main for side sewers. Fittings shall be of sufficient strength to withstand all handling and load stresses encountered.

(2) Fittings shall be of the same materials as the pipe. Material joining the fittings shall be of the same material as the pipe.

(3) Material joining the fittings to the pipe shall be free from cracks and shall adhere tightly to each joining surface.

(4) All fittings shall be capped or plugged, and shall be gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout lug. The plug shall be able to withstand all test pressures without leaking. When later removed, the plug shall permit continuation of piping with jointing similar to joints in the installed line.

(b) Mechanical Couplings: Mechanical couplings shall be wrought steel. Installation procedures must meet the manufacturers' recommendations.

6. **Line Tap Saddle**

All saddles approved for sanitary sewer tap installation (see Section 401.4.02.b.5) shall be allowed on storm taps, and as follows:

(a) DFW/HPI saddle—an elastomeric polyvinyl chloride saddle with steel-reinforced edges and stainless-steel bands, series 300. This saddle is allowed on PVC, clay, IPS, concrete, asbestos cement, and PE pipe.

(b) Saddles installed on corrugated aluminum pipe shall be fabricated and installed using stainless-steel nuts and bolts. Bolts and nuts shall conform to AWWA C-111/ANSI A21.11.

c. Workmanship

1. **Line and Grade**

(a) Survey control hubs for both line and grade shall be provided by the design engineer in accordance with Section 301.1.15, "Surveying."

(b) Variance from the established line and grade shall not be greater than ¼ inch for grade and ½ inch for line, provided that such variation does not result in a level or reverse-sloping invert.

(c) The contractor shall check line and grade as necessary. If the limits prescribed in these standards are not met, the work shall be immediately stopped, the City's authorized representative notified, and the cause remedied before proceeding with the work.

(d) Variation in the invert elevation between adjoining ends of pipe, due to nonconcentricity of joining surface and pipe interior surfaces, shall not exceed 1/64 per inch of pipe diameter, or ½ inch maximum.

2. **Pipe Handling**

(a) The contractor shall unload pipe only by approved means. Pipe shall not be unloaded by dropping it to the ground and pipe shall not be dropped or dumped into trenches.

(b) Pipe shall not be unloaded or stored within the public right-of-way unless approved by the City's authorized representative.

(c) The contractor shall inspect all pipe and fittings before lowering them into trenches to ensure that no cracked, broken, or otherwise defective materials are used.

(d) The contractor shall clean the ends of pipe thoroughly, remove foreign matter and dirt from inside the pipe, and keep it clean during laying and joining.

(e) The contractor shall lower the pipe into the trench in such a manner as to avoid any physical damage to the pipe.

(f) The contractor shall remove all damaged pipe from the job site.

3. **Foreign Material**

(a) The contractor shall take all necessary precautions to prevent excavated or other foreign material from entering the pipe during the laying operation.

(b) At all times, when laying operations are not in progress, the contractor shall use a mechanical plug at the open end of the last laid section of pipe to prevent entry of foreign material or creep of the gasketed joints.

4. **Pipe Laying**

(a) Trench excavation shall be in accordance with Section 6, "Trench Excavation and Backfill."

(b) Pipe laying shall proceed upgrade, with the spigot ends pointing in the direction of flow.

(c) After a section of pipe is lowered into the prepared trench, the contractor shall clean the end of the pipe to be joined, the inside of the joint, and the rubber ring (if required) immediately before joining the pipe.

(d) At the location of each joint, dig bell (joint) holes of ample dimensions in the bottom of the trench and at the sides, where necessary, to permit the joint to be made properly.

(e) The joint shall be assembled according to the recommendations of the manufacturer. The contractor shall provide all special tools and appliances required for the joint assembly. The contractor shall take care to properly align the pipe before forced entirely home.

(f) Upon completion of pipe laying all pipe joints shall be in the "home" position, which is defined as the position where the least gap (if any) exists, when the pipe components that comprise the joint are fitted together as tightly as the approved joint design will permit. Gaps at pipe joints shall not exceed that allowed by the manufacturer's recommendations.

(g) Joints that exceed the manufacturers allowed gap shall be repaired as required by the City's authorized representative at no cost to the City. Where 3 or more joint gaps between two structures exceed that recommended by the manufacturer, then all pipe from the first gap to the structure shall be properly re-laid at the Contractor's sole expense.

(h) After the joint is made, the pipe shall be checked for alignment and grade.

(i) The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.

(j) After installation, the contractor shall backfill the trench to the extent necessary to prevent pipe movement from any cause including uplift or floating. Upon inspection and approval by the City's authorized representative, the contractor shall complete backfill of the trench.

(k) Do not lay pipe in water or when, in the opinion of the City's authorized representative, trench conditions are unsuitable.

5. **Movable Shield:** When pipe is laid in a movable trench shield, the contractor shall take all necessary precautions to prevent the pipe joints from pulling apart when the shield is moved ahead. The bottom of the shield shall not extend below the springline of the pipe without recompacting the pipe zone.

6. **Cutting Pipe:** When cutting or machining the pipe is necessary, the contractor shall use only the tools and methods recommended by the pipe manufacturer and approved by the City's authorized representative. The contractor shall cut ductile

iron pipe using a method approved by the City's authorized representative; all burrs or rough edges shall be removed before joining pipe. The contractor shall not flame-cut the pipe.

7. **Transition Fittings:** When joining different types of pipes, the contractor shall use approved ridged fittings. Where ridged fittings are not available, flexible fittings with No. 305 stainless steel bands, such as Fernco, Caulder, or approved equal, may be considered upon approval of the City's authorized representative. Flexible fittings may require additional support under the coupling. Bell type couplings are considered flexible.

   (a) Shear ring/ridge transition couplings meeting ASTM C-564 or equal shall be used.

   (b) PVC couplers or adapters shall meet the specifications for ASTM D-3034, SDR 35 pipe fittings.

   (c) Ductile iron transition couplings shall be manufactured from ductile iron conforming to ASTM A-536, grade 65-45-12, for center and end rings. Rubber gaskets, bolts, and nuts shall conform to AWWA C-111/ANSI A21.11.

8. **Concrete Closure Collars**

   (a) The contractor shall pour closure collars against undisturbed earth, remove all water from the excavation, and construct suitable forms to obtain shapes that will provide full bearing surfaces against undisturbed earth, as indicated in Detail No. S-2190 of these standards.

   (b) Closure collars shall be used only when approved by the City's authorized representative, and then only to make connections between dissimilar pipe or where standard rubber-gasketed joints are impractical.

   (c) Before the closure collars are installed, the contractor shall wash the pipe to remove all loose material and soil from the surface where they will be placed.

9. **Trench Backfill:** The contractor shall place trench backfil in accordance with Section 6, "Trench Excavation and Backfill."

10. **Storm Sewer Laterals and Tees**

    (a) Lateral storm sewers shall be connected to new storm sewer mains with manufactured tee fittings per Section 301.9.03.b.5, "Fittings", except where storm sewer laterals are larger than 50% of the diameter of the main line. Such storm laterals shall be connected to the main line through the installation of a manhole. Line taps in new storm sewer mains are not permitted.

    (b) Install storm sewer laterals and tee fittings in accordance with Detail No. S-2175 of these standards.

    (c) Lateral pipe and fittings shall consist of one type of material throughout and no interchanging of pipe and fitting material is allowed.

11. **Line Taps**

(a) Line taps are allowed on existing storm sewer lines only and shall be core-drilled unless otherwise approved by the City's authorized representative. Core-drilled holes shall be made using a cylinder-style hole saw for plastic pipe material only, or a diamond core bit for concrete and ductile iron pipes.

(b) Line tap connections to storm lines shall be located a minimum 12" from the storm mainline pipe bell.

(c) PVC tee saddles shall be installed in accordance with Detail No. S-2155 of these standards. Inserta Tee® shall be installed in accordance with Detail No. S-2160 of these standards.

(d) Line taps shall be centered on the spring line of the pipe being tapped.

(e) The area around the line tap installation site shall be cleaned and free of all rough edges before installing the fittings.

(f) While installing the connection, no rock, dirt, or debris shall be allowed to enter the main sewer line from the core hole.

(g) The contractor shall install ¾"-0" crushed aggregate in the pipe zone around the line tap, from 6 inches below the pipe to 12 inches above the pipe.

(h) Laterals shall have tracer wire installed beside the pipe and plastic caution tape installed 1-foot above the pipe crown as shown in Detail No. S-2175 of these standards.

301.10.00 CONSTRUCTION SPECIFICATIONS

301.10.01 General Provisions

The specifications outlined here, together with the standards established by the Oregon DEQ, the U.S. Environmental Protection Agency, and any other applicable requirements of the City, shall govern the character and quality of material, equipment, installation, and construction procedures for gravity-flow portions of public storm systems.

301.10.02.1 Scheduling

a. The contractor shall plan their construction work in conformance with Section 101.8.02, "Scheduling."

b. Newly installed storm sewer lines shall not be placed in service until necessary testing is complete and system has been approved by the City's authorized representative.

301.10.03 Environmental Protection, Erosion Prevention, and Sediment Control

The contractor shall take all appropriate measures and precautions to minimize the work's impact on the environment and shall control erosion, as outlined in Section 101.9.00, "Environmental Protection, Erosion Prevention, and Sediment Control."

301.10.04 Interferences and Obstructions

Various obstructions may be encountered during the course of the work. The contractor shall follow the guidelines established in Section 101.8.05, "Interferences, Obstructions, and Abandoned Utilities."

301.10.05.1 Abandon Storm Facilities

a. **Storm Sewer Pipe:** Storm sewer pipe facilities to be abandoned shall be cut off and completely removed at 48-inches minimum below finish grade, unless specifically stated otherwise. Storm sewer pipe to be abandoned shall be removed or completely filled with a flowable, Controlled Low-Strength Material (CLSM) as directed by the City's authorized representative.

b. **Manholes:** Manholes to be abandoned shall have manhole frame, cover, grade rings, cone section or flat slab top removed and manhole sections cut and removed at 48-inches minimum below finish grade, unless specifically stated otherwise. The manhole base shall be rubblized or perforated to prevent the entrapment of water. The remaining portion of manhole shall be backfilled with Class B material in accordance with Section 6, "Trench Excavation and Backfill."

301.10.06 Contaminated Soil or Hazardous Material

If during construction contaminated soil or hazardous materials or chemicals are encountered, the Contractor shall follow the procedures specified in Section 101.9.02, "Contaminated Soils or Hazardous Materials."

301.10.07 Trench Excavation, Preparation, and Backfill

Trench excavation, preparation, and backfill shall conform to the requirements of Section 6, "Trench Excavation and Backfill."

301.10.08 Preservation, Restoration, and Cleanup

a. **Cleanup:** Cleanup of all construction debris, excess excavation, and excess materials and complete restoration of all fences, mailboxes, ditches, culverts, signposts, and similar items shall be completed according to Section 101.8.16, "Preservation, Restoration, and Cleanup."

b. **Preservation of Drainage Ditches:** After backfilling the trenches, the contractor shall restore all public and private storm drain ditches that were destroyed, damaged, or otherwise modified during construction to the condition of the ditch before construction. Ditches shall be built in their original locations unless otherwise redesigned as part of the project.

301.10.09 Bores

a. General

The carrier pipe in all bores shall be installed inside a steel case, unless otherwise approved by the City's authorized representative (see Detail No. S-2165 of these standards).

b. Installation

1. **Casing:** The casing shall be smooth steel of a size to permit proper construction to the required line and grade. The steel casing shall be fabricated in sections for field-welded joints. The casing wall thickness shall be a minimum of ¼ inch for pipe diameters of 6 to 12 inches and shall be a minimum of 5/16 inch for pipe diameters of 15 to 24 inches, or in accordance with the requirements of the jurisdiction of the right-of-way.

2. **Pipe Supports:** The sewer pipe shall be continuously supported on three sides by pipe supports, except at joints. Pipe supports shall be No. 2 HDPE plastic block, or approved equal. Strapping and hardware shall be stainless steel.

3. **Placing Fill in Casing:** The annular space shall be completely filled between the casing and pipe with lean grout or sand to prevent pipe flotation.

4. **Concrete Seals and Fill:** After the storm pipe is tested and approved, concrete plugs shall be poured at each end of the casing. The annular space between the casing and pipe shall be completely filled with lean grout or sand to prevent pipe flotation.

c. Railroad Crossings

Prior to beginning any under-track work, applicant shall obtain proper permit(s) from ODOT or present owner of railroad line and written approval of plans from user(s) of railroad line. Install the pipe by tunneling, jacking, boring or similar methods, approved by the Railroad. Install the pipe to the lines and grades established and backfill completely all voids around the installation with specified material, to the satisfaction of the railroad.

301.11.00 FLOOD MANAGEMENT

301.11.01 Purpose

The purpose of these standards is to reduce the risk of flooding, prevent or reduce the risk to human life and property, and maintain the functions and values of floodplains, such as allowing for the storage and conveyance of stream flows through existing and natural flood conveyance systems.

301.11.02 Flood Management Areas

Flood management areas shall include, but are not limited to, the following:

a. Land identified within the 100-year floodplain and floodway, as shown on the Federal Emergency Management Agency (FEMA) flood insurance maps.

b. Land identified in updated flood studies or any other authoritative data documenting flood elevations, as approved by the City. The design engineer shall use the most recent and technically accurate information available to determine flood areas.

301.11.03 Flood Plain Delineation

In areas of the City where the 100-yr flood plain has not been defined as per Section 301.11.02, "Flood Management Areas," the City Engineer may require a study to delineate the 100-yr flood plain prior to development of a site to access the potential impact to upstream or downstream properties.

301.11.04 Design Criteria

Design and construction of improvements within the 100-yr flood plain shall be in conformance with these Standards, Section 4.172, "Flood Plain Regulations" of the Wilsonville City Code, and all applicable federal, state, and local statutes and rules governing floodplains and flood hazard areas.

a. All fill placed in a floodplain shall be balanced with an equal amount of removed soil material and shall not decrease the floodplain storage capacity at any stage of a flood (2-, 10-, 25-, or 100-year event). No net fill in any floodplain is allowed except when *all* of the following conditions are met:

   1. When an area has received special protection from floodplain improvement projects that lower the floodplain or otherwise protect affected properties.

   2. Where the exceptions comply with adopted master plans, watershed management plans, or subbasin plans, if any.

   3. When all required permits and approvals have been obtained in compliance with FEMA rules and other local, state, and federal laws regarding fill in floodplains.

b. Large areas may not be excavated to gain a small amount of fill in a floodplain. Excavation areas shall not exceed the fill areas by more than 50% of the square footage, unless approved by the City's authorized representative.

c. Any excavation dug below the winter low-water elevation shall not count toward compensating for fill, because those areas would be full of water in the winter and not available to hold stormwater after a rain. Winter low-water elevation is defined as the water surface elevation during the winter when it has not rained for at least three days, and the flows resulting from storms have receded. The elevation can be determined from records, studies, or field observation. Any fill placed above the 100-year floodplain will not count toward the fill volume.

d. The excavated area must be designed to drain if it is an area identified to be dry in the summer, e.g., if it is used for a park or mowed in the summer. Excavated areas identified to remain wet in the summer, such as a constructed wetland, shall be designed not to drain. For areas that are to drain, the lowest elevation shall be at least

6 inches above the winter low-water elevation, and sloped to drain. Slopes of 1% will be allowed in areas of less than 1,000 square feet.

e. Excavation to balance a fill shall be on the same parcel as the fill unless it is not reasonable or practicable to do so. In such cases, the excavation shall be in the same drainage basin, within points of constriction on the conveyance system, if any, as near as practical to the fill site, and shall be constructed as a part of the same development project.

f. Temporary fills permitted during construction shall be removed at the completion of construction and before the close of the in-stream work window, as defined by the ODFW or federal, state, or other local authority.

g. Excavation and fill required for the construction of detention/retention facilities or other facilities, such as levees, shall be specifically designed to reduce or mitigate flood impacts. Levees shall not be used to create vacant buildable land.

h. Excavation and fill required to restore or enhance floodplains, riparian areas, wetlands, uplands, and streams, including but not limited to the planting of vegetation and daylighting of existing storm pipes, shall be permitted as long as the design complies with applicable federal, state, and local standards.

i. The floodplain may not be modified to increase water velocities such that streambank erosion will be increased, unless the streambanks are protected to prevent the increased erosion.

j. Uncontained areas of hazardous materials, as defined by the Oregon DEQ, are prohibited in flood management areas.

k. Any proposed work within, or modification to, a floodway must be certified by a Professional Engineer registered in the State of Oregon as to how it conforms to these standards and FEMA regulations.

l. For streams, creeks, rivers, and other watercourses where the floodway has not been identified, the entire floodplain shall be treated as a floodway unless a study has been prepared by a Professional Engineer registered in the State of Oregon and approved by the City's authorized representative to define the floodway limits for a stream section.

301.12.00 SOURCE CONTROLS

301.12.01 Applicability

Some site characteristics and 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 this section. The site characteristics and uses in this section have been identified as potential sources for 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 source controls for managing these pollutants at their source.

Stormwater discharge benchmarks for pollutants exist in National Pollutant Discharge Elimination System (NPDES) industrial stormwater 1200-Z permits issued by the Oregon Department of Environmental Quality (ODEQ) 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 (OAR) 340 Division 041 for discharges to surface waters.

These source controls apply to all development, including new development, redevelopment, tenant improvements, or those existing sites proposing new off-site discharges. With tenant improvements, only those areas of a structure or activity area that are being disturbed under the permit are required to make the structural changes identified in this section. With new off-site discharges, only those proposed areas draining off-site will be subject to these regulations.

The requirements of this section are in addition to the applicable requirements as identified in these standards. Development sites discharging to storm and sanitary sewers are required to provide pollution reduction and flow control for stormwater in accordance with the standards.

Applicants may propose alternatives to the source controls identified in this section in accordance with Section 301.1.03 "Alternative Design and Construction Standards". Requests for alternative source control or alternative design elements will require an additional review process and may delay issuance of related site development, building and/or plumbing permits.

Note: Developments which have existing or proposed off-site stormwater BMP facilities are not exempt from the source control requirements of this section.

301.12.02 Goals and Objectives for Source Control

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

a. Prevent stormwater pollution by eliminating pathways that may introduce pollutants into stormwater.

b. Protect soil, groundwater, and surface water by capturing pollutants and reducing impacts to the environment.

c. Permit the wastewater discharges and areas with the potential for relatively consistent wastewater discharges (such as vehicle washing facilities) to the sanitary sewer system. Excluding non-contaminated stormwater runoff.

d. 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.

e. Safely contain spills on-site, avoiding preventable discharges to any storm sewers, sanitary and/or drainageways.

f. Emphasize structural BMP controls over operational procedures. Structural BMP 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.

301.12.03 Signage Requirements

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

a. Signs shall be located and plainly visible from all activity areas. More than one sign may be needed to accommodate larger activity areas. Signs shall be water-resistant. They shall include the following information:

    1. Safety precautions
    2. Immediate spill response procedures—for example: "Turn the valve located at..." or "Use absorbent materials".
    3. Emergency contact(s) and telephone number(s).

b. Signs may need to be in more than one language if required to effectively communicate with employees and delivery personnel.

c. Any applicable spill response supplies need to be clearly marked and located where the signage is posted and near the high-risk activity area. More than one spill response kit may be necessary to accommodate larger activity areas.

d. Signage requirements for specific activities are noted in applicable sections.

301.12.04 Request for Alternative Method of Source Control

In accordance with Section 301.1.03, applicants may request an alternative method of source control by notifying the City's authorized representative.

The City's authorized representative will check the submitted information for completeness and make a final determination about the request.

301.12.05 Additional Requirements

Conformance with this section's requirements does not relieve the applicant of other applicable local, state, or federal regulatory or permit requirements. This section is intended to complement any additional requirements, and is not expected to conflict with, exclude, or replace those requirements. In case of a conflict, the most stringent local, state, or federal regulations generally apply. Any conflict will be resolved by the City's authorized representative in consultation with appropriate agencies. Some of the more common additional requirements that may apply are summarized below:

a. Spill response supplies, such as absorbent material, containment booms, and protective clothing, shall be available at all potential spill areas. Employees shall be familiar with the site's operations and maintenance plan; spill prevention, containment and countermeasure (SPCC) plan; and/or proper spill cleanup procedures.

b. Some facilities may be required to obtain an NPDES Industrial Stormwater General Permit 1200-Z before discharging to the City's storm sewer system or to waters of the state. Applicants may also be required to obtain an Industrial Wastewater Discharge Permit 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. The applicant shall obtain approval from the City's authorized representative prior to discharge of any substance into the public/private storm or sanitary sewer system.

c. An evaluation will be done during the stormwater management plan review process to determine if source control and/or discharge permit(s) are required. If a NPDES discharge permit is required, the permit application process will be independent of the stormwater management plan review/approval process. However, the stormwater management plan may have to be revised to accommodate industrial permitting compliance requirements (e.g., submittal of a Non-Residential form and/or NPDES Discharge Permit Application form, sampling points, pretreatment facilities, and monitoring sites). Please note that a change in site activity and/or discharges could trigger source control, NPDES discharge and other related permitting requirements in the future.

d. The requirements presented in this section do not exclude or replace the requirements of other applicable codes or regulations, such as the hazardous substances storage requirements of articles 79 and 80 of the Oregon State Fire Code; the SPCC regulations of 40 CFR 112 (EPA); the Resource Conservation and Recovery Act (RCRA); Willamette Basin Total Maximum Daily Load (TMDL) Programs regulated by ODEQ; or any other applicable local, state, or federal regulations or permit requirements.

301.12.06 Public Sanitary Sewer Discharge Permit

Connection/discharge to the public sanitary sewer system requires prior approval by the Public Works Director.

301.12.07 Fuel Dispensing Facilities and Surrounding Traffic Areas

a. Applicability

The requirements in this section apply to all development where vehicles, equipment, or fuel tanks are refueled on the premises; whether a large-sized 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.

The discharge or point of connection to the public system shall be authorized and permitted by the City. Discharges of hydrocarbons are prohibited to the public sanitary and storm sewer systems. When a containment or storage device is utilized the owner or responsible person shall contact the City's authorized representative and

Public Works Director for authorization to open any valve and discharge to a public sanitary or stormwater sewer system.

b. Requirements

1. **Cover:** The fuel dispensing area shall be covered with a permanent canopy, roof, or awning 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.

   (a) 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.

   (b) 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.

2. **Pavement:** A paved fueling pad of asphalt or 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 7 feet from the edge of the fueling pad.

3. **Drainage:** The paved area beneath the cover shall be hydraulically isolated from the surrounding area through grading, berms, or drains. This will prevent uncontaminated stormwater from running onto the area and carrying pollutants away. Drainage from the hydraulically isolated area shall be directed to an authorized pretreatment facility. Surrounding runoff shall be directed away from the hydraulically isolated fueling pad to a stormwater disposal point that meets all stormwater management requirements of this manual and other applicable code requirements.

4. **Signage:** Signage shall be provided at the fuel dispensing area and shall be plainly visible from all fueling activity areas. Detailed signage information is located in Section 301.12.03, “Signage Requirements”.

5. Pretreatment – Coalescing Oil water separator

   (a) An oil/water separator with a coalescing plate shall be installed in the catchment area. The purpose of the device is to treat runoff from the cleaning of the fueling area and prevent small spills from entering the public sanitary sewer system.

   (b) Coalescing plate separators shall be designed to achieve 100-parts per million (pmm) non-polar oil and grease 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. Use of surfactants or emulsifying agents shall be prohibited.

(c) Standard flow from a 5/8-inch hose is estimated to be 10 gallons per minute (gpm).

(d) For specially designed washing units, check the vendor specifications for maximum flow rates. 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 manufacture specifications and have a maintenance plan reviewed and approved by the City.

6. Spill Control Manholes

A spill control manhole shall be installed on the discharge line of the fueling pad before the public sanitary sewer line tie-in. The tee section shall extend 18 inches below the outlet elevation, and 60 cubic feet of dead storage volume shall be provided below the outlet elevation for storage of oil, grease, and solids. The manhole shall be located on private property. A shut-off valve is required prior to discharge to the public sanitary sewer system and shall be in the closed position at all times with a clear visible way to verify that it is closed. Any discharge to the public sanitary sewer system will need approval from the City.

7. Shut-Off Valves

Shut off valves are required to protect sewer systems from spill risks that present a danger for widespread contamination, system damages, or risk to the public health.

Shut-off valves with a clear visible way to verify that it is closed are required for any of the following situations:

(a) Site or activity areas are exposed to corrosives or oxidizers that can harm conveyance system components (such as, but not limited to, battery acid).

(b) 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 conveyance and disposal systems, causing widespread impacts and difficult cleanup situations.

(c) Substances that are known to infiltrate through soils and contaminate groundwater.

(d) 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.

(e) 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 with a clear visible way to verify that it is closed, and opened only to allow incidental drainage activities that do not pose a threat or risk to the disposal point system. Any discharge to the public sanitary sewer system will need to be approved by the Public Works Director. The valve shall be closed immediately after drainage activities are completed.

(f) Shut-off valves shall be located on private property and downstream of the exposed area's collection system. All valves shall be installed and maintained as per manufacturer's recommendations with a clear visible way to verify that it is closed. For more information about shut-off valves and associated valve boxes, contact the City's authorized representative.

8. Additional Fuel Dispensing Facilities Requirements

(a) Information shall be submitted as part of the stormwater management plan submittals to facilitate tracking of spill control manhole and shut-off valve installations.

(b) Installation, alterations, or removal of above-ground fuel tanks larger than 55 gallons, and any related equipment, are subject to additional building permit requirements. For technical questions and permitting, contact the City's authorized representative.

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

(a) Secondary containment equal to 110% of the product's largest container or 10% of the total volume of product stored, whichever is larger.

(b) 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 to control disposal. Any discharge to the public sanitary sewer system will need to be approved by the Public Works Director. If no public sanitary sewer is available, drainage shall be directed to a temporary holding facility for proper disposal and may require a water pollution control facility (WPCF) permit from the Water Quality Division of ODEQ.

(c) An impervious floor within all containment areas. Floors shall be sealed to prevent spills from contaminating the groundwater.

(d) Truck loading and off-loading areas. These areas shall follow cover, pavement, drainage, spill control, and shut-off valve requirements identified for fuel dispensing facilities.

(e) Shut-off valves should be installed for the drainage of the tank yard. The valves shall be installed downstream of the drainage system of the primary containment area and kept closed with a clear visible way to verify that it is closed. Valves installed for the drainage of the truck pad and sub-bermed containment areas shall be installed on the sanitary waste line downstream of the spill control manhole. Any discharge to the public sanitary sewer system will need to be approved by the Public Works Director.

(f) Approval of a batch discharge from the City is required before draining a containment area. This approval will determine appropriate disposal methods, identify pretreatment requirements (if applicable), and approval of the discharge. Pretreatment may be required for oil and grease removal, and testing may be required at the owner's expense to establish the specific characteristics of the discharge. Contact the City's authorized representative to request authorization for batch discharge.

(g) 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.

10. Exceptions

The requirement to cover the fuel dispensing area can be appealed if the fuel dispensing area is generally used to service oversized equipment (e.g., cranes) that cannot maneuver under a roof or canopy. In accordance with Section 301.1.03, information shall be submitted as part of the building permit application to evaluate exception qualifications.

(a) Propane tanks are exempt from the requirements of this section.

(b) Existing fueling areas are not required to install source controls identified in this section if the scope of work is limited to the following:

(1) A new canopy installation over an existing fuel pad that is not being upgraded.

(2) An underground tank replacement for compliance with state regulations.

(3) The replacement of a fuel pump on an existing fuel pad that is not being upgraded.

(c) If any improvements are made to the fueling activity area and/or pad, such as regrading or surface replacement, retrofits are required to comply with all fueling activity source controls identified in this section.

301.12.08 Above-Ground Storage of Liquid Materials

a. Applicability

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

b. Requirements

1. Containment

(a) 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 receiving system. A containment device and/or structure for accidental spills shall have enough capacity to capture a minimum of 110% of the product's largest container, or 10% of the total volume of product stored, whichever is larger.

(b) Double-walled containers are generally exempt from these spill containment requirements.

(c) Quantity thresholds of products that are generally exempt from these spill containment measures are:

(1) Janitorial and cleaning supplies of less than 100 pounds net weight or 15 gallons net volume. These supplies shall be packaged for consumer use in containers of five gallons or less or having a net weight of less than 30 pounds per container. This does not include cleaners or solvents used for cleaning machinery or motor vehicle and machine parts.

(2) Office and stationary supplies less than 100 pounds net weight. These supplies shall be packaged for consumer use in containers sized less than 5 gallons in size or 30 pounds in weight.

2. Cover

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

(1) 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.

(2) 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.

3. Pavement

A paved storage area is required unless otherwise approved by the City's authorized representative. The storage area shall be paved with asphalt or concrete and shall meet all applicable building code requirements. Sizing of the paved areas shall be adequate to cover the area intended for storage. In accordance with Section 301.1.03, the applicant shall clearly identify any requested alternative method.

4. Drainage

All paved storage areas shall be hydraulically isolated through grading, berms, or drains to prevent uncontaminated stormwater run-on to a storage area.

(a) 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 public sanitary sewer or authorized pretreatment facility.

(b) Uncovered storage areas with containment: Water will accumulate in uncovered storage areas during and after rain. Any contaminated water shall 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.

(c) All discharges to the public sanitary sewer shall be, at a minimum, considered batch discharges and require approval by the Public Works Director and pretreatment and testing at the expense of the owner prior to discharge. In some cases, 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 public sanitary sewer or storm sewer. 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 City's authorized representative.

5. Signage

   Signage shall be provided at the liquid storage area and shall be plainly visible from all surrounding activity areas. Detailed information is located in Section 301.12.03, "Signage Requirements".

6. Additional Requirements

   (a) Information shall be submitted as part of the building permit application to facilitate tracking of containment and shut-off valve installations.

   (b) A shut-off valve with a clear visible way to verify that it is closed may be required for the covered storage area if the applicant elects to install drainage facilities to an approved public sanitary sewer connection. The City will make this determination based on the type of material stored and the proposed system receiving the discharge.

   (c) 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). Any discharge to the public sanitary sewer system will need to be approved by the Public Works Director. Except when excess stormwater is being discharged, the valve shall always be kept closed with a clear visible way to verify that it is closed so any spills within the activity area can be effectively contained.

(d) Tank farms shall follow the criteria established for bulk fuel terminals in Section 301.12.07, "Fuel Dispensing Facilities and Surrounding Traffic Areas". 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.

(e) 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 City permit requirements, or state and federal laws pertaining to water quality. Contact the City's authorized representative for further information and requirements.

301.12.09 Solid Waste Storage Areas, Containers, and Trash Compactors

a. Applicability

The requirements in this section apply to all commercial and industrial development with facilities that store 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 containers include compactors, barrels, dumpsters, and garbage cans.

Requirements of this section also apply to activity areas used to collect and store refuse or recyclable materials, such as can or bottle return stations, grease containers, and debris collection areas.

This section applies to multi-family residential sites of three 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 the temporary storage of wood pallets or cardboard.

b. Requirements: The following design requirements apply for approval of solid waste storage and handling activity areas in the City.

2. Pavement

A paved waste storage area is required when a structural cover or trash compactor is used. The area shall be paved with asphalt or concrete and meet all applicable building code requirements. Sizing of the paved area shall adequately cover the activity area intended for refuse storage, or the trash compactor(s) and associated equipment.

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.

301.12.10 Exterior Storage of Bulk Materials

a. Applicability

1. 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 three categories, based on risk assessments for each material stored: high-risk, low-risk, and exempt. These include, but are not limited to, the following general types of materials:

TABLE 3.13 EXTERIOR STORAGE BULK MATERIALS

High-Risk Materials	Low-Risk Materials	Exempt Materials
• Recycling materials with potential effluent • 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 • Lime/lye/soda ash • Animal/human wastes	• Recycling materials without potential effluent • Scrap or salvage goods • Metal • Sawdust/bark chips • Sand/dirt/soil (including contaminated soil piles) • Material by-products without potential effluent • Unwashed gravel/rock • Compost • Asphalt	• Washed gravel/rock • Finished lumber • Rubber and plastic products (hoses, gaskets, pipe, etc.) • Clean concrete products (blocks, pipe, etc.) • Glass products (new, non-recycled) • Inert products

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

   (a) Have no measurable solubility or mobility in water and no hazardous, toxic, or flammable properties.

   (b) Exist in a gaseous form at ambient temperature.

   (c) Are contained in a manner that prevents contact with stormwater (excluding pesticides and fertilizers).

b. Requirements

1. Pavement

   (a) Low-risk material storage areas are not required to be paved.

   (b) High-risk material storage areas shall be paved beneath the structural cover. Sizing of the paved area shall adequately cover the activity area intended for storage.

2. Drainage

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

   (b) 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 run-on of uncontaminated stormwater into the storage area and migration of 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 plans.

   (c) 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.

3. Additional Requirements

   (a) Information shall be submitted as part of the stormwater management plan/building permit application to facilitate tracking of containment, sampling manholes, and shut-off valve installations.

   (b) 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.

   (c) 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 or if an alternative source control is proposed. The City's authorized representative will review for applicability of this requirement.

   (d) Signage shall be provided at the storage area if 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. Detailed information and examples are provided in Section 301.12.03, Signage Requirements".

   (e) A shut-off valve with a clear visible way to verify that it is closed may be required if the applicant elects to install drainage facilities to an approved public sanitary sewer. The City's authorized representative will make this determination based on the type of material stored and the proposed system receiving the discharge.

301.12.11 Material Transfer Areas/Loading Docks

a. Applicability

1. 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).

2. 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:

   (a) The area is designed (size, width, etc.) to accommodate a truck or trailer being backed up to or into it, and

   (b) The area is expected to be used specifically to receive or distribute materials to and from trucks or trailers.

3. 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. Examples of domestic uses include 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 City's authorized representative for help in determining if requirements apply.

b. Requirements

1. Pavement

   A paved material transfer area of 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.

2. Isolation

   (a) 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.

   (b) 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.

   (c) 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.

4. Signage

   Signage shall be provided at the material transfer area and shall be plainly visible from all surrounding activity areas. Detailed information is located in Section 301.12.03, "Signage Requirements".

5. Additional Requirements

   (a) Information shall be submitted as part of the building permit application to facilitate tracking of shut-off valve installations.

   (b) 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 stormwater management plan at the time of the building permit application, and shall be painted at the facility with bright or fluorescent floor paint.

   (c) A shut-off valve with a clear visible way to verify that it is closed may be required for the sanitary drainage facilities of the material transfer area. The City's authorized representative will make this determination, based on the type of material being transferred and the proposed system receiving the discharge.

   (d) Shut-off valves are required to protect the public sanitary sewer and drainage way systems from spills of chemicals and other constituents that may provide a danger of widespread contamination, system damage, or risk to public health.

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

      (1) Site activity areas that are exposed to corrosives or oxidizers that can harm conveyance system components (such as battery acid).

      (2) 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.

      (3) Substances that are known to infiltrate through soils and contaminate groundwater.

   (f) 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.

   (g) Prior to transfer activities of harmful substances, the valves shall be closed with a clear visible way to verify that it is closed and reopened only after the transfer is complete. The shut-off valves shall be located on private property and downstream of the exposed area's collection system.

(h) All valves shall be installed and maintained in accordance with manufacturer specifications. For more information about shut-off valves and associated valve boxes, contact the City's authorized representative.

301.12.12 Equipment and/or Vehicle Washing Facilities

a. Applicability

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

b. Requirements

1. Cover

(a) 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 stormwater disposal point that meets all applicable code requirements.

(1) 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.

(2) 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.

2. Pavement

A paved wash pad of asphalt or concrete shall be 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.

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 an approved public sanitary sewer or authorized pretreatment facility. If connected to the public sanitary sewer, Wilsonville City Code requires that equipment and/or vehicle washing facilities shall be equipped with a water recycling system approved by the Public Works Director. Best available technology shall be utilized for the pretreatment system of any drainage to the public sanitary sewer system. For further questions, contact the City's authorized representative. Surrounding runoff shall be directed away from the hydraulically isolated washing pad to a stormwater disposal point that meets all applicable requirements of this section.

4. Oil Controls

Wilsonville City Code requires that equipment and/or vehicle washing facilities shall be equipped with a water recycling system approved by the Public Works Director. Best available technology shall be utilized for the pretreatment system of any drainage to the public sanitary sewer 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 City's authorized representative.

(a) Washing Areas Protected with a Cover or Located Inside a Structure.

(1) 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.

(2) Coalescing plate separators shall be designed to achieve 100-ppm non-polar oil and grease 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. Standard flow from a 5/8-inch hose is estimated to be 10 gpm. For specially designed washing units, check the vendor specifications for maximum flow rates.

(b) Any pumping devices shall be installed downstream of the separator to prevent oil emulsification.

(c) 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.

(d) All separators shall be maintained per the manufacture specifications and City approved maintenance plan.

(e) Wilsonville City Code requires that equipment and/or vehicle washing facilities shall be equipped with a water recycling system approved by the Public Works Director. Best available technology shall be utilized for the pretreatment system of any drainage to the public sanitary sewer system.

301.12.13 Land with Suspected or Known Contamination

a. Applicability

1. 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 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 pollutant throughout this manual, this section refers to pollutants as contaminants and/or contamination.

2. Because of local, state, and federal regulations, special handling and management of site 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 and may delay issuance of related stormwater management plans and building permit approvals. Applicants are advised to contact the City's authorized representative early on in the plan design process (before plan submittal) if they are aware or suspect the site has contaminants or is adjacent to a contaminated site.

3. To research contaminant information, refer to ODEQ's Environmental Cleanup Site Information (ECSI) database, which can be found at: **http://www.deq.state.or.us/lq/ecsi/ecsi.htm**

   (a) If records indicate there is a potential of contamination on the site the applicant shall contact ODEQ prior to pre- and post-construction activities to ensure conditions of record are not violated. For technical questions related to site contamination and clean-up, contact the Land Quality Division of ODEQ.

   (b) All regulatory divisions or departments of ODEQ referenced in this section can be reached by calling ODEQ's Northwest Region Portland Office.

   (c) If a Phase 1 ODEQ Site Assessment was required the report shall be submitted to the City for review.

   (d) If contamination is discovered subsequent to stormwater management plan approval the owner shall immediately take steps to protect health and safety, and contact the City and ODEQ. Plan approval is suspended until the contamination is resolved.

4. 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:

   (a) Excavation and stockpiling of contaminated soils (soil management)

   (b) 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 conveyance systems.

b. Requirements

1. Stormwater discharges from sites suspected of contamination, whether proposed as a temporary construction connection or as permanent connection to any public storm or sanitary sewer system, will require a special authorization from the City's authorized representative. After reviewing the proposal and a characterization of the contaminants from the site, the City may make one of the following decisions:

(a) Approve discharges to the public storm and/or sanitary sewer system with restrictions such as described in this section or as is necessary given the nature of the discharge.

(b) Require the applicant to obtain an NPDES permit from ODEQ for the anticipated discharge prior to connection to a public system.

(c) Require that the applicant become part of the City's Industrial Pretreatment Program.

(d) Deny the request to discharge to the public storm and/or sanitary sewer system.

(e) Allow unrestricted connection to the public storm and/or sanitary sewer system, with a testing point for future monitoring.

2. 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.

3. Soil Management

(a) Stockpiles of contaminated soils shall be covered with temporary plastic film or sheeting to prevent stormwater from coming into contact with them.

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

(c) 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.

4. Construction Dewatering

(a) All construction dewatering discharges resulting from groundwater or precipitation (rainfall) will be evaluated for contamination before disposal methods can be approved.

(b) Laboratory analysis reports will be required, as defined in this section.

(c) A temporary sampling point may be necessary. The temporary sampling point will be agreed upon between the City's authorized representative and the applicant.

(d) Source control requirements will be identified as part of the review process of the laboratory analysis reports and the proposed stormwater management. Source controls, sampling points, and the disposal point shall be identified on the erosion control plan of the within the proposed stormwater management.

(e) If on-site infiltration is the proposed method for disposal, authorizations are required from the City and the Land Quality Division of ODEQ. Private

infiltration systems for construction dewatering shall be located and maintained on private property, outside the public rights-of-way.

(f) If a public sanitary system is the proposed method of disposal, authorizations are required from the City's authorized representative, and will be allowed only if extensive pretreatment is implemented and the discharge is approved by the City. All groundwater and surface water discharges to the public sanitary sewer system shall be approved by the Public Works Director and shall meet local discharge limits and will be subject to discharge volume charges.

(g) 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 City, NPDES Discharge Permit or other state and federal regulations for the receiving surface water.

(h) If a receiving stream is the proposed method for disposal, authorizations are required from the City, and the Land Quality and Water Quality Divisions of ODEQ.

(i) For technical assistance on obtaining a batch discharge approval for construction dewatering activities, contact the City's authorized representative.

5. Post-Construction Surface Drainage Systems

All discharges from sites with suspected or known contamination shall identify an appropriate stormwater disposal location and obtain discharge permits from the appropriate agencies.

(a) If on-site infiltration is the proposed method for disposal, authorizations are required from the City and the Land Quality Division of ODEQ. Private infiltration systems shall be located and maintained on private property, outside the public rights-of-way.

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

i. (c) If an off-site public storm or sanitary sewer system is the proposed method for disposal**,** authorization is required from the City. A permanent monitoring point may be required to ensure compliance with local discharge regulations. If monitoring is necessary, a permanent structure (such as a sampling manhole or flow-through vault) shall be installed on the discharge line of the subsurface drainage system.

301.12.14 Covered Vehicle Parking Areas

a. Applicability

The requirements in this section apply to all development with a covered vehicle parking area, except single-family and duplex residential sites. Existing parking structures are not required to retrofit unless the structure is being redeveloped. New parking structures are required to meet these requirements.

b. Requirements

1. Top Floor Drainage of a Multi-Level Parking Structure: Stormwater runoff from the top floor shall be directed to a stormwater disposal point that meets all water quality requirements of these Standards and any other applicable code requirements.

2. 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 an approved public sanitary sewer system. Prior to discharge all applicable pretreatment requirements shall be met.

3. Adjacent, Uncovered Portions of the Site: The surrounding uncovered portions of the site shall be designed so stormwater does not enter the covered parking areas. This can be accomplished through grading or drains.

c. Exceptions

Single-level covers (canopies, overhangs, and carports) are exempt from the requirements of this section.

301.12.15 Industrial and Commercial High Traffic Areas

a. Applicability

The requirements in this section apply to all new development with vehicle parking areas for developments zoned industrial or commercial with high traffic volumes.

b. Requirements

Industrial and Commercial Activities with an Average Daily count Trip (ADT) of 100 vehicles per 1,000 square feet of gross building area are required to provide additional pretreatment as specified below.

1. Paved traffic areas with a drainage area of over 10,000 square feet directed to a permanent pretreatment facility shall have adequate pretreatment for petroleum products prior to discharging to the stormwater BMP treatment facility. Parking areas of over 10,000 square feet that are broken up into drainage areas of less than 10,000 square feet do not require this pretreatment unless they fall into other categories described in this section or the Standards.

2. An oil/water separator with a coalescing plate shall be installed between the drainage in catchment and the stormwater BMP treatment facility. The purpose of the device is to treat and remove hydrocarbons from entering the stormwater BMP facility. This device shall be maintained per the manufactures specification and the approved maintenance plan.

   (a) Coalescing plate separators shall be designed to achieve 100-ppm non-polar oil and grease 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.

   (b) Flow rates will be determined by the drainage area served by the device. The device will be sized to meet the water quality treatment requirements as specified in Section 301.4.04, "Design Criteria".

   (c) 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.

   (d) All separators shall be maintained per the manufacture specifications and the applicant shall submit an Operation and Maintenance Plan to be approved by the City.

301.12.16 ODEQ 1200-Z Permit Requirements and Procedures

The requirements in this section apply to facilities identified in Table 1: Sources Covered by the ODEQ New 1200-Z Industrial Stormwater General Permit Document, which can be found in the Water Quality Permit Program section of the ODEQ website.

Facilities identified in Table 1 that may discharge stormwater from a point source to surface waters or to conveyance systems that discharge to surface waters are required to obtain coverage under the 1200-Z permit. To obtain coverage under the permit, facilities must complete the application and registration procedures listed under the *Permit Coverage and Exclusion of Coverage* portion of the New 1200-Z Industrial Stormwater General Permit Document.

301.13.00 OPERATION AND MAINTENANCE REQUIREMENTS

This section describes operation and maintenance requirements that are generally applicable to all private stormwater management facilities. The person designated by the applicant as the responsible party in the Stormwater Maintenance Requirements and Access Easement shall be responsible for operation and maintenance of private stormwater management facilities. An operation and maintenance plan (O&M plan) shall be prepared by the applicant for the stormwater management facility and shall be submitted to the City of Wilsonville Natural Resources Program for review and approval. Maintenance activities shall be documented annually by sending a report of what was completed to the City of Wilsonville Natural Resources Program, by May 1st of each year.

301.13.01 Inspection Program

a. Routine facility inspection will provide three major benefits:

   1. Development of a condition history.

   2. Improved scheduling efficiency.

   3. Preventive maintenance opportunities.

b. Inspection records shall be used to:

   1. Determine where special maintenance conditions exist.

   2. Determine optimal frequencies for future inspection and maintenance.

   3. Generate scheduled and unscheduled (i.e., repair) work orders.

   4. Assure facility operation and aesthetics.

301.13.02 Requirements

a. The applicant shall be responsible for having inspections conducted, maintaining stormwater management facilities, and submitting yearly reports documenting inspection and maintenance activities to the City of Wilsonville Natural Resources Program.

b. Proprietary stormwater management facilities shall be maintained in accordance with the manufacturer specifications and requirements.

c. Inspection and maintenance of the facilities, with the record drawing plans in hand, shall be done in compliance with the Stormwater Maintenance Requirements and Access Easement. If applicable to the stormwater management facility, the design and maintenance specifications shall be used.

d. All required inspections and any maintenance activities performed shall be documented in the annual report as required by the City's Stormwater Maintenance Requirement and Access Easement.

e. Inspection reports shall be in a format and accuracy approved by the City of Wilsonville Natural Resources Program. Inspection reports shall be submitted to the City on a yearly basis.

f. The applicant shall keep inspection records to track the progressive development of the system over time. The inspection records shall include:

   1. General condition of vegetative area(s) and growing medium, predominant plant species, distribution, and success rate (where applicable).

   2. Sediment condition and depth in forebay (or other pretreatment structure), treatment facility, bench planting zones, and other sediment-removal components.

   3. Water elevations and other observations (sheen, smell, etc.).

4. Condition of the inlet, outlet, and overflow structures and devices, diversion structures, trash-removal devices, risers, spillway, embankments, and remaining storage capacity.

5. Unscheduled maintenance needs.

6. Components that do not meet the performance criteria and require immediate maintenance.

7. Common problem areas, solutions, and general observations.

8. Aesthetic conditions.

301.13.03 Structures

Applicant shall be responsible for maintaining all facility structures in good working order. Stormwater management facility structures include, but are not limited to, the following: stormwater pipes, stormwater manholes, sand/oil separators, monitoring manholes, flow control devices, energy dissipaters, headwalls, trash grates, underground detention facilities, catch basins, ditch inlets, area drains, clean-outs, access roads, safety fences, sediment fences, and biofiltration bags. Maintenance may consist of cleaning, repairing, and/or replacing structures or portions of structures as needed to maintain their functional purpose.

301.13.04 Planting Bed Soils

a. In areas where greater than 10% of planting bed vegetation has died, have soil tested as recommended by a Professional Landscape Architect registered in the State of Oregon.

b. Amend soil as per recommendations of a Professional Landscape Architect registered in the State of Oregon; if needed redesign plantings to correct problems, and reestablish soil coverage.

301.13.05 Vegetation Management

a. Vegetated stormwater management facilities may require a number of control practices during their initial 2-year period in order to meet the requirements for establishing healthy vegetation.

b. Requirements

1. Maintain plantings for a period of two years after the date of final construction approval by the City's authorized representative. During the establishment period, remove undesired vegetation with minimal (or preferably no) use of toxic herbicides and pesticides at least three times in year 1, and once or twice in the summer of year 2, unless otherwise approved by the City's authorized representative. Replace plants that die during this period as per recommendations and planting time frame given in Appendix B.2.00, "Landscape Guidelines."

2. At the end of the two-year warranty period, healthy plant establishment shall be achieved for at least 90% of the vegetation (see Section 301.15.02, "Landscape

Inspection for Warranty," for landscape survival criteria). The O&M plan shall specify the long-term maintenance schedule after the warranty period.

3. Selectively irrigate if necessary during the establishment period, during times of drought, or until the vegetation becomes established. It is preferred that the facility be designed to sustain its function without a permanent irrigation system.

4. Replenish mulch at least annually, and specify the mulching schedule in the O&M plan. Mulching shall be done to retain topsoil, heat, and moisture, and to inhibit weed growth. Use temporary fencing to protect seedlings from foraging animals.

5. Schedule maintenance outside sensitive wildlife and vegetation seasons. Minimize plant disturbance during maintenance activities.

6. Do not use fertilizers, herbicides, or pesticides for vegetation maintenance, unless it is specifically called for in the O&M plan.

7. Use replacement plants that conform to the initial planting plan and to Appendix B, "Landscape Requirements."

301.13.06 Sediment Management/Pollutant Control

a. Sediment and other pollutants that degrade water quality will accumulate in stormwater management facilities. The contractor shall remove all accumulated pollutants and sediment to maintain proper facility operation. Periodic testing will help determine appropriate sediment-removal schedules.

b. Requirements:

1. Place a sediment marker (see Detail No. S-2260 of these standards) in the forebay or in an area not likely to be damaged by incoming storm flows and where it can be easily seen by maintenance personnel.

2. Remove sediment when accumulations reach 1 foot in depth, 50% of the designed sediment storage depth, or if sediment accumulation inhibits facility operation. The 50% full capacity shall be identified and marked on sediment marker during facility construction.

3. Test sediment before removing it if the stormwater management facility serves a commercial/industrial site or a multifamily structure or development. Sediment shall be tested according to protocol established in the O&M plan, and any additional information resulting from site-specific conditions and use. Testing could include parameters such as oil and grease, heavy metals (lead, zinc, and cadmium), nutrients (e.g., phosphorus), and organics such as pesticides that may accumulate. Testing must be site specific if a commercial/industrial discharger is being served; City of Wilsonville reserves the right to require testing of specific contaminants. Applicant shall provide the test results to the City of Wilsonville Natural Resources Program prior to excavation and disposal of sediment.

4. Dispose of sediments at the time of excavation in a manner meeting applicable state and federal requirements. If sediment disposal requires special handling,

disposal documentation shall be provided to the City of Wilsonville Natural Resources Program.

5. Investigate and control, or report the pollutant source, if sediment or other pollutants are accumulating more rapidly than assumed when the O&M plan was formulated. Direct pollution-control complaints to the City of Wilsonville Natural Resources Program.

301.13.07 Insect/Vector Control

a. Standing water associated with some types of treatment systems can attract insects.

b. The following measures shall be the primary methods of insect control. The method are not presented in order of implementation, but one or all of these methods shall be used before considering any other measures:

1. Install predacious bird and bat nesting boxes.

2. Change the water level of ponds every four days or so to disrupt the larval development cycle of mosquitoes.

3. Stock ponds and other permanent water facilities with fish or other predatory species.

4. Use mosquito larvicide, such as Bacillus thurengensis or Altoside® formulations, only if absolutely necessary. Any pesticide or larvicide shall be applied by a licensed individual.

c. Additional assistance with vector monitoring and control may be obtained from the local vector control office.

301.13.08 Access and Safety

O&M programs shall provide for safe and efficient access to a facility and shall be in compliance with Section 101.8.09, “Safety Requirements”. The following are general requirements; specific conditions may require site-specific modifications:

a. Secure easements necessary to provide facility and maintenance access (if applicable).

b. Use only trained and certified personnel to access confined spaces.

c. Maintain ingress/egress routes to design standards, in a manner that allows efficient maintenance of the facility.

d. Ensure that fencing is in good repair.

301.14.00 TESTING PROCEDURES

301.14.01 General

a. The contractor shall furnish all necessary testing equipment and perform the tests in a manner satisfactory to the City's authorized representative.

b. All gravity storm systems shall be inspected and tested after backfill has passed the required compaction test(s) based on AASHTO T-180 and roadway base rock has been placed, compacted, and approved. All details of testing procedures shall be subject to approval of the City's authorized representative.

c. If repair work is required on a section of the system, that portion of the system shall be retested.

d. Deflection testing shall be done in the presence of the City's authorized erepresentative.

e. All testing shall be completed and accepted by the City's authorized representative before paving of overlying roadways will be permitted.

f. Prior to the start of storm system testing, all manholes shall be re-numbered as assigned by the City's authorized representative. All testing shall reference the City assigned manhole numbers.

301.14.02 Line Cleaning

Before testing and City inspection of the system, the contractor shall plug the closest downstream manhole, ball and flush, and clean all parts of the system. The contractor shall remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at the plugged manhole using a vacuuming process. At no time, shall any material be flushed into the downstream city storm sewer system. When the City's authorized representative inspects the system, any foreign matter still present shall be removed from the system by repeating the cleaning process. ***No material shall be flushed into the downstream city storm sewer system.***

301.14.03 Deflection Test for Flexible Pipe

Storm systems constructed of flexible pipe shall be deflection-tested by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95% of the nominal pipe diameter, unless otherwise specified by the City's authorized representative. The mandrel shall be a rigid, nonadjustable, odd-numbered-leg (9 legs minimum) mandrel having an effective length of not less than its nominal diameter. Testing shall be done manhole-to-manhole and after the line is completely balled and flushed with water, and after compaction tests of backfill are completed and accepted. Testing shall be conducted in the presence of the City's authorized representative. The contractor shall be required to locate and repair any sections that fail the test and to retest those sections. All repairs shall follow and be in compliance with the manufacturer's recommendations. Any mechanical device meant or intended to come into contact with the pipe material in an attempt to re-round the pipe is strictly prohibited.

301.14.04 Video Inspection of Gravity Systems

All storm systems shall be video-inspected and approved prior to City acceptance. Video inspection shall take place after trench backfill and compaction has been completed and accepted, and channels have been poured in manholes. All pipes shall be thoroughly cleaned in accordance with Section 301.14.02, "Line Cleaning" immediately prior to the video inspection; only that water remaining from cleaning shall be present in the system. Video inspection shall be continuous from manhole to manhole without breaks or interruptions in the recording. The camera shall have the ability to tilt up to 90 degrees and rotate 360 degrees on the axis of travel. An inspection of all lateral connections shall be conducted using the tilt capabilities of the camera. A 1/2-inch target ball shall be placed in front of the camera. There shall be no observed infiltration and observed sags must be less than 0.5 inch.

The City's authorized representative shall be notified and shall be present during video-inspection of the system, unless otherwise approved by the City's authorized representative. A copy of the video and a written video inspection report, on a City-approved form, shall be supplied to the City's authorized representative. The video shall be recorded in color CD or DVD format. Video shall include a visual footage meter recording. Problems revealed during the inspection shall be noted on the video and in the written report. After repairs have been made, the line shall be re-inspected and re-tested. If excessive foreign material, in the opinion of the City's authorized representative, is encountered during video inspection, the line shall be cleaned in accordance with Section 301.14.02, "Line Cleaning" and re-video inspected.

301.14.05 Locate Wire Testing

Prior to paving, the contractor shall notify the City's authorized representative that the storm sewer locate wire is ready for testing. City personnel shall connect to the locate wire and attempt to locate storm sewer system piping, including services. All points of the storm sewer system piping shall be located from at least two connection points to be considered to have adequate coverage. The contractor will be required to locate and repair any gaps in the locate wire coverage. Failed sections shall be retested until adequate coverage is obtained.

301.15.00 WARRANTIES AND ACCEPTANCE

301.15.01 Stormwater and Surface Water Acceptance Policy

The City of Wilsonville will accept new stormwater and surface water installations or systems built to the "Public Works Standards," providing that the following conditions are met.

a. Dedication of any required easements or rights-of-way have been recorded with the County Recorder and the Engineering Department receives a reproducible copy of the recorded documents.

b. After completion of construction of the total project, and after all testing has been satisfactorily completed, project closeout shall proceed as outlined in Section 101.8.17.a, "Project Completion."

c. The Contractor or Applicant shall be responsible for providing Maintenance Assurance for Public Improvements as outlined in Section 101.8.17.b, "Maintenance Assurance." Public storm improvements shall be warranted for a minimum of two years.

d. At any time during the warranty period, the City's authorized representative has reason to believe the public stormwater improvements have defects that were the result of faulty workmanship or flaws in construction material, the responsible party shall be required, at that party's own cost, to video-inspect the sewer line and repair any problems or faults revealed during video inspection by replacing those sections. The video inspection shall be done during the winter, if possible, or during the wet weather months, to identify all leaks.

e. Before the end of the Construction Maintenance period, the City's authorized representative shall inspect the project for any remaining deficiencies. If the deficiencies that remain are determined to be the responsibility of the contractor or the applicant, the contractor or applicant shall then make such repairs.

f. The Landscape Maintenance assurance shall be released two years after acceptance of construction, providing the landscaping meets the 90% survival level (see Section 301.15.02, "Landscape Inspection for Warranty").

301.15.02 Landscaping Inspection for Warranty

a. The City's authorized representative shall inspect the condition of all landscaping located within the public right-of-way and/or the stormwater management facility at the end of the first year of the post-construction period. The City's authorized representative shall provide an interim inspection report to the applicant with a specific summary of any deficiencies. Failure of the City to provide the interim report shall not release the applicant from the responsibility for providing established landscaping at the end of the two-year landscaping maintenance period.

b. If at any time during the warranty period the landscaping falls below the 90% survival level, the applicant shall reinstall all deficient planting at the next appropriate planting opportunity. The two-year maintenance period shall begin anew from the date of replanting.

c. The 90% survival level shall meet the following criteria:

   1. In the opinion of the City's authorized representative, landscaping is established and healthy.

   2. Each plant group (trees, shrubs, herbaceous, and aquatics) shall meet the 90% survival level.

   3. Each planting zone (wet, moist, and dry) shall meet the 90% survival level.

d. Areal coverage shall meet the 90% survival level.

APPENDIX A

LANDSCAPE REQUIREMENTS: VEGETATED STORMWATER MANAGEMENT FACILITIES

A.1.00 Introduction

a. This appendix provides information on plant selection and design guidance for a variety of stormwater management facilities. The role of plants in facilities is critical. The success or failure of a facility can depend on the proper selection and location of plants. The main purpose of vegetation in facilities is to provide the maximum amount of water quality benefit for stormwater management.

b. The surface area of a typical stormwater facility allows runoff to pond and evaporate while sediments settle into a layer of mulch. The organic mulch layer prevents soil bed erosion and retains moisture for plant roots. It also provides a medium for biological growth and the decomposition or decay of organic matter. The soil stores water and nutrients to support plant life. Worms and other soil organisms are very good at degrading organic pollutants, like petroleum-based compounds. They also help mix organic material, increase aeration, and improve water infiltration and water holding capacity. Bacteria and other beneficial soil microbes process the majority of pollutants, including most of the nitrogen. The stiff structure of plants such as rushes and sedges slows water passage and traps sediments within the surface area of the facility. (BES Stormwater Management Manual - 2008)

c. In designing vegetated stormwater management facilities, there are a range of considerations for plant selection and design, including the site context, protection of native biodiversity, creation of habitat, limitation of noxious invasive species, and aesthetics. The following sections provide guidance for the proper selection of plants.

A.2.00 Native and Adapted Plants

a. Plants approved for stormwater management facilities can be grouped into three categories: natives, native cultivars, and non-native adapted plants.

   1. **Native plants** 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 management facilities and should be used whenever suitable.

2. **Native cultivars** 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 management facilities. 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.

3. **Non-Native adapted** plants are plants that 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 plants that have proven to be non-invasive.

b. The plant lists provided for each type of stormwater management facility identifies native, native cultivars and non-native adapted plants that are approved for use. The use of plants not identified on the plant lists shall be approved by the City's authorized representative.

A.2.01 Relationship of Form and Hydrology

a. Careful consideration of the soil moisture conditions within a stormwater facility will help to ensure the success of a planting design (See *Planting Zones by Facility Type*). Planting conditions for sloped, basin-like stormwater facilities such as swales, rain gardens and constructed wet ponds have a variety of moisture levels from dry to wet. Soil conditions at and near the bottom of the facility can be wet due to frequent or constant inundation, and side slopes vary from wet at the bottom to relatively dry near the top. The moisture gradient varies with the designed maximum water depth, the time it takes for a facility to drain after a storm event, and the steepness of the side slopes.

b. The zone from the bottom of the facility to the designed high water line or top of freeboard should be planted with plants that tolerate occasional standing water and wet-to-moist conditions. Above the designed high water line vegetation is not affected by stormwater entering the facility and should be planted with species well-suited to the local climate and site-specific conditions (i.e., solar aspect, micro climate, etc.). Planting conditions are more uniform for planters and vegetated filter strips because of the relatively uniform and flat surface.

A.2.02 Vegetated Stormwater Management Facilities and Habitat

a. A habitat is a space that provides food, water, and shelter for the survival and reproduction of an organism. Vegetated stormwater management facilities can be designed to mimic the natural habitats, processes, and hydrology of a particular site.

b. The environmental benefits of vegetated stormwater management facilities include:

   1. Less disturbance to sites than conventional stormwater management methods

   2. Reduced and delayed peak stormwater flows

   3. Reduced discharge of pollutants

   4. Increased planted space and habitat

   5. Creation of a multifunctional landscape that enhances visual and functional amenities

c. Vegetated stormwater management facilities also generate a variety of off-site benefits that preserve and enhance riparian and wetland habitats "downstream" from the facility by reducing the negative environmental effects associated with urban development. Nearly all vegetated stormwater management facilities have the potential to create and improve habitat on and near the site. Water is one of the most important factors in the creation of habitat, and because most stormwater management facilities receive large amounts of stormwater they offer a great opportunity to create habitat. Planting vegetation is one of the most practical ways to create habitat within a stormwater management facility.

d. All of the vegetated stormwater management facilities have planting design guidelines, such as required plant spacing and plant types, but there is flexibility to maximize habitat for a variety of organisms such as invertebrates, amphibians, small mammals, and birds. Created habitat can also enhance conditions for predators that feed on mosquitoes.

A.2.03 Climate and Microclimate

a. All stormwater management facility vegetation should be well-adapted to both the northwest regional climate and the facility's microclimate.

b. Although regional climate dictates average seasonal temperatures, amount of rainfall and available daylight, site-specific microclimates can vary considerably and should be factored into the planting design, particularly in an urbanized environment. For example, sword fern is a plant native to woodlands of the Pacific Northwest that likely would not survive if placed in a south facing flow-through planter with direct sun exposure most of the day and heat radiating off the building. But sword fern placed in a flow-through planter on the north side of the building likely would thrive.

A.2.04 Habitat Diversity and Layering of Plants

a. Natural environments in the Pacific Northwest are characterized by diverse, layered plant habitats. A forest typically has three broad habitats vertically arranged one on top of the other; low-growing groundcovers, topped by shrubs, topped by arborescent shrubs (shrubs that look like small trees) and trees. These layers vary in composition and form from one habitat type to another, such as the different northwest habitats of

forest, wetland, and riparian. Different organisms occupy different niches within these habitats, creating greater biodiversity.

b. A range of habitats can be created in vegetated stormwater management facilities by selecting a variety of complementary vegetation to plant together, such as groundcovers, perennials, shrubs, and trees. The structural variety of a diversified planting design can also be very pleasing to the eye. Vegetated stormwater management facilities should reflect a natural ordering of plantings, as well as mimicking a mixture of deciduous and evergreen materials.

A.2.05 Maintenance

Water efficient irrigation shall be applied for at least the first 2 years after construction of the facility, particularly during the dry summer months, while plantings become established. If temporary irrigation is installed it must be removed by the end of the maintenance period. The following maintenance inspections and activities shall be performed:

1. Check regularly for weeds. Remove weeds or invasive plants such as blackberries and ivy, and implement a weed control program as needed.

2. Check mulch regularly to maintain uniform coverage. Many vegetated stormwater management facilities specify a mulch cover such as river rock to prevent erosion and moisture loss during dry periods.

3. Replant bare patches as necessary to comply with the facility's coverage requirements and maintenance plan.

4. Implement all of the required maintenance activities listed in the vegetated stormwater management facility details.

A.2.06 Planting Zones by Vegetated Stormwater Management Facility Type

Vegetation for stormwater facilities is categorized according to the degree of soil moisture that will be encountered in the facility. For green roofs, the critical planting factor is the depth of the planting soil. Consideration of these zones will enhance the success of a facility's planting design.

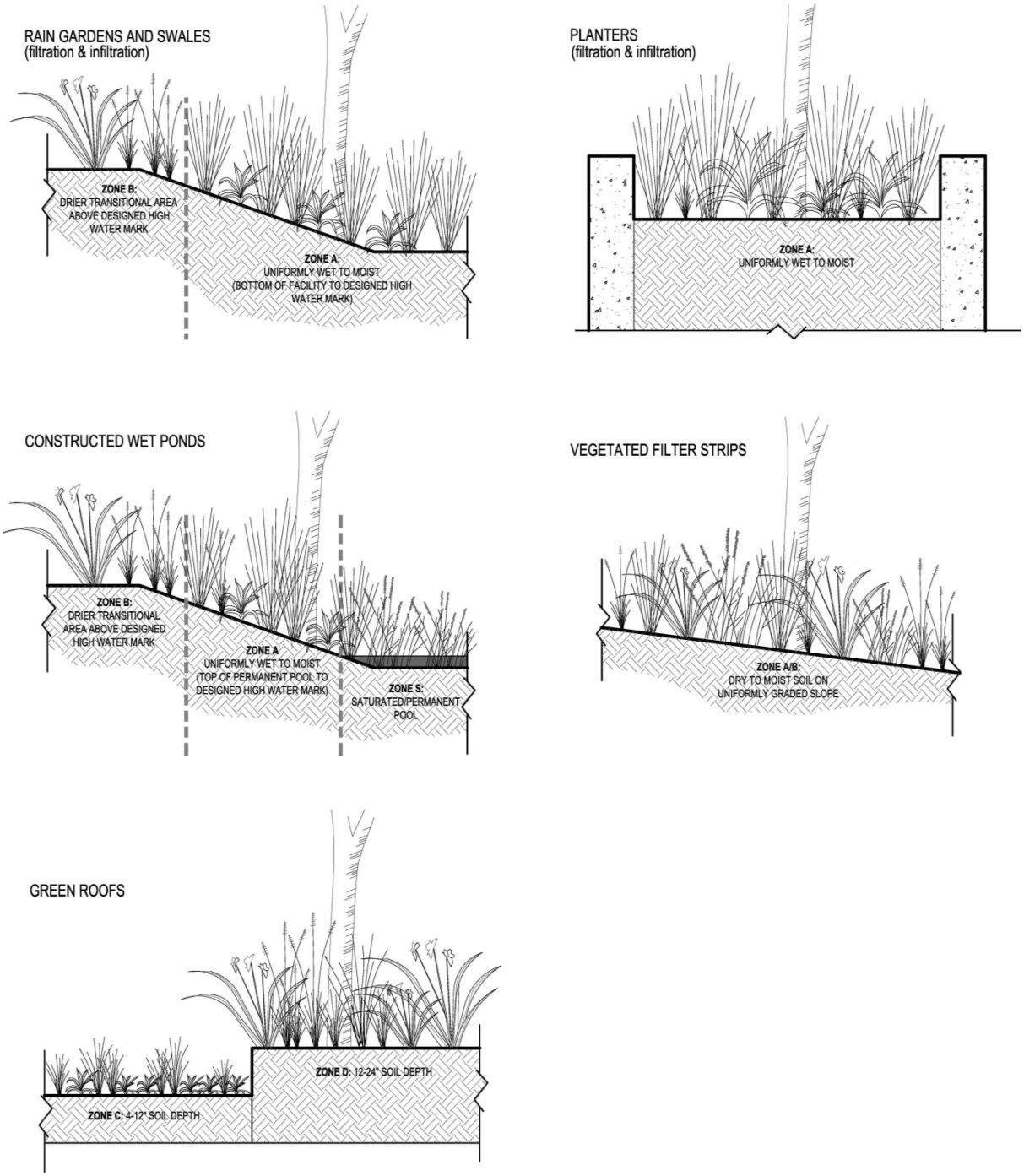

Figure A-1. Planting Zones by Vegetated Stormwater Management Facility Type

A.3.00 Planting Plan Methods

Planting plans are required for development projects with stormwater management facilities. Planting plans should address four major components: hydrology, soils, plant materials, and maintenance. When developing planting plans, the following steps should be used:

a. Step 1: Assess Hydrologic and Hydraulic Conditions

Use the City's BMP sizing tool and cross sections in Figure A-1 to assign appropriate hydrologic zones to the facilities and identify them on the plan. Most facilities include one or more of the following planting zones with respect to hydrology during the growing season:

1. Wet (Zone S): standing or flowing water/nearly constant saturation; anaerobic soils

2. Moist (Zone A): periodically saturated; anaerobic and/or aerobic soils

3. Dry (Zones B, C, and D): infrequent inundation/saturation, if any; aerobic soils

b. Step 2: Identify Plants to be Preserved, Select Plant Materials, Quantities, Placement, and Assign Planting Zones and Specifications to Plans

1. Preservation: Every effort shall be made to protect a site's existing native vegetation. Native vegetation along natural areas and the Significant Resource Overlay Zone shall be retained to the maximum extent practicable.

2. Selection: Plant selection shall be from the plant lists found in Tables A1-A5, unless approved by the City's authorized representative. Planting requirements are as follows:

   (a) Deep rooting trees and shrubs (e.g. willow) shall not be planted on top of concrete pipes, or within 10 feet of retaining walls, inlet/outlet structures or other culverts; and

   (b) Large trees or shrubs shall not be planted on berms over four feet tall that impound water. Small trees or shrubs with fibrous root systems may be installed on berms that impound water and are less than four feet tall.

3. Quantities: Plant quantities shall be calculated as follows, unless approved by the City's authorized representative. All quantities shall be calculated per 100 square foot of facility area.

   (a) Moisture Zone (S): 115 herbaceous plants.

   (b) Moisture Zone (A): 3 large shrubs / small trees, 4 small shrubs, and 115 groundcover plants.

(c) Moisture Zone (B): 1 tree, 3 large shrubs / small trees, 4 small shrubs, and 115 groundcover plants.

(d) Moisture Zone (C & D): 115 sedums, succulents, and herbaceous plants

4. Fully Lined Facilities – Trees are not required

5. Minimum Sizes:

(a) Herbaceous Plants: SP #4 container

(b) Small Shrubs / Groundcover: # 1 container

(c) Large Shrubs / Small Trees: 30” Height

(d) Deciduous Trees: 1” caliper

(e) Evergreen Trees: 6’ height

6. Design: All planting plans must have a minimum of 50 percent evergreen plants and at least two species from the Herbaceous and Small Shrubs/Groundcover plant communities.

c. Step 3: Determine Plant Installation Requirements and Assign Specifications to Plans

1. Timing: Containerized stock shall be installed only from February 1 through May 1 and October 1 through November 15. Bare root stock shall be installed only from December 15 through April 15. Seeding shall occur only between March 1 through May 15 and September 1 through October 15. Planting or seeding outside these times may require additional measures to ensure survival which shall be specified on the plans and require the City’s approval.

2. Erosion Control: Grading, soil preparation, and seeding shall be performed during optimal weather conditions and at low flow levels to minimize sediment impacts. Site disturbance shall be minimized and desirable vegetation retained, where possible. Slopes shall be graded to support the establishment of vegetation. Where seeding is used for erosion control, an appropriate native grass, *Regreen* (or its equivalent), or sterile wheat shall be used to stabilize slopes until permanent vegetation is established. Biodegradable fabrics (coir, coconut or approved jute matting (minimum ¼ inch square holes) may be used to stabilize slopes and channels. Fabrics such as burlap may be used to secure plant plugs in place and to discourage floating upon inundation. No plastic mesh that can entangle wildlife is permitted. Consult Section 101.9.00, Environmental Protection, Erosion Prevention, and Sediment Control for additional information.

3. Mulching: Mulching for stormwater management facilities shall be per **Section A.3.7**.

4. Plant Protection from Wildlife: Depending on site conditions, appropriate measures shall be taken to limit wildlife-related damage.

5. Irrigation: Appropriate plant selection, along with adequate site preparation and maintenance, reduces the need for irrigation. However, unless site hydrology is currently adequate, a City approved irrigation system or equivalent shall be used during the 2-year plant establishment period. Watering shall be at a rate to maintain all plantings in a healthy thriving condition during establishment Other irrigation techniques, such as deep watering, may be allowed with prior approval by the City's authorized representative.

6. Access: Stormwater management facility access requirements are provided in Section 301.11.04.

d. Step 4: Determine Plant Monitoring and Maintenance Requirements

1. Monitoring: Site visits are necessary throughout the growing season to assess the status of the plantings, irrigation, mulching, etc. and ensure successful plant establishment.

2. Weed Control: The removal of non-native, invasive weeds shall be necessary throughout the maintenance period, or until a healthy stand of desirable vegetation is established.

3. Plant Replacement and Preservation: At the end of the maintenance period, all plants not in a healthy growing condition, will be noted and as soon as seasonal conditions permit, shall be removed from the site and replaced with plants of the same species and size as originally specified. Prior to replacement, the cause of loss (wildlife damage, poor plant stock, etc.) shall be documented with a description of the corrective actions taken.

e. Step 5: Prepare Construction Documents and Specifications

The construction documents and specifications shall include:

1. 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 planting area.

2. Planting plan and specifications shall include all of the following:

   (a) Planting table that documents the common name, scientific name, distribution (zone and spacing), condition and size of plantings

   (b) Installation methods for plant materials

   (c) Mulching

(d) Plant tagging for identification

(e) Plant protection

(f) Seeding mix, methods, rates, and areas

3. Irrigation plan and specifications, including identification of water source, and, maintenance of the system.

4. 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 2-year monitoring period.

5. Access points for installation and maintenance including vehicle access if required.

6. Standard drawing details (north arrow, scale bar, property boundaries, project name, drawing date, name of designer and Property Owner).

A.4.00 Stormwater Facility Growing Medium

Furnish imported growing medium for vegetated stormwater management facilities conforming to the following:

a. Standard Blend: Use this blend for all vegetated stormwater management facilities, except those in the right-of-way where compaction from foot traffic is a concern.

1. General Composition: The medium shall be a blend of loamy soil, sand, and compost that is 30 to 40 percent compost (by volume) and meets the criteria in this specification.

2. Analysis Requirements for the Blended Material:

(a) Particle Gradation: A particle gradation analysis of the blended material, including compost, shall be conducted in conformance with ASTM C1 17/C136 (AASHTO T1 1/T27). The analysis shall include the following sieve sizes: 1 inch, 3/8 inch, #4, #10, #20, #40, #60, #100, and #200. The gradation of the blend shall meet the following gradation criteria.

Sieve Size	Percent Passing
1 inch	100
# 4	60 -100
# 10	40-100
# 40	15-50

# 100	5-25
# 200	3-5

(b) The blend shall have a Coefficient of Uniformity (D60/D10) equal to or greater than 6 to ensure that it is well graded (has a broad range of particle sizes). The coefficient is the ratio of two particle diameters on a grain-size distribution curve; it is the particle diameter at 60 percent passing divided by the particle diameter at 10 percent passing.

3. Organic Matter Content: An analysis of soil organic matter content shall be conducted in conformance with ASTM D2974 (loss on ignition test). The soil organic matter content shall be a minimum of 10 percent, as reported by that test.

4. Measured pH: The blended material shall be tested and have a pH of 5.5 to 7.

b. Infiltration Blend for the Right-of-Way: Use this blend for facilities in the right-of-way where compaction from foot traffic is a concern. Approval is required.

1. General Composition: The medium shall be a mix of sand and compost, blended by volume. The medium shall consist of 60 to 70 percent sand and 30 to 40 percent compost (by volume).

2. Analysis Requirements**:** The requirements are the same as those specified in Section A.4.00.a for the "Standard Blend." The single difference is the particle gradation criteria, which are as follows.

Sieve Size	**Percent Passing**
1 inch	100
# 4	60-100
# 10	40-100
# 40	15-50
# 100	5-20
# 200	3-5

c. General Requirements for the Blended Material:

1. The material shall be loose and friable.

2. It shall be well mixed and homogenous.

3. It shall be free of wood pieces, plastic, screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of weeds and invasive plants including but not limited to:

   (a) Cirsium arvense (Canadian Thistle)

   (b) Convolvulus spp. (Morning Glory)

   (c) Cytisus scoparus (Scotch Broom)

   (d) Dipsacus sylvestris (Common Teasel)

   (e) Festuca arundinaceae (Tall Fescue)

   (f) Hedera helix (English Ivy)

   (g) Holcus canatus (Velvet Grass)

   (h) Lolium spp. (Rye Grasses)

   (i) Lotus corniculatus (Bird's Foot Trefoil)

   (j) Lythrium salicaria (Purple Loose Strife)

   (k) Melilotus spp. (Sweet Clover)

   (l) Myriophyllum spicatum (Eurasian Milfoil)

   (m) Phalaris arundinaceae (Reed Canary Grass)

   (n) Rubus discolor (Himalayan Blackberry)

   (o) Solanum spp. (Nightshade)

   (p) Trifolium spp. (Clovers), and

   (q) Not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when

moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

4. It shall have no visible free water.

5. It shall be obtained from naturally well drained construction or mining sites where topsoil occurs at least 4 inches deep; it shall not be obtained from bogs, wetlands, or marshes.

d. Compost: The compost shall be derived from plant material and provided by a member of the U.S. Composting Council Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of providers in Portland.

1. 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 U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:

(a) 100 percent of the material must pass through a 1/2-inch screen.

(b) The pH of the material shall be between 6 and 8.

(c) Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight.

(d) The organic matter content shall be between 35 and 65 percent.

(e) The soluble salt content shall be less than 6.0 mmhos/cm.

(f) Germination (an indicator of maturity) shall be greater than 80 percent.

(g) The stability shall be between classes 5-7.

(h) The carbon/nitrogen ratio shall be less than 25:1.

(i) The trace metals test result = “pass.”

e. Submittals: At least 14 working days in advance of construction, submit the following:

1. Documentation for the three analyses (particle gradation with calculated coefficient of uniformity; organic matter content; pH) described in this specification. The analyses shall be performed by an accredited laboratory with certification maintained current. The date of the analyses shall be no more than 90 calendar days prior to the date of the submittal. The report shall include the following information:

(a) Name and address of the laboratory

(b) Phone contact and e-mail address for the laboratory

(c) Test data, including the date and name of the test procedure

2. A compost technical data sheet from the vendor of the compost. The analysis and report must be consistent with the sampling and reporting requirements of the U.S. Composting Council STA program. The analysis shall be performed and reported by an approved independent STA program laboratory.

3. The date of the analysis shall be no more than 90 calendar days prior to the date of the submittal.

4. A description of the location, equipment, and method proposed to mix the material.

f. Stormwater Management Facility Growing Medium Installation

1. Protection of the Growing Medium: The growing medium shall be protected from all sources of contamination, including weed seeds, while at the supplier, in conveyance, and at the project site.

2. Placement of the Growing Medium: The medium shall be placed in loose lifts, not to exceed 8 inches and each lift shall be compacted with a water-filled landscape roller. The material shall not otherwise be mechanically compacted.

3. Timing of Plant Installation: Weather permitting, plants shall be installed as soon as possible after placing and grading the growing medium in order to minimize erosion and further compaction.

4. Erosion Control: Temporary erosion control measures are required until permanent stabilization measures are functional, including protection of overflow structures.

5. Protection of the Facility: In all cases, the facility must be protected from foot or equipment traffic that is unrelated to the construction of the facility. Temporary fencing or walkways should be installed as needed to keep workers, pedestrians, and equipment out of the facility. Under no circumstances should materials and equipment be stored in the facility.

6. Stormwater management facilities shall be kept clean and shall not be used as erosion and sediment control structures during construction.

7. Wet and Winter Conditions: Placement of the growing medium will not be allowed when the ground is frozen or saturated or when the weather is determined to be too wet.

g. Watering, Fertilizing, and Mulching

1. Water all plants during establishment to maintain all plantings in a healthy thriving condition.

2. Fertilizers should generally be avoided in stormwater facilities. Fertilize all plants during establishment as needed with slow release, organic (low yield) material.

3. The purpose of mulching soils is to conserve moisture, hold plantings and topsoil in place, limit weed establishment and moderate soil temperatures.

4. Mulch for Vegetated Stormwater Facilities: The use of mulch in frequently inundated areas shall be limited to avoid any possible water quality impacts including the leaching of tannins and nutrients, and the migration of mulch into waterways. Mulches to be used shall be a stable and inert (non-leaching) matter of sufficient mass and density that it will not float in standard flows. Mulch cover should be maintained throughout the life of the stormwater facility with minimum thickness of 2 inches in depth.

h. Stormwater Facility Plant Lists

1. The plant lists provided in the following tables are separated by facility type (such as planters, rain gardens, green roof, etc.). Each facility list includes a suitability matrix for limiting contextual factors (such as moisture zones and width of facility) as well as a listing of specific characteristics for each species, such as native to the area, if it is an evergreen, its average height and the on-center spacing.

2. The following characteristics are included in plant matrices to aid in plant selection:

   (a) Botanical name, Common 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

   (b) Zone: Denotes the planting moisture zone as noted in the facility diagrams in Figure A-1. Some plants work in multiple moisture zones, and others only in a particular dry, moist, or wet condition.

   (c) Origin: The distinction between Northwest native plants, cultivated varieties of Northwest Natives, and plants that are non-native but adapted to our specific climate.

   (d) Type/Size: A range of factors to aid in plant selection showing individual plant characteristics:

      (1) (E)vergreen/(D)ecidious: Identifies the characteristic of a plant to keep foliage during winter months. Planting placement and selection should maintain a balance of evergreen and deciduous materials.

(2) Potential Height: Maximum size at maturity to use as a design guideline.

(3) On-Center Spacing: Optimum spacing for new plantings. This is to be used as a guideline and may vary slightly depending on site conditions.

(e) Context Factors

(1) Facilities less than 3 feet wide: Narrow conditions require plants that are not too large and will outgrow or have potential for roots to damage, narrow planters.

(2) Fully Lined Facility: Limit larger material or plants with aggressive roots.

(3) Parking Area: Use plant materials that do not limit necessary line of sight visibility.

(4) Streets: Use plant materials that do not limit necessary line of sight visibility.

(5) Adjacent to Buildings: Limit plants that are too large for areas next to buildings and would not be compatible with building footings, windows or other systems.

TABLE A-1: STORMWATER FACILITY PLANT LISTS: PLANTERS (INFILTRATION AND FILTRATION)

Planters (infiltration and filtration)	Zone	Origin			Type/Size			Context Factors				
Plant Name ***Botanical,*** **common**	Moisture zone (A) Uniformly wet to moist	NW native	NW native cultivar	Non-native adapted	(E)vergreen /(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants												
Carex densa, Dense sedge	•	•			E	24"	12"	•	•	•	•	•
Carex rupestris, Curly sedge	•			•	D	14"	12"	•	•	•	•	•
Carex testacea, New zealand orange sedge	•			•	E	24"	12"	•	•	•	•	•
Eleocharis ovata, Ovate spike rush	•	•			E	30"	12"	•	•	•	•	•
Juncus ensifolius, Dagger-leaf rush	•			•	D	10"	12"	•	•	•	•	•
Juncus patens, Spreading rush	•	•			E	36"	12"	•	•	•	•	•
Shrubs/Groundcover												
Cornus sericea, Red twig dogwood	•	•			D	6'	4'			•		•
Cornus sericea 'Kelseyi', Kelsey dogwood	•		•		D	24"	24"	•	•	•	•	•
Mahonia aquifolium, Oregon grape	•	•			E	5'	3'		•	•	•	•
Physocarpus capitatus, Pacific ninebark	•	•			D	10'	3'		•			
Polystichum munitum, Sword fern	•	•			E	2'	2'	•	•	•	•	•
Rosa pisocarpa, Swamp rose	•	•			D	8'	3'		•			•
Large Shrubs/Small Trees												
Rubus spectabilis, Salmonberry	•	•			D	10'	4'		•			•
Salix lucida var. 'Lasiandra', Pacific willow	•		•		D	13'	6'					
Salix purpurea nana, Blue arctic willow	•			•	D	8'	6'			•		
Salix sitchensis, Sitka willow	•	•			D	20'	6'					
Spirea douglasii, Douglas spiraea	•	•			D	7'	4'		•			•
Viburnum edule, Highbush cranberry	•	•			D	6'	4'		•	•	•	
Trees												
Acer circinatum, Vine maple	•	•			D	15'	10'	•	•	•		•
Acer rubrum, Red maple	•			•	D	40'	25'		•	•	•	
Alnus rubra, Red alder	•	•			D	80'	15'			•		
Crataegus douglasii, Black hawthorn	•	•			D	40'	10'		•	•		
Fraxinus latifolia, Oregon ash	•	•			D	30'	20'			•		
Malus fusca, Pacific crabapple	•	•			D	30'	10'	•	•	•		
Nyssa sylvatica, Black tupelo	•			•	D	25'	20'			•	•	
Salix hookeriana, Hooker's willow	•	•			D	15'	10'			•		
Thuja plicata, Western red cedar	•	•			E	150'	25'			•		

TABLE A-2: STORMWATER FACILITY PLANT LISTS: RAIN GARDENS AND SWALES (INFILTRATION AND FILTRATION)

Rain Gardens and Swales (infiltration and filtration)	Zone		Origin			Type/Size			Context Factors				
Plant Name ***Botanical*, common**	Moisture zone (A) Uniformly wet to moist	Moisture zone (B) Drier transitional area	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully-lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants													
Carex obnupta, Slough sedge	•		•			E	48"	12"		•	•	•	•
Carex testacea, New Zealand orange sedge	•				•	D	24"	12"		•	•	•	•
Deschampsia cespitosa, Tufted hair grass	•		•			D	36"	12"	•	•	•	•	•
Elymus glaucus, Blue wild rye	•	•	•			E	24"	12"	•	•	•	•	•
Juncus ensifolius, Dagger-leaf rush	•				•	D	10"	12"	•	•	•	•	•
Juncus patens, Spreading rush	•	•			•	E	36"	12"	•	•	•	•	•
Scirpus microcarpus, Small fruited bulrush	•		•			E	24"	12"	•	•	•	•	•
Small Shrubs/Groundcover													
Arctostaphylos uva-ursi, Kinnickinnick		•	•			E	6"	12"	•	•	•	•	•
Cornus sericea 'Kelseyi', Kelsey dogwood	•	•		•		D	2'	12"	•	•	•	•	•
Fragaria chiloensis, Coastal strawberry		•	•			E	6"	12"	•	•	•	•	•
Mahonia aquifolium, Oregon grape	•	•	•			E	5'	3'		•	•	•	•
Physocarpus capitatus, Pacific ninebark	•		•			D	6'	3'		•			
Polystichum munitum, Sword fern	•	•	•			E	2'	2'	•	•	•	•	•
Spirea betulifolia, Birchleaf spiraea	•	•	•			D	2'	2'	•	•	•	•	•
Symphoricarpus alba, Snowberry	•	•	•			D	3'	3'	•	•	•	•	•
Large Shrubs/Small Trees													
*Cornus sericea,*Red-Twig dogwood	•	•	•			D	6'	4'					
Holodiscus discolor, Western serviceberry	•	•	•			*D*	*6'*	*4'*		•	•	•	
Rosa nutkana, Nootka rose	•	•	•			D	8'	4'		•		•	
Omleria cerasiformis, Indian plum	•		•			D	6'	4'		•	•	•	
Ribes sanguimeum, Red flowering currant	•	•	•			D	8'	4'		•	•	•	•
Salix sitchensis, Sitka willow	•		•			D	15'	5'					
Spirea douglasii, Douglas spiraea		•	•			D	7'	4'		•	•	•	•
Trees													
Acer circinatum, Vine maple	•	•	•			D	15'	8'	•	•	•	•	•
Alnus rubra, Red alder	•	•	•			D	80'	20'					•
Cornus nuttalii, Pacific dogwood	•	•	•			D	20'	10'	•	•	•	•	•
Fraxinus latifolia, Oregon ash	•		•			D	30'	25'					
Malus fusca, Pacific crabapple	•		•			D	30'	10'	•	•			•
Pseudotsuga menziesii, Douglas fir	•	•	•			E	200'	30'					
Thuja plicata, Western red cedar	•	•	•			E	150'	20'			•		

TABLE A-3: STORMWATER FACILITY PLANT LISTS: CONSTRUCTED WET PONDS

Constructed Wet Ponds	Zone			Origin			Type/Size			Context Factors				
Plant Name ***Botanical*, common**	Moisture zone (S) Saturated/permanent pool	Moisture zone (A) Uniformly wet to moist	Moisture Zone (B) Drier transitional area	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully -lined facility	Parking areas	Streets	Adjacent to buildings
Herbaceous Plants														
Alisma plantago-aquatica, Water plantain	•			•			D	24"	12"	•	•			
Camassia quamash, Camas lily		•	•	•			D	24"	12"	•	•	•	•	•
Carex obnupta, Slough sedge	•	•		•			E	48"	12"		•	•	•	•
Deschampsia cespitosa, Tufted hair grass		•		•			D	36"	12"	•	•	•	•	•
Eleocharis ovata, Ovate spike rush	•			•			E	30"	12"	•	•			
Elymus glaucus, Blue wild rye		•	•	•			E	24"	12"	•	•	•	•	•
Juncus ensifolius, Dagger-leaf rush	•	•				•	D	10"	12"	•	•	•	•	•
Juncus patens, Spreading rush	•	•	•			•	E	36"	12"	•	•	•	•	•
Sagittaria latifolia, Wapato	•			•			D	24"	12"	•	•			
Scirpus acutus, Hardstem bulrush	•					•	D	10"	12"	•	•			
Scirpus microcarpus, Small fruited bulrush	•	•		•			E	24"	12"	•	•	•	•	•
Veronica liwanensis, Speedwell		•				•	D	2"	12"	•	•	•	•	•
Small Shrubs/Groundcover														
Cornus sericea 'Kelseyi', Kelsey dogwood	•	•	•		•		D	2'	1'	•	•	•	•	•
Mahonia aquifolium, Oregon grape		•	•	•			E	5'	3'		•	•	•	•
Physocarpus capitatus, Pacific ninebark	•	•		•			D	6'	3'		•			
Polystichum munitum, Sword fern		•	•	•			E	2'	2'	•	•	•	•	•
Spirea betulifolia, Birchleaf spiraea		•	•	•			D	2'	2'	•	•	•	•	•
Smphoricarpus alba, Snowberry		•	•	•			D	3'	3'	•	•	•	•	•
Large Shrubs/Small Trees														
*Cornus sericea,*Red-Twig Dogwood	•	•	•	•			D	6'	4'					
Holodiscus discolor, Western serviceberry		•	•	•			D	6'	4'		•	•	•	
Rosa nutkana, Nootka rose		•	•	•			D	8'	4'		•		•	
Omleria cerasiformis, Indian plum		•		•			D	6'	4'		•	•	•	
Ribes sanguimeum, Red flowering currant		•	•	•			D	8'	4'		•	•	•	•
Salix sitchensis, Sitka willow	•	•		•			D	15'	5'					
Spirea douglasii, Douglas Spiraea			•	•			D	7'	4'		•	•	•	•
Ceanothus velutinus, Snowbrush		•	•	•			E	6'	3'		•	•	•	•
Trees														
Acer circinatum, Vine maple		•	•	•			D	15'	8'	•	•	•	•	•
Acer rubrum, Red Maple	•	•	•			•	D	40'	25'		•	•	•	
Alnus rubra, Red alder	•			•			D	80'	20'					•
Cornus nuttalii, Pacific Dogwood		•	•	•			D	20'	10'	•	•	•	•	•
Fraxinus latifolia, Oregon Ash	•	•		•			D	30'	25'					
Malus fusca, Pacific Crabapple	•	•		•			D	30'	10'	•	•			•

TABLE A-3: STORMWATER FACILITY PLANT LISTS: CONSTRUCTED WET PONDS

Constructed Wet Ponds	Zone			Origin			Type/Size			Context Factors				
Plant Name ***Botanical*, common**	Moisture zone (S) Saturated/permanent pool	Moisture zone (A) Uniformly wet to moist	Moisture Zone (B) Drier transitional area	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3 feet wide	Fully -lined facility	Parking areas	Streets	Adjacent to buildings
Pseudotsuga menziesii, Douglas fir		•	•	•			E	200'	30'					
Thuja plicata, Western red cedar	•	•	•	•			E	150'	20'			•		

TABLE A-4: STORMWATER FACILITY PLANT LISTS: VEGETATED FILTER STRIPS

Vegetated Filter Strips	Zone	Origin			Type/Size			Context Factors					
Plant Name ***Botanical*, Common**	Moisture zone (A/B) Dry to moist on slope	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3' wide	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Herbaceous Plants													
Aster suspicatus, Douglas' aster	•	•			D	36"	12"	•	•	•	•	•	•
Camassia quamash, Camas lily	•	•			D	24"	12"	•	•	•	•	•	•
Deschampsia caespitosa, Tufted hair grass	•	•			D	36"	12"	•	•	•	•	•	•
Festuca rubra, Red fescue	•	•			E	24"	12"	•	•	•	•	•	•
Elymus glaucus, Blue wild rye	•	•			E	24"	12"	•	•	•	•	•	•
Juncus patens, Spreading rush	•			•	E	36"	12"	•	•	•	•	•	
Lupinus polyhyllus, Large-leaved lupine	•	•			D	36"	12"	•	•	•	•	•	•
Sedum oreganum, Oregon stonecrop	•	•			E	4"	12"	•	•	•	•	•	•
Sisyrinchium californicum, Yellow-eyed grass	•	•			E	4"	12"	•	•	•	•	•	•
Veronica liwanensis, Speedwell	•			•	D	2"	12"	•	•	•	•	•	
Small Shrubs/Groundcover													
Cornus sericea 'Kelseyi', Kelsey dogwood	•		•		D	2'	12"	•	•	•	•	•	
Fragaria chiloensis, Coastal strawberry	•	•			E	6"	12"	•	•	•	•	•	•
Gaultheria shallon, Salal	•	•			E	24"	24"	•	•	•	•	•	•
Mahonia aquifolium, Oregon grape	•	•			E	5'	3'		•	•	•	•	•
Physocarpus capitatus, Pacific ninebark	•	•			D	6'	3'		•				•
Polystichum munitum, Sword fern	•	•			E	2'	2'	•	•	•	•	•	•
Rosa pisocarpa, Swamp rose	•	•			D	8'	3'		•	•			•
Spirea betulifolia, Birchleaf spiraea	•	•			D	2'	2'	•	•	•	•	•	•
Symphoricarpus alba, Snowberry	•	•			D	3'	3'	•	•	•	•	•	•
Large Shrubs/Small Trees													
*Cornus sericea,*Red-Twig dogwood	•	•			D	6'	4'						•
Holodiscus discolor, Western serviceberry	•	•			D	6'	4'		•	•	•		•
Omleria cerasiformis, Indian plum	•	•			D	6'	4'		•	•	•		•
Ribes Sanguimeum, Red flowering currant	•	•			D	8'	4'		•	•	•	•	•
Salix stichensis, Sitka willow	•	•			D	15'	5'						•
Salix purpurea nana, Blue arctic willow	•			•	D	8'	6'			•	•	•	
Ceanothus sanguineum, Redstem ceanothus	•	•			E	7'	3'		•	•	•	•	•

TABLE A-4: STORMWATER FACILITY PLANT LISTS: VEGETATED FILTER STRIPS

Vegetated Filter Strips	Zone	Origin			Type/Size			Context Factors					
Plant Name ***Botanical*, Common**	Moisture zone (A/B) Dry to moist on slope	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing	Facilities < 3' wide	Fully-lined facility	Parking areas	Streets	Adjacent to buildings	In buffer area
Trees													
Acer circinatum, Vine maple	•	•			D	15'	8'	•	•	•	•	•	•
Alnus Rubra, Red alder	•	•			D	80'	20'					•	•
Cornus nuttalii, Pacific dogwood	•	•			D	20'	10'	•	•	•	•	•	•
Fraxinus Latifolia, Oregon ash	•	•			D	30'	25'						•
Malus Fusca, Pacific crabapple	•	•			D	30'	10'	•	•			•	•
Pseudotsuga menziesii, Douglas fir	•	•			E	200'	30'						•
Thuja plicata, Western red cedar	•	•			E	150'	20'			•			•

TABLE A-5: STORMWATER FACILITY PLANT LISTS: GREEN ROOFS

Green Roofs	Zone		Origin			Type/Size		
Plant Name ***Botanical*, common**	Moisture Zone (C) Extensive Ecoroof	Moisture zone (D) Intensive Roof Garden	NW native	NW native cultivar	Non-native adapted	(E)vergreen/(D)eciduous	Potential height	Typical on center spacing
Sedums and Succulents								
Delosperma ssp., Ice plant	•	•			•	E	4"	6-12"
Malephora crocea v. purpureo, Coppery mesemb	•	•			•	E	10"	6-12"
Sedum acre, Biting stonecrop	•				•	E	2"	6-12"
Sedum album, White stonecrop	•				•	E	3"	6-12"
Sedum divergens, Pacific stonecrop	•				•	E	3"	6-12"
Sedum hispanicum, Spanish stonecrop	•				•	E	3"	6-12"
Sedum kamtschaticum, Kirin-so	•	•			•	D	6"	6-12"
Sedum oreganum, Oregon stonecrop	•	•	•			E	4"	6-12"
Sedum sexangulare, Tasteless stonecrop	•	•			•	E	4"	6-12"
Sedum spathufolium, Stonecrop	•	•			•	E	4"	6-12"
Sedum spurium, Two-row stonecrop	•	•			•	E	6"	6-12"
Sempervivum tectorum, Hens and chicks	•				•	E	3"	6-12"
Herbaceous Plants								
Achillea millefolium, Common yarrow	•	•			•	D	24"	24"
Artemesia 'Silver Mound', Artemesia	•	•			•	D	12"	12"
Castilleja foliosa, Indian paintbrush	•	•	•			D	10"	12"
Dianthus ssp., Dianthus	•				•	D	12"	12"
Erigeron discoideus, Fleabane	•				•	D	12"	12"
Festuca glauca 'Elijah's Blue', Elijah's blue fescue	•	•			•	E	12"	12"
Fragaria chiloensis, Coastal strawberry	•	•	•			E	6"	12"
Gilia capitata, Blue thimble flower	•		•			D	12"	12"
Lobularia maritima, Sweet alyssum	•				•	D	12"	12"
Polystichum munitum, Sword fern	•	•	•			E	24"	24"
Thymus serphyllum, Creeping thyme	•				•	D	3"	6"
Veronica liwanensis, Speedwell	•				•	D	2"	6"

APPENDIX B

INFILTRATION TESTING

B.1.00 GENERAL

a. To properly size and locate stormwater management facilities, it is necessary to characterize the soil infiltration conditions at the location of the proposed facility.

b. 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.

c. A qualified professional shall exercise judgment in the selection of the infiltration test method. The three infiltration testing methods used to determine a design infiltration rate are:

   1. Open pit falling head

   2. Encased falling head

   3. Double-ring infiltrometer

B.2.00 TESTING CRITERIA

a. Testing shall be conducted or observed by a qualified individual working under the supervision of a Professional Engineer (PE), Registered Geologist (RG), or Certified Engineering Geologist (CEG) licensed in the state of Oregon.

b. The location and depth of the test shall correspond to the facility location and depth.

c. Infiltration testing should not be conducted in engineered or undocumented fill.

d. Test Pit or Boring logs shall be provided as supporting information with infiltration and depth to groundwater tests.

Note: All testing data shall be documented with the project's submittals. The submittals shall adequately demonstrate that the proposed facilities 1) are appropriate to the assessment and characterization of the site, 2) will work, based on in situ infiltration tests, and 3) are sized appropriately, based on design infiltration rates.

B.2.01 Depth and Location of Required Tests

a. Infiltration tests shall be performed at the base of the proposed facility.

b. 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.

c. 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.

d. 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.2.02 Minimum Number of Required Tests

a. At least one test for any proposed facility.

b. The number of tests, at the discretion of the qualified professional, shall produce a picture of the subsurface conditions that fully represents the conditions throughout the facility site. However, the City reserves the right to direct the frequency and number of tests to be performed.

c. 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. At a minimum an infiltration test shall be performed in each soil stratum proposed to be used for infiltration.

d. Factors of Safety

Table B-1 lists the minimum allowable factors of safety 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 maximum design infiltration rate is 20 inches per hour.

TABLE B-1. INFILTRATION RATE SAFETY FACTOR	
Test Method	**Required Correction Factor**
Encased Falling Head	3
Open Pit Falling Head	2
Double-Ring Infiltrometer	Public Facilities: 1 Private Facilities: 2

B.2.03 Open Pit Falling Head Test Procedure

The open pit falling head test 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.

The following steps shall be followed in completing the test procedure:

a. 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, scarify the sides and bottom of the hole with a sharp-pointed instrument, and remove the loose material from the bottom of the test hole.

b. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.

c. 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.

d. 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).

e. 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.

f. 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.

g. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour. If the water has not completely drained within 1 hour, continue taking measurements at 20-minure intervals for another hour (2 hour maximum) 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 sand or gravel (or 8 inches above the bottom of the hole).

h. 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 6 inches above the sand or gravel (or 8 inches above the bottom of the hole). Enter results into the data table (See **Figure B-2**).

i. 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 **Figure B-2**.

j. 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:

1. Approximate the area over which the water is infiltrating.

2. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.

3. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches, including floor and area of sidewalls exposed to infiltration).

k. Continue excavating the test pit a minimum of five feet below the testing elevation (B.2.06.b). Upon completion the excavation shall be backfilled.

B.2.04 Encased Falling Head Test Procedure

The encased falling head test 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.

The following steps shall be followed in completing the test procedure:

a. 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.

b. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.

c. Add clean water to the casing to 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.

    1. 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..

    2. In sandy soils with little or no clay, soaking is not necessary. If after filling the casing twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

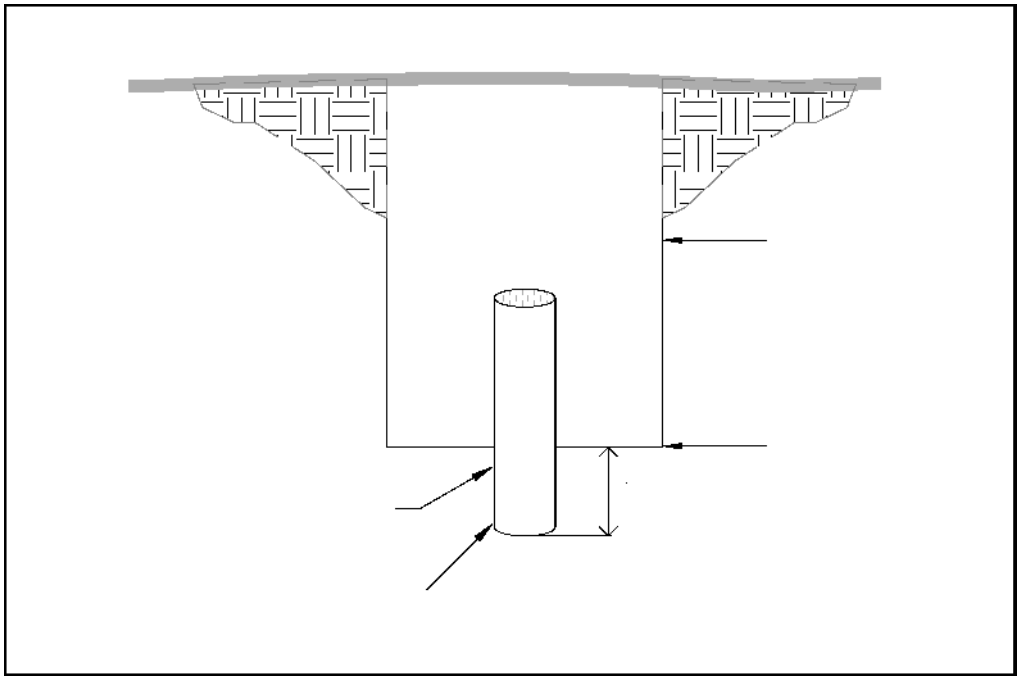

Figure B.1. Encased Falling Head Procedure

d. To conduct the first trial of the test, add clean water to the pipe to approximately 6 inches above the sand or gravel (or 8 inches above the bottom of the hole) 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.

e. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour. If the water has not completely drained within 1 hour, continue taking measurements at 20-minure intervals for another hour (2 hour maximum) 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 shall be readjusted to the 6 or 8 inch level. Enter results into the data table (see **Figure B-2**). At no time during the test is the water level allowed to rise more than 6 inches above the sand or gravel (or 8 inches above the bottom of the hole).

f. 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.

g. Continue boring a minimum of 5 feet below the testing elevation (B.2.06.b). Upon completion of the boring, fill borehole in compliance with Oregon DEQ requirements.

B.2.05 Double Ring Infiltrometer Test

The double-ring infiltrometer test procedure shall conform to ASTM 3385-09. 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.2.06 Reporting Requirements

In addition to the information required by the state for a signed and stamped geotechnical report, the following information should be included in the project's submittals:

a. Infiltration results in inches per hour.

b. 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 and the seasonal high groundwater or soil layer that could reduce the infiltration rate.

c. 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.

d. Discussion of how the test was performed:

1. Open pit (size of area)
2. Encased falling head
    (a) Pipe type
    (b) Embedment depth
    (c) Size of pipe
3. Double ring infiltrometer
    (a) Pipe type
    (b) Embedment depth
    (c) Size of pipe
4. Soil types with depth (Test Pit and/or Boring logs)
5. Groundwater observations–seasonal high groundwater level estimation

FIGURE B-2. INFILTRATION TEST DATA TABLE EXAMPLE

Location: Lot 105, Low Point Heights Subdivision			**Date:** 6/28/2010	**Test Hole Number:** B-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 Top Soil		
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	4.08	-		Filled with 8"
9:20	20	4.16	0.08	2.88	
9:40	20	4.24	0.08	2.88	
10:00	20	4.31	0.07	2.52	
10:20	20	4.37	0.06	2.16	
10:40	20	4.44	0.07	2.52	
11:00	20	4.50	0.06	2.16	
11:20	20	4.55	0.05	1.98	
					Adjusted to 8" 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.

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**