Chapter 4

RUNOFF TREATMENT AND CONTROL

4.01 General Provisions

- 4.01.1 Introduction
- 4.01.2 Application and Interpretation of this Chapter
- 4.01.3 Organization of Chapter

4.02 Water Quantity Control Requirements for Conveyance Capacity

- 4.02.1 Mitigation Requirement
- 4.02.2 Criteria for Requiring Onsite Detention for Conveyance Capacity

4.03 Hydromodification Approach Requirements

- 4.03.1 General
- 4.03.2 Hydromodification Assessment Requirement
- 4.03.3 Hydromodification Assessment Methodology
- 4.03.4 Reach-Specific Risk Level Evaluation
- 4.03.5 Hydromodification Approach Selection
- 4.03.6 Criteria for Requiring Implementation of a Hydromodification Approach

4.04 Water Quality Treatment Requirements

- 4.04.1 General
- 4.04.2 Required Treatment Design Efficiency
- 4.04.3 Criteria for Requiring Implementation of a Water Quality Approach
- 4.04.4 Green Infrastructure Infiltration Approach
- 4.04.5 Green Infrastructure Treatment Approach
- 4.04.6 Proprietary Treatment Approach

4.05 Site Design Considerations

- 4.05.1 Purpose
- 4.05.2 Design Considerations

4.06 Summary of Stormwater Management Approaches

4.07 Stormwater Management Approach Design Considerations

- 4.07.1 Pretreatment
- 4.07.2 Erosion Protection
- 4.07.3 Vegetation
- 4.07.4 Fencing
- 4.07.5 Walls
- 4.07.6 Access
- 4.07.7 Maintenance Responsibilities
- 4.07.8 Proprietary Treatment or Grey Infrastructure

4.08 Stormwater Management Approach Sizing

- 4.08.1 Impervious Area Used In Design

4.08.2 Storm Events Used in Design
4.08.3 Infiltration Rates for Facility Sizing
4.08.4 Simplified Sizing
4.08.5 Standard Sizing
4.08.6 Peak-Flow Matching Hydraulic Design Criteria
4.08.7 Flow Duration Curve Matching Hydraulic Design Criteria

4.09 Stormwater Management Approach and Facility Standards

4.09.1 Water Quality Maintenance Holes
4.09.2 Detention Pond
4.09.3 Underground Detention
4.09.4 Vegetated Swale
4.09.5 Extended Dry Basin
4.09.6 Constructed Water Quality Wetland
4.09.7 Structural Planter
4.09.8 Non-Structural Planter (Rain Garden)
4.09.9 Street-Side Planter
4.09.10 Constructed Filter Strip
4.09.11 Vegetated Filter Strip
4.09.12 Green Roofs
4.09.13 Porous Pavement
4.09.14 Stormwater Tree
4.09.15 Structural Soils

Chapter 4

RUNOFF TREATMENT AND CONTROL

4.01 General Provisions

4.01.1 Introduction

The purpose of this Chapter is to outline design requirements for storm and surface water management related to water quality, quantity control for conveyance capacity, and hydromodification. The provisions of this chapter are intended to prevent or reduce adverse impacts to the drainage system and water resources of the Tualatin River Basin.

4.01.2 Application and Interpretation of this Chapter

a. The provisions of this Chapter shall apply to all Development projects within District and City jurisdictions. Interpretations of such provisions and their application in specific circumstances shall be made by the District and City.

b. The following categories are generally exempt from the requirements of this chapter:

1. Farming practice as defined by ORS 30.930, except that building associated with farm practices and uses are subject to the requirements of these standards.

2. Action by a public utility or other governmental agency to remove or alleviate an emergency condition.

3. Road and parking area preservation/maintenance projects such as pothole and square cut patching, surface sealing, mill/resurface or overlaying of existing asphalt or concrete pavement, provided the preservation/maintenance activity does not expand the existing area of impervious coverage by 1,000 square feet or greater.

4. Standalone project elements that consist solely of safety and/or access improvements to stairs, ramps, sidewalks, curbs, corners, and medians that install accessibility and pedestrian safety features, provided the activity is primarily focused on replacing existing impervious area and does not expand the total impervious area coverage of the project by 1,000 square feet or greater. Examples include Americans with Disabilities Act (ADA) improvements, enhanced pedestrian crossings, and concrete curb extensions. See Section 4.04.3.a.4 for projects that result in 1,000 square feet or greater of new impervious surface.

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

6. Maintenance or repair of existing utilities.

c. Any City operating a local program may adopt more restrictive design standards within its jurisdiction.

d. Notwithstanding 4.01.2.b, where District and City standards conflict, the District's standards shall apply.

e. Projects that result in stormwater infrastructure that will be owned, operated, and maintained by Oregon Department of Transportation (ODOT), or are otherwise required to meet ODOT stormwater management requirements, may be designed using the ODOT design storm for water quality treatment and design details for stormwater management practices. Local CWS standards shall be used to evaluate project area thresholds for requiring stormwater management, and where ODOT and CWS standards conflict, treatment of the larger contributing impervious area shall apply.

f. Projects that receive federal funding or are otherwise required to meet federal stormwater management requirements may request local acceptance of this stormwater management plan, if demonstrated to be comparable to local standards. The agency responsible for operating the local stormwater system (CWS or City) may, in its sole discretion, determine if the system resulting from the proposed plan can be operated and maintained as part of the local program.

g. The use of Development techniques that mimic natural systems, including LIDA and Green Infrastructure, shall be prioritized as feasible according to the criteria outlined in these standards in Sections 4.04.3 through 4.04.6.

4.01.3 Organization of Chapter

The organization of this Chapter is intended to follow the site evaluation and design process, as described below:

a. Sections 4.01- 4.05

Stormwater management requirements that are applicable given a project's characteristics and location.

b. Section 4.06

Overview of stormwater management approaches that may be used on a project to meet applicable stormwater management requirements.

c. Sections 4.07- 4.09

Sizing and design criteria for stormwater management facilities and approaches.

4.02 Water Quantity Control Requirements for Conveyance Capacity

4.02.1 Mitigation Requirement

Each new development shall incorporate techniques for mitigating its impacts on the public stormwater system in accordance with Section 5.05. The District or City shall determine which of the following techniques may be used to satisfy this mitigation requirement.

a. Construction of permanent onsite stormwater quantity detention facilities designed in accordance with this Chapter; or

b. Enlargement or improvement of the downstream conveyance system in accordance with this Chapter and Chapter 5; or

c. Payment of a Storm and Surface Water Management System Development Charge (SWM SDC), as provided in CWS Ordinance 28, which includes a water quantity component to meet these requirements. If District or City requires that an onsite detention facility be constructed, the Development shall be eligible for a credit against SWM SDC fees, as provided in District Ordinance and Rules.

4.02.2 Criteria for Requiring Onsite Detention for Conveyance Capacity

Onsite facilities shall be constructed when any of the following conditions exist:

a. There is an identified downstream deficiency, and the District or City determines that detention rather than conveyance system enlargement is the more effective solution.

b. There is an identified regional detention site within the boundary of the Development.

c. Water quantity facilities are required by District adopted watershed management plans or subbasin master plans or District approved subbasin strategy.

4.03 Hydromodification Approach Requirements

4.03.1 General

Owners of new Development and other activities that create and/or Replace 1,000 square feet or greater of impervious surface or increase the amount or rate of surface water leaving a site, are required to implement or fund

techniques to reduce impacts to the downstream receiving water body. The following techniques may be used to satisfy this requirement:

a. Construction of a permanent stormwater facility listed in Table 4-3 as approvable for the management of hydromodification; or

b. Construction or funding of a hydromodification approach that is consistent with a District-approved subbasin strategy; or

c. Payment of a Hydromodification Fee-In-Lieu.

4.03.2 Hydromodification Assessment Requirement

Unless specifically waived in writing by the District, a Hydromodification Assessment is required of all activities described in Section 4.03.1, unless the activity meets any of the following criteria:

a. The project results in the addition and/or Replacement of less than 12,000 square feet of impervious surface.

b. The project is located in an area with a District-approved subbasin strategy with an identified regional stormwater management approach for hydromodification.

4.03.3 Hydromodification Assessment Methodology

A Hydromodification Assessment is necessary to determine the Risk Level of the Receiving Reach, Development Class, and Project Size Category for a project. These three parameters are used to determine the Hydromodification Approach requirements for a project.

A Hydromodification Map is published on the District's website to assist with the assessment, and below is the methodology for determining each parameter:

a. Risk Level

1. Locate the Project Site on the Hydromodification Map.
2. Determine the Point of Discharge by evaluating the existing or proposed surface water conveyance system, and find the location where stormwater outfalls to a Sensitive Area. If the Sensitive Area is a wetland or pond, continue to follow the flow path until it reaches a stream. The Point of Discharge is the location where stormwater enters a stream. If a project drains in more than one direction, each drainage basin and Point of Discharge should be evaluated independently.

3. Identify the Receiving Reach, which is the section of stream that begins at the Point of Discharge and extends along the centerline of the stream for ¼ mile downstream from the Point of Discharge.

4. Determine the Risk Level

   A) Locate the Receiving Reach on the Hydromodification Map and use the Map Key to determine the mapped Risk Level. If the Receiving Reach includes more than one Risk Level, select the highest level.
   B) If the applicant, City, or District identifies additional Receiving Reach conditions that may result in a different Risk Level than is identified on the Hydromodification Map, conduct a site-specific evaluation of each Receiving Reach in accordance with the Risk Level Evaluation described in Section 4.03.4.

5. Use the result of Section 4.03.3.(a)(4) above to identify the Risk Level, which will be one of the following categories:

   A) High
   B) Moderate
   C) Low

b. Development Class

1. Determine the Development Class at the location of the Project Site by using either of the following two methods:

   A) Locate the Project Site on the Hydromodification Map and use the Map Key to determine the Development Class.
   B) Identify the date that the area that includes the Project Site was incorporated by Metro into the Urban Growth Boundary. For the purposes of the Hydromodification Assessment, areas added prior to 2002 are classified as Developed Area and areas added after 2002 and remain largely undeveloped are classified as Expansion Area.

2. Use the result of Section 4.03.3.(b)(1) to identify the Development Class, which will be one of the following categories:

   A) Developed Area
   B) Expansion Area

c. Project Size Category

1. The Project Size Category is determined by calculating the area of proposed new and/or Replaced impervious surface. Calculate this area using the methodology described in Section 4.08.1.

2. Use the results to identify the Project Size Category, which will be one of the following:

A) Small: 1,000 to 12,000 square feet
B) Medium: over 12,000 to 80,000 square feet
C) Large: over 80,000 square feet and larger

4.03.4 Reach-Specific Risk Level Evaluation

If the applicant, City, or District identifies additional Receiving Reach conditions that may result in a different Risk Level than is identified on the Hydromodification Map (per Section 4.03.3), a reach-specific evaluation of the Receiving Reach may be used to determine the Risk Level. Use the evaluation results for the following four parameters in conjunction with Table 4-1 to determine the Risk Level. Identify the Risk Level associated with each parameter in Table 4-1. If there is more than one Risk Level, select the highest to represent the Receiving Reach.

a. Stream Gradient

Determine the longitudinal slope of the Receiving Reach using one of the following methods:

1. Desktop Methodology: Using the current LiDAR bare earth model, determine the slope of the stream channel along the centerline within the Receiving Reach at 50-foot intervals. Determine the channel slope for each interval, and use the average slope of the steepest three segments to determine the Risk Level in Table 4-1.
2. Field Methodology: Measure the slope of the stream along the deepest part of the channel within the Receiving Reach at 50-foot intervals. Determine the channel slope for each interval. Use the average slope of the steepest three segments to determine the Risk Level in Table 4-1.

b. Stream Bank Height Ratio

Measure the height difference between the toe of the streambank and the top of the streambank (measurement A), and the toe of the streambank and ordinary high water ("bankfull"; measurement B). Take measurements beginning at the upstream limit of the Receiving Reach and repeat at 100-foot increments throughout the Receiving Reach. Calculate the stream Bank Height Ratio, as A/B, for each 100-foot increment. Use the average of the three highest values to determine the Risk Level in Table 4-1.

c. Valley Confinement

Determine the square footage of area adjacent to and within 135 feet laterally of the stream ("adjacent land" in Table 4-1) that is confined by steep (>25%) or moderately steep (10-25%) slopes using the current

LiDAR bare earth digital elevation model. Use the result to determine the Risk Level in Table 4-1.

d. Landslide Susceptibility

Determine the landslide susceptibility of land adjacent to and within 135 feet laterally of the stream ("adjacent land" in Table 4-1) using one of the following methods:

1. Desktop Methodology: Using the current landslide susceptibility map issued by the Oregon Department of Geology and Mineral Industries, determine the landslide susceptibility within 135 feet laterally of the stream in the Receiving Reach. Polygons that are less than 1,000 square feet in area may be ignored. Use the result to determine the Risk Level in Table 4-1.
2. Field Methodology: A site-specific evaluation may be made by a Certified Engineering Geologist or a Geotechnical Engineer that the areas within 135 feet laterally of the stream in the Receiving Reach contain no location susceptible to slope failure under current climatic and land cover conditions. The evaluation must describe how changes in the condition or pattern of land cover, drainage, or vertical or lateral channel migration or inundation would affect slope stability within the Receiving Reach. The result of the analysis may be used to demonstrate Risk Level as low, otherwise, the result of the desktop methodology will apply.

TABLE 4-1
REACH-SPECIFIC PARAMETERS FOR RISK LEVEL

Parameter	Low	Moderate	High
Stream Gradient	< 2%	2% - 4%	> 4%
Bank Height Ratio	< 1.2	1.2 - 1.4	> 1.4
Valley Confinement	50% or less of the Receiving Reach and adjacent land has land surface slopes exceeding 10%.	More than 50% of the Receiving Reach and adjacent land has land surface slopes that exceed 10%.	More than 50% of the Receiving Reach and adjacent land has land surface slopes that exceed 25%.
Landslide Susceptibility	No portion of the Receiving Reach and adjacent land is mapped as "moderate", "high" or "very high" landslide susceptibility.	Any portion of the Receiving Reach and adjacent land is mapped as "moderate," and no areas are mapped as "high" or "very high" landslide susceptibility.	Any portion of the Receiving Reach and adjacent land is mapped as "high" or "very high" landslide susceptibility.

4.03.5 Hydromodification Approach Selection

Using the results of the Hydromodification Assessment described in Section 4.03.3, determine the corresponding project category from Table 4-2 below.

TABLE 4-2
HYDROMODIFICATION APPROACH PROJECT CATEGORY TABLE

<table>
<tr><th>Development Class/
Risk Level</th><th>Small Project
1,000 – 12,000 SF</th><th>Medium Project
>12,000 – 80,000 SF</th><th>Large Project
> 80,000 SF</th></tr>
<tr><td>Expansion/ High</td><td rowspan="6">Category 1</td><td rowspan="2">Category 3</td><td rowspan="3">Category 3</td></tr>
<tr><td>Expansion/ Moderate</td></tr>
<tr><td>Expansion/ Low</td><td>Category 2</td></tr>
<tr><td>Developed/ High</td><td>Category 3</td><td rowspan="3">Category 2</td></tr>
<tr><td>Developed/ Moderate</td><td rowspan="2">Category 2</td></tr>
<tr><td>Developed/ Low</td></tr>
</table>

Stormwater management options for each category are listed below:

a. Category 1

Projects in Category 1 represent those with the lowest anticipated risk. Any of the following options may be used to address hydromodification:

1. Infiltration facility, using the Simplified Sizing, as described in Section 4.08.4; or
2. Payment of a Hydromodification Fee-In-Lieu in accordance with District Rates and Charges; or
3. Any option listed in Category 2 or 3.

b. Category 2

Projects in Category 2 represent those with a moderate anticipated risk. Any of the following options may be used to address hydromodification:

1. Infiltration facility, using the Standard Sizing, described in Section 4.08.5; or
2. Peak-Flow Matching Detention, using design criteria described in Section 4.08.6; or
3. Combination of Infiltration facility and Peak-Flow Matching Detention, using criteria described in Section 4.08.5 and 4.08.6; or

4. Any option listed in Category 3.

c. Category 3

Projects in Category 3 represent those with the highest anticipated risk. Any of the following options may be used to address hydromodification:

1. Peak-Flow Matching Detention and LIDA:

A) Peak-Flow Matching Detention using the design criteria described in Section 4.08.6, and
B) Management of runoff from 30% of the impervious area using any LIDA in Table 4-3, sized in accordance with Section 4.08.4.b, and designed as described in Section 4.09; or

2. Flow Duration Curve Matching Detention, using the sizing methodology described in Section 4.08.7.

d. Tualatin River Adjustment

The project category may be adjusted to Category 1 for projects that discharge directly to the Tualatin River. An applicant may request a project category adjustment if a project meets the following criteria:

1. The Point of Discharge is directly to the Tualatin River, and

2. The stormwater conveyance system from the project site to the Tualatin River is completely piped or, if open channel conveyance, the system is lined with rock or other material that is not at risk of downcutting or damage caused by increased stormwater discharge.

4.03.6 Criteria for Requiring Implementation of a Hydromodification Approach

a. A Hydromodification Approach shall be implemented onsite unless any of the following conditions exist:

1. The result of Section 4.03.5 is that the project is Category 1 and the applicant selects Fee-In-Lieu; or

2. The project is located within a District approved stormwater management strategy area, and implementation of an approach is not a requirement of the Development; or

3. In the judgment of the District, implementation of an onsite hydromodification approach is impracticable or ineffective due to topography, soils, landslide risk, high water table, or other site conditions. The District may require a site-specific analysis (e.g., infiltration testing, geotechnical evaluation) to support such a determination; or

4. In the judgment of the District, onsite implementation results in the inefficient use of District or City resources for long-term operations and maintenance; or

5. In the judgment of the District, the proposed Development is likely to have a negligible impact and onsite implementation of a hydromodification approach will result in little or no benefit to the Receiving Reach, based on the District's analysis of the stream or the applicant's request for an Infill Exemption demonstrating all of the following factors:

   A) The Risk Level associated with the Receiving Reach is Low or Moderate. This is to ensure that highly sensitive stream reaches are not negatively impacted.
   B) The size of the impervious surface created and/or Replaced by a project is moderate to small. Until the District has performed its analysis, a project's impervious surface is moderate to small when the proposed new and/or impervious surface created by the Development is 25,000 square feet or less. Calculate this area using the methodology described in Section 4.08.1.
   C) The discharge from the project is small compared with the total tributary drainage flow in the receiving stream. Until the District has performed its analysis, a project's discharge will be considered small when the additional flow from the proposed Development is less than 10% of the total tributary drainage flow at the Point of Discharge.
   D) The project is located in a drainage basin with a high level of existing Development tributary to the downstream end of the Receiving Reach. Until the District has performed its analysis, drainage basins with less than 10 % of remaining developable area shall be considered to have a high level of existing Development. The remaining developable area within a drainage basin may exclude land uses that are not likely to be developed, including but not limited to parks, cemeteries, undevelopable tracts, and protected natural resources.

b. If construction or implementation of a hydromodification approach is not required as a result of meeting any condition outlined in Section 4.03.6.a, the applicant shall pay a Fee-In-Lieu of construction or implementation of a Hydromodification Approach in accordance with District Rates and Charges.

4.04 Water Quality Treatment Requirements

4.04.1 General

Owners of new Development and other activities that create and/or Replace 1,000 square feet or greater of impervious surfaces are required to implement

or fund a permanent Water Quality Approach to reduce contaminants entering the storm and surface water system. The sequence of priority for water quality treatment is:

a. Green Infrastructure Infiltration Approach
b. Green Infrastructure Treatment Approach
c. Proprietary Treatment Approach
d. Water Quality Fee-in-Lieu (as described in 4.04.3.c)

The Water Quality Approach sequence of priority shall be implemented as feasible, based on criteria described in Sections 4.04.3 through 4.04.6.

4.04.2 Required Treatment Design Efficiency

a. Water Quality Approaches shall be designed to treat runoff from all Development projects as described in Section 4.08.1.

b. Water Quality Approaches shall be designed to target removal of 80% of the total suspended solids (TSS) and 65% of the total phosphorus from the runoff from the impervious area that is tributary to the facility.

c. The TSS and phosphorus removal efficiencies are dependent on the quality of runoff flowing into the stormwater quality facilities. These target removal efficiencies are associated with the Water Quality Approach design requirements and are not intended as a basis for performance evaluation or compliance determination of the Water Quality Approach installed or constructed pursuant to this Chapter.

d. The Water Quality Approaches listed in Table 4-3 as approvable for Treatment are available for meeting the treatment design efficiency standard in this section.

4.04.3 Criteria for Requiring Implementation of a Water Quality Approach

a. A Water Quality Approach shall be implemented onsite unless, in the judgment of the District or City, any of the conditions in 4.04.3.a.1-5 exist. If conditions limit implementation of an onsite Water Quality Approach, refer to 4.04.3.b first and then 4.04.3.c.

    1. There is an effective regional or alternate approach within the subbasin that is demonstrated to have the capacity to provide treatment of runoff from the site to address the water quality treatment requirements as outlined in Section 4.04.

    2. Any of the siting conditions listed below restrict the implementation of a Water Quality Approach.

        A) Regulatory Floodway: Stormwater infiltration and treatment facilities are prohibited within the identified Floodway.

B) Drainage and Topographic Constraints: Stormwater infiltration and treatment facilities are not required on all or a portion of the site where topography prevents runoff from reasonably draining to the facility. The design process must demonstrate a reasonable effort to manage stormwater with thoughtful site planning and evaluation of alternative site layouts.

C) Access and Maintenance Constraints: Stormwater infiltration and treatment facilities may not be required for treatment where in the judgment of the District or City the location would prevent or significantly reduce proper maintenance or routine inspection of the facility.

D) Protected Natural Features: Placement of stormwater infiltration and treatment facilities is limited in Vegetated Corridors consistent with the requirements of Chapter 3 and prohibited in natural resource and natural hazard areas as regulated under local, state, or federal requirements.

3. Implementation of an onsite approach is impractical, inconsistent with local jurisdictional authorities, ineffective, and/or results in the inefficient use of District or City resources for long-term operations and maintenance.

4. Standalone project elements that consist solely of safety and/or access improvements to stairs, ramps, sidewalks, curbs, corners, and medians that install accessibility and pedestrian safety features, provided the activity is primarily focused on replacing existing impervious area and where the activity also expands the total impervious area coverage of the project by 1,000 square feet or greater. Examples include ADA improvements, enhanced pedestrian crossings, and concrete curb extensions. See Section 4.01.2.a.4 for these project types when they result in adding less than 1,000 square feet of new impervious surface to the total impervious area coverage of the project.

5. The project results in new and Replaced impervious surface area that is less than 2,640 square feet, and there is no net increase in total impervious surface area.

b. If an onsite Water Quality Approach cannot be constructed or implemented to manage the runoff from the Development's impervious surface, then with District or City approval, an onsite or off-site stormwater management approach may be designed to manage runoff from an equivalent area of existing impervious surface.

c. If construction or implementation of a Water Quality Approach is not required as a result of meeting any condition outlined in Section 4.04.3 (a) (1)-(5) or 4.04.3.b, the Owner of the Development shall pay a Fee-In-Lieu

of construction or implementation of a Water Quality Approach in accordance with District or City Rates and Charges.

4.04.4 Green Infrastructure Infiltration Approach

a. A Water Quality Approach prioritizing Green Infrastructure and infiltration (i.e., retention) of the Water Quality Design Storm (Section 4.08.2) shall be implemented onsite unless, in the judgment of the District or City, any of the prohibitions or limitations in this section exist, or as described in Section 4.04.6.b.

b. Infiltration approaches (i.e., unlined facilities) are prohibited in the situations listed below. In these situations, an alternative shall be used as described in Sections 4.04.5 (Green Infrastructure Treatment Approach) through 4.04.6 (Proprietary Treatment Approach).

1. Landslide Susceptibility: Infiltration facilities are prohibited on sites with "high" or "very high" landslide susceptibility as designated by the most current version of SLIDO: Statewide Landslide Information Database for Oregon.

2. Slopes: Infiltration facilities are prohibited where slopes are ≥25%. Infiltration facilities are generally prohibited where slopes are ≥15% and <25%, unless accompanied by a geotechnical report describing conditions under which infiltration can be safely implemented.

3. Contaminated Soils: Infiltration facilities are prohibited where there is the presence of subsurface contamination, such as would be documented in a "no further action" determination following site cleanup or listed as an active cleanup site by Oregon Department of Environmental Quality.

4. Depth to Seasonal High Groundwater: Infiltration facilities are prohibited on sites where depth to seasonal high groundwater, persistent restrictive layer, or competent bedrock is less than 3 feet below finished grade.

5. Infiltration adjacent to roadways and buildings must be consistent with approvals from the applicable road or building authority, and without those approvals is prohibited.

c. Where not prohibited, as described in Section 4.04.4.b above, infiltration is assumed to be feasible but limited on sites located in C, D, or C/D soils as shown in the most current version of the Web Soil Survey produced by the Natural Resources Conservation Service (Web Soil Survey - Home) or in soils where the measured infiltration rate is less than 1.0 inch per hour. For these sites, provide treatment and partial infiltration of the Water Quality Design Storm (Section 4.08.2) through an unlined Green

Infrastructure Infiltration Approach with an underdrain (see Section 4.04.5) that is sized in accordance with Section 4.08.4 (Simplified Sizing) or Section 4.08.5 (Standard Sizing).

d. Infiltration is assumed to be feasible on sites located in A, B, or A/B soils as shown in the most current version of the Web Soil Survey produced by the Natural Resources Conservation Service (Web Soil Survey - Home). In areas that do not have any of the infiltration prohibitions as listed above, and that are located in A, B, or A/B soils, infiltration testing is required as outlined in Section 4.08.3. Facility sizing requirements are based on the following infiltration conditions:

    1. If the measured infiltration rate is greater than or equal to 1.0 inch per hour, provide full infiltration of the Water Quality Design Storm (Section 4.08.2) through an unlined Green Infrastructure infiltration facility (no underdrain) sized in accordance with either Section 4.08.4 (Simplified Sizing) or Section 4.08.5 (Standard Sizing).

    2. If the measured infiltration rate is less than 1.0 inch per hour, or if infiltration testing is not conducted, size an unlined facility with an underdrain as if it was located in a C, D, or C/D soil as specified in Section 4.04.4.b.

e. Areas with "moderate" landslide susceptibility require dispersed infiltration unless accompanied by a geotechnical report describing conditions under which infiltration can be safely implemented.

4.04.5 Green Infrastructure Treatment Approach

a. When infiltration is prohibited as defined in Section 4.04.4, a Green Infrastructure Treatment Approach shall be implemented onsite, except as described in Section 4.04.6.b. The facility must be constructed with an impermeable liner and sized in accordance with Section 4.08.4 (Simplified Sizing) or Section 4.08.5 (Standard Sizing).

b. Green Infrastructure Treatment Approaches are prohibited when the depth to seasonal high groundwater is less than 3 feet below the final ground surface, as determined by a geotechnical report. If a Green Infrastructure Treatment Approach is prohibited, refer to Section 4.04.6.

4.04.6 Proprietary Treatment Approach

a. When Green Infrastructure Infiltration or Treatment Approaches are infeasible, as defined in Sections 4.04.4 and 4.04.5, with District or City approval, Proprietary Treatment Approaches may be used to treat the Water Quality Design Storm (Section 4.08.2).

b. A Proprietary Treatment Approach may also be used, with District or City approval, when the following zoning and land use constraints exist and prevent the implementation or practical functioning of a Green Infrastructure Infiltration or Treatment Approach:

1. Treatment of runoff from new and expanded collector and arterial roadways where no other opportunities exist for treatment without necessitating the removal of homes or businesses.

2. Treatment of runoff from Development in transit-oriented or similar high-density zoning classifications.

4.05 Site Design Considerations

4.05.1 Purpose

Low Impact Development Approaches (LIDA) and Green Infrastructure provide pollutant reduction associated with urban Development. Generally, the first priority for LIDA site layout is to conserve existing resources and minimize stormwater runoff generated from urban Development to mimic natural hydrologic processes.

4.05.2 Design Considerations

The following site design techniques may be used to reduce hydrologic impacts and optimize stormwater design for Development projects:

a. Site design that includes a combination of more than one stormwater management approach (e.g., detention pond and infiltration facility) may be used to reduce the size of any one individual facility.

b. Site design that conserves natural resources, reduces the amount of new and Replaced impervious surfaces, and mimics natural hydrologic processes may be used as a strategy to reduce the size of stormwater facilities.

c. Stormwater management approaches shall be designed so that flow from the Development is treated off-line from the storm conveyance system and reconnected with conveyance of any upstream flows following treatment. These off-line stormwater approaches may be sized to provide stormwater management for the Development area requiring management only. If an off-line approach is not feasible, and additional off-site flows are routed through the facility, the stormwater approach must be designed to manage all flow from the contributing drainage/tributary area to achieve the intended purpose of the facility (i.e., to meet hydromodification and/or water quality treatment standards).

d. Selection of appropriate stormwater management approaches, including surface infiltration, should ensure there are no adverse upstream or

downstream drainage impacts, and an appropriate maintenance program can be developed to sustain the functionality of the system.

e. Discharges to Water Quality Sensitive Areas shall maintain the hydroperiod and flows of pre-development site conditions to the extent necessary to protect the characteristic functions of the Water Quality Sensitive Area. Conversely, discharge of flows that may be critical to downstream Water Quality Sensitive Areas into other catchments will not be permitted unless addressed in the applicant's Service Provider Letter.

4.06 Summary of Stormwater Management Approaches

Table 4-3 provides a summary of the stormwater management approaches available for meeting the design requirements in this Chapter. Treatment approaches shall be used in combination with pretreatment, as specified in Section 4.07.1.

Proprietary Treatment Facilities meeting the requirements of Section 4.07.8 may be used when infiltration and LIDA/green infrastructure are infeasible as described in Section 4.04.6.

Alternative stormwater management approaches that can be demonstrated, to the satisfaction of the District, to meet the standards in this section shall be considered, as outlined in Section 1.06.

TABLE 4-3
SUMMARY OF APPROVABLE STORMWATER MANAGEMENT APPROACHES

Stormwater Management Approach[1]	**Infiltration Approach [3] Per Section 4.04.4**	**Treatment Approach[4] Per Section 4.04.5**	**Green Infrastructure**	**Quantity for Conveyance Capacity**	**Hydromodification Approach**
Water Quality Maintenance Hole[2]					
Detention Pond			✓	✓	✓
Underground Detention				✓	✓
Vegetated Swale		✓	✓		
Extended Dry Basin	✓	✓	✓	✓	✓
Constructed Water Quality Wetland		✓	✓	✓	✓
Structural Planter	✓	✓	✓	✓	✓
Non-Structural Planter (Rain Garden)	✓	✓	✓	✓	✓
Street-Side Planter	✓	✓	✓	✓	✓
Constructed Filter Strip		✓	✓		
Vegetated Filter Strip		✓	✓		
Green Roofs			✓	✓	✓
Porous Pavement	✓		✓	✓	✓
Stormwater Tree			✓		✓
Structural Soils			✓		✓
Proprietary Treatment System		✓			

1. *Approaches in the right-of-way must be approved by the local road authority.*
2. *Pretreatment only.*
3. *Approach is required to be unlined allowing for infiltration into native soil or subgrade.*
4. *Structural, Non-Structural, and Street-Side Planters require an impermeable liner when being used as a treatment approach and infiltration is prohibited.*

4.07 Stormwater Management Approach Design Considerations

4.07.1 Pretreatment

a. Pretreatment Required

Unless approved by the District, incoming flows to the stormwater management approach shall be pretreated using a water quality maintenance hole in accordance with Section 4.09.1, or as specified within the design criteria for specific stormwater management approaches. Other pretreatment methods such as a proprietary device, filter strip, or trapped catch basin may be approved by the District or City.

b. Proprietary Pretreatment Devices

1. The use of proprietary pretreatment devices may be permitted on a case-by-case basis with approval by the District or City.
2. The devices shall be sized in accordance with the manufacturer's recommendations using the minimum treatment flow as the water quality flow.
3. Technical submittals from the manufacturer are required, including hydraulic design criteria, particulate removal efficiency, and maintenance requirements and schedule.

4.07.2 Erosion Protection

a. Inlets to stormwater management approaches shall be protected from erosive flows through the use of an energy dissipater or a rip rap stilling basin of appropriate size based on flow velocities. Flow shall be evenly distributed across the treatment area.

b. Coconut matting or District-approved alternative shall be used in the treatment area of swales and below the water quality volume levels of ponds and all other zones.

4.07.3 Vegetation

a. Except as specified in Section 4.09, vegetation shall be in accordance with Appendix A: Planting Requirements.

b. No invasive species shall be planted or permitted to remain within an area used for water quality treatment or water quantity management, including, but not limited to, invasive species identified in the most current version of the District's Integrated Pest Management Plan.

4.07.4 Fencing

a. Unless otherwise approved by the District or City, delineation fencing shall be required around facilities and/or tracts containing facilities.

b. Fencing shall be a 4-feet high, vinyl-clad chain link fence with a 12-foot-wide lockable gate, conforming to Standard Detail 792, except as described below in subsections c and d.

c. If a facility is located adjacent to a Vegetated Corridor, Water Quality Sensitive Area, or other protected habitat or natural area, wildlife-friendly fencing shall be utilized.

d. If, in the opinion of the District or City, risk of damage to the facility and/or public safety is minimal, split rail fencing, dense vegetated hedges, or other approved method may be used to delineate the facility boundary. Fencing or similar barriers that blend into the surrounding neighborhood or site may be used, to the extent that they do not impede maintenance access or increase operation and maintenance costs to the District or City.

4.07.5 Walls

a. Retaining walls may serve as pond walls if the design is prepared and stamped by a registered professional engineer and a fence is provided along the top of the wall. At least 25% of the pond perimeter shall be vegetated to a side slope of 3H:1V or flatter.

b. Walls are not allowed in the treatment areas of any water quality approach.

c. Structural walls and walls that are 4 feet or higher (not including footings), or that are periodically inundated, shall meet all the following criteria:

1. Be approved by a licensed structural or geotechnical engineer; and

2. The District shall not have maintenance responsibility for the wall. The party responsible for maintenance of the walls within the tract or easement shall be clearly documented on the plat or in alternate form as approved by the District.

4.07.6 Access

a. General Access Requirement

Unless otherwise approved by the District or City, access roads shall be provided for maintenance of all stormwater management approaches. The following criteria are considered to be the minimum required for facilities maintained by the District or City. Other permitting jurisdictions may have more restrictive requirements. If the design Engineer anticipates that any of the requirements will not be met due to the configuration of the

proposed Development, the design Engineer is advised to meet with District or City staff to gain approval for the deviation prior to submittal.

b. Standard Road Design

1. The road section shall be three (3) inches of class "C" asphaltic concrete; over two (2) inches of ¾ inch–0 inch compacted crushed rock; over six (6) inches of 1½ inches–0 inch compacted crushed rock; over subgrade compacted to 95% AASHTO T-99; or, the design Engineer may submit an alternate design certified as capable of supporting a 30-ton maintenance vehicle in all weather conditions.
2. Strengthened sidewalk sections shall be used where maintenance vehicles will cross.
3. Maximum grade shall be 10% with a maximum 3% cross-slope.
4. Minimum width shall be 12 feet on straight runs and 15 feet on curves.
5. Curves shall have a minimum 40-foot interior radius.
6. Access shall extend to within 10 feet horizontal of the center of all sumped structures unless otherwise approved by the District or City.
7. The District or City may require a curb or other delineator at the edge of the road for drainage, a curb stop, or to demarcate the road where the road edge is not apparent.
8. The side slope for road embankments shall be 2H:1V or flatter.
9. A vehicle turnaround shall be provided when the access road exceeds 40 feet in length.

c. Alternate Access Road

An alternate access road design meeting the requirements of this section may be approved by the District or City for facilities in which access is required for general maintenance and long-term care of the facility, but where there is no structure requiring regular maintenance.

1. The road section shall meet the requirements of 4.07.6(b)(1) or an alternate section certified as capable of supporting AASHTO HS-20 loading.
2. As an alternative to the requirements of 4.07.6(c)(1), a concrete grid paver surface may be constructed by removing all unsuitable material, laying a geotextile fabric over the native soil, placing a structural border and pavers, filling the honeycombs/grids with soil, and planting appropriate grasses.

3. Strengthened sidewalk sections shall be required where maintenance vehicles will cross.

4. Maximum grade shall be 20% with a maximum 3% cross-slope.

5. Minimum finished width shall be 12 feet.

6. The District or City may require a curb or other delineator at the edge of the road for drainage, a curb stop, or to demarcate the road where the road edge is not apparent.

7. The side slope for road embankments shall be 2H:1V or flatter.

8. A vehicle turnaround shall be provided when the access road exceeds 40 feet in length.

4.07.7 Maintenance Responsibilities

a. Newly constructed stormwater management approaches shall be considered public and maintained by the District or City, except when the runoff is from:

   1. A single parcel, or

   2. More than one commercial or industrial parcel that has an easement or similar legally binding agreement to facilitate maintenance, access, and conveyance, in a form acceptable to the District or City, or

   3. ODOT right-of-way and the stormwater infrastructure is owned and maintained by ODOT.

b. Publicly maintained stormwater management approaches shall be covered by a surface and stormwater management easement dedicated to the District or City. The District or City shall also be granted an access easement to maintain the approaches. The District will typically not own the land the stormwater management approach is on.

c. Unless otherwise approved by the District or City, Development creating multiple parcels intended for separate ownership shall enclose the publicly maintained stormwater management approaches in a tract.

d. Unless otherwise approved by the District or City, private stormwater management approaches shall be maintained by the Owner and have a Private Stormwater Facility Agreement per Section 2.08.2.

4.07.8 Proprietary Treatment or Grey Infrastructure

a. Applicability

Proprietary treatment systems shall meet the removal efficiency requirement defined in Section 4.04.2 and be approved by the District for use in the situations identified in Section 4.04.6.

b. Maintenance

1. Proprietary treatment systems require a long-term maintenance plan identifying maintenance techniques, schedule, and responsible parties. This maintenance plan shall be submitted and approved with the drainage report for a project.

2. Treatment of runoff from multiple parcels may only be used if the District or City responsible for maintenance approves the system in writing.

4.08 Stormwater Management Approach Sizing

4.08.1 Impervious Area Used In Design

The impervious area used in design of stormwater management approaches for Development shall be determined as described below.

a. For new home construction on single-family and duplex lots, and residential partitions and subdivisions, stormwater management approaches shall be sized using the following criteria:

1. Actual impervious surface area in all public and private rights-of-way and common space created by the Development and existing impervious area proposed to remain on site (e.g., existing structures and paved areas).

2. An assumed rate of 2,640 square feet of impervious surface area for residential homes on single-family and duplex lots greater than 3,000 square feet. The assumed rate is inclusive of existing and new structures, and all uses associated with an equivalent service unit (e.g., home, garage, and driveway),

3. For lots that are 3,000 square feet or smaller, impervious area may be based on any of the following:

A) The maximum allowable impervious area per lot, including driveways and buildings, as calculated using the local land use jurisdiction's development code.
B) An assumed rate of 2,640 square feet of impervious surface area per lot.
C) Actual impervious surface area, if final building plan for the lot is available.

b. For residential additions, remodels, and other activities on a single-family lot other than new home construction, the stormwater management

approach shall be sized based on the actual new and Replaced impervious area, up to 2,640 square feet.

c. For all Development and redevelopment other than single-family and duplex residential, stormwater management approaches shall be sized based on the actual new and Replaced impervious area.

Impervious surface areas shall be determined based upon building permits, construction plans, or other appropriate methods of measurement deemed reliable by District or City.

4.08.2 Storm Events Used in Design

a. Water Quality Design Storm:

Stormwater quality treatment and infiltration approaches shall be designed for a 1.0 inch, 24-hour design storm based on an NRCS Type IA rainfall distribution. Infiltration Facilities shall be designed to draw down the runoff from the Water Quality Design Storm within 48 hours from the onset of the 24-hour design storm.

b. Conveyance and Detention Design Storms:

Conveyance and detention design storms to be used in Peak Flow Hydrologic Analyses are provided in Table 4-4.

TABLE 4-3

Recurrence Interval	Total 24-Hour Precipitation Depth (water equivalent inches)
2 years	2.50
5 years	3.10
10 years	3.45
25 years	3.90

4.08.3 Infiltration Rates for Facility Sizing

a. For facility sizing, the project soil type may be obtained from the soil series data as mapped on the NRCS WebSoil Survey (Web Soil Survey - Home). Facility sizing methodology is described in Section 4.08.4 (Simplified Sizing) and Section 4.08.5(Standard Sizing).

b. Projects that are in A, B, or A/B soils:

1. If the facility has a contributing impervious area of > 15,000 square feet, conduct infiltration testing for facility sizing as specified in 4.08.3.d.

2. If the facility has a contributing impervious area of ≤ 15,000 square feet, an assumed design infiltration rate of 0.5 inch per hour or less may be used in lieu of infiltration testing.

c. Projects that are located in C, D, or C/D soils must include an underdrain in stormwater facilities and, if no infiltration testing is conducted, use an assumed design infiltration rate of 0.5 inch per hour or less. Infiltration testing may be conducted electively, or required by the City or District, and must be completed as specified in 4.08.3.d to obtain a measured and design infiltration rate for use in sizing facilities in these soil types.

d. For infiltration testing, the following conditions apply:

1. Onsite infiltration tests at multiple locations (1 per ¼ acre or 1 per 2 proposed infiltration-based facilities, as needed to support facility design), performed at the elevation of the base of the proposed infiltration facility.

2. Where conducted, infiltration testing of native soil shall use either open pit or encased falling head infiltration methods, or a double-ring infiltrometer. For projects with a contributing drainage area > 15,000 square feet, these tests must be performed by a qualified civil engineer (PE) or certified engineering geologist (CEG).

3. A factor of safety of 2 shall be used to convert the measured infiltration rate to a design infiltration rate, unless a greater factor of safety is recommended by the qualified PE or CEG.

4. Additional infiltration testing may be required at selected locations or during specific seasonal conditions, due to unique topography, soils, drainage, or groundwater conditions on or near the Development site. At District or City discretion, secondary independent testing may be required, to verify infiltration results.

5. Where multiple tests are performed on a site, generally, the lowest measured infiltration rate applies unless in the judgment of the District or City there is technical justification to apply a different infiltration rate.

4.08.4 Simplified Sizing

a. Either Simplified Sizing (Section 4.08.4) or Standard Sizing (Section 4.08.5) may be used for facilities where the contributing impervious area to an individual Water Quality Approach is ≤ 15,000 square feet per facility. Facilities with contributing impervious areas >15,000 square feet, and facility types that do not have a simplified sizing factor listed in Table 4-5 or 4-6 shall be sized using Standard Sizing (Section 4.08.5).

b. Water Quality Sizing

Facility sizing factors are provided for unlined infiltration facilities in Table 4-5 and for lined treatment facilities in Table 4-6. These sizing factors shall be used to calculate the required water quality surface area (treatment area) of the selected treatment facility as follows:

Treatment Area = Contributing Impervious Area x Sizing Factor

Infiltration rates in Table 4-5 represent design infiltration rates, which are reflective of the measured infiltration rates divided by a factor of safety of 2, or an assumed design infiltration rate (see Section 4.08.3.d.3).

1. Infiltration Facilities Located in A, B, or A/B Soils:

   A) Use the sizing factors for the specified design infiltration rate up to a maximum design infiltration rate of 2 inches per hour.
   B) If infiltration testing is not conducted, as provided in Section 4.08.3, or if the design infiltration rate is <0.5 inch/hour, use the sizing factors specified in Table 4-5 for an assumed design infiltration rate of 0.5 inch/hr.

2. Infiltration Facilities Located in C, D, or C/D Soils:

   A) If infiltration testing is not conducted, use the sizing factors specified in Table 4-5 for an assumed design infiltration rate of 0.5 inch per hour and provide an underdrain.
   B) If infiltration testing is conducted and the measured infiltration rates are > 1 inch per hour, use the sizing factor for the specified design infiltration rate up to a maximum design infiltration rate of 2 inches per hour.

3. Lined Treatment Facilities Located in any Soil Type:

   If infiltration is prohibited due to site constraints, as specified in Section 4.04.4.b, use the facility sizing factors provided for lined treatment facilities in Table 4-6.

TABLE 4-5
FACILITY SIZING FACTORS FOR UNLINED INFILTRATION FACILITIES

Facility Type	Facility Width (ft)[1]	Design Infiltration Range (in/hr)[2]			
		0.5	1.0	1.5	2.0
		Facility Sizing Factor[3, 4]			
Planter (Structural Planter[5] – Section 4.09.7 and Street-side Planter[6] – Section 4.09.9)	All widths	4.2%	2.7%	2.1%	1.8%
Rain Garden[7] (Non-Structural Planter, Section 4.09.8)	2.5 (bottom)	7.7%	5.3%	4.2%	3.6%
	3.0 (bottom)	7.2%	5.0%	4.0%	3.4%
	3.5 (bottom)	6.9%	4.8%	3.8%	3.3%
	4.0 (bottom)	6.7%	4.6%	3.7%	3.1%
	4.5 (bottom)	6.5%	4.5%	3.6%	3.0%
	5.0 (bottom)	6.3%	4.3%	3.5%	2.9%
	5.5 (bottom)	6.2%	4.2%	3.4%	2.9%

1. *Minimum planter width is 2.5 feet for both unlined structural planters and unlined non-structural planters (rain garden).*
2. *See section 4.08.3 for infiltration testing procedures and factor of safety.*
3. *Sizing factors may be interpolated between listed design infiltration rates.*
4. *Sizing factors for rain gardens represent the top surface area of the facility, including side slopes of 3:1.*
5. *For unlined structural planters, sizing factors are based on an assumed 6 inches of ponding depth, 2 inches of freeboard, 18 inches of growing medium, 3 inches of choker course, and 9 inches of drain rock.*
6. *For unlined street-side planters, sizing factors are based on an assumed 4 inches of ponding depth, 2 inches of freeboard, 18 inches of growing medium, 3 inches of choker course, and 15 inches of drain rock.*
7. *For unlined non-structural planters (rain gardens), sizing factors are based on an assumed 6 inches of ponding depth, 6 inches of freeboard, 18 inches of growing medium, 3 inches of choker course, and 9 inches of drain rock.*

TABLE 4-6
FACILITY SIZING FACTORS FOR LINED TREATMENT FACILITIES

Facility Type	Bottom Width[1] (ft)	Sizing Factor[2]
Planter (Structural Planters[3] – Section 4.09.7, and Street-side Planters[4] – Section 4.09.9)	All widths[4]	1.4%
Rain Garden[5] (Non-Structural Planters, Section 4.09.8)	2.5	2.8%
	3.0	2.7%
	3.5	2.5%
	4.0	2.5%
	4.5	2.4%
	5.0	2.3%
	5.5	2.2%

1. *Minimum planter width is 2.5 feet for structural planters, streetside planters, and non-structural planters (rain gardens).*
2. *Sizing factors for rain gardens represent the top surface area of the facility including side slopes of 3:1.*
3. *For lined structural planters, sizing factors are based on an assumed 6 inches of ponding depth, 2 inches of freeboard, 18 inches of growing medium, 3 inches of choker course, and 9 inches of drain rock.*
4. *For lined street-side planters, sizing factors are based on an assumed 4 inches of ponding depth, 2 inches of freeboard, 18 inches of growing medium, 3 inches of choker course, and 15 inches of drain rock.*
5. *For lined non-structural planters (rain gardens), sizing factors are based on 6 inches of ponding depth, 6 inches of freeboard, 18 inches of growing medium, 3 inches of choker course, and 9 inches of drain rock.*

c. Hydromodification Sizing

A 12% sizing factor shall be used to calculate the required vegetated surface area of the selected facility to meet both the hydromodification and water quality requirement. A sizing factor of 12% assumes the site infiltration rate is less than 2 inches per hour.

d. Water Quality for Vegetated Filter Strip

The sizing of a vegetated filter strip must meet all the following criteria:

1. The maximum contributing impervious surface is 2,640 square feet or is a linear project such as a trail that is no greater in width than 15 feet.
2. Flows must be distributed uniformly across the vegetated filter strip.
3. The contributing impervious surface must be adjacent to the vegetated filter strip. When part of a Vegetated Corridor as described in Chapter 3, a filter shall be approved as an allowed use consistent with the Service Provider Letter.

4. The minimum width of the vegetated filter strip shall be:

   A) Three times the width of the contributing linear project impervious surface area. or
   B) 50 feet adjacent to one single-family residence.

5. The width of the vegetated filter strip treatment area shall be measured from the edge of the impervious surface and in the direction of stormwater flow.

4.08.5 Standard Sizing

a. The standard sizing methodology must be used for facilities with a contributing impervious surface area > 15,000 square feet, and facility types that do not have simplified sizing factors provided in Section 4.08.4. Water Quality Volumes and Flows to be used for standard sizing are described below.

1. Water Quality Design Storm

   The Water Quality Design Storm is the storm required to be treated, as described in Section 4.08.2. The storm defines both the volume and rate of runoff.

2. Water Quality Volume (WQV)

   The WQV is the volume of water that is produced by the water quality storm. The WQV equals 1.0 inch over the impervious area that is required to be treated, as shown in the formula below:

$$\text{Water Quality Volume (cu.ft.)} = \frac{1.0\text{ (inch)} \times \text{Area (sq.ft.)}}{12\text{ (inch/ft.)}}$$

3. Water Quality Intensity (WQI)

   The WQI is the design rainfall intensity estimated to represent 80% of average annual runoff.

$$\text{Water Quality Intensity} = 0.09\text{ inch/hr}$$

   or

$$\text{Water Quality Flow (cfs)} = \frac{0.09\text{ (inch/hr)} \times \text{Area (sq.ft.)}}{12\text{(inch/ft)}(\text{ 60 min/hr})(60\text{ sec/min})}$$

b. Water Quality Sizing

1. Infiltration Facilities Located in A, B, or A/B Soils or where the measured infiltration rate is ≥1 inch/hour:

A) Facilities shall be unlined and sized to fully infiltrate the water quality volume. Full infiltration of the water quality volume shall occur within 48 hours from the onset of the Water Quality Design Storm.
B) Sizing shall be based on infiltration testing results as specified in Section 4.08.3. If infiltration testing is not performed, see Section 4.08.5.b.2.
C) The maximum design infiltration rate shall not exceed 2 inches/hour.

2. Infiltration Facilities Located in C, D, or C/D Soils:

A) If infiltration testing is not conducted, or the measured infiltration rates are < 1 inch/hour, facilities shall be unlined with underdrains and sized with a design infiltration rate of 0.5 inch/hour and to fully treat the water quality volume.
B) If infiltration testing is conducted and the measured infiltration rates are ≥1 inch/hour, the facility shall be sized as described in Section 4.08.5.b.1.
C) Facilities are assumed to have incidental infiltration and should include underdrains, overflows and/or other bypass structures to manage flows in excess of the water quality volume.

3. Facilities Located in any Soil Type where Infiltration is Prohibited:

A) If infiltration is prohibited due to site constraints, as specified in Section 4.04.4.b, facilities shall be lined with underdrains and sized to fully treat the water quality volume or water quality flow depending on facility type.
B) Facilities should include underdrains, overflows, and/or other bypass structures to manage flows in excess of the water quality volume.

4. Proprietary Facilities: Facilities shall be sized according to manufacturer's specifications to fully treat the water quality volume or water quality flow depending on facility type (see also Section 4.07.1.b).

c. Sizing Infiltration facilities for Hydromodification

1. Hydromodification Storm and Drawdown

A) If an infiltration facility can be designed to manage the 10-year, 24-hour storm in Subsection 4.08.2.b. and infiltrate this volume in 36 hours or less, then the hydromodification standard has been met.
B) Facilities that cannot meet this standard but can provide partial infiltration may be used. Overflow must be managed as described in Subsection 4.08.6.c.

2. Hydromodification Volume

A) Infiltration design shall be assessed by dynamic flow routing through the facility or facilities to underlying soil. Documentation of the proposed design shall be included in the drainage report. Acceptable analysis programs include those listed below, as well as others using the SBUH or TR-55 methodology, provided the considerations outlined in Section 5.04.2 are followed.

i. HEC-HMS (or HEC-1)
ii. SWMM
iii. City of Portland's Presumptive Approach Calculator (PAC): facility must pass the Flow Control criteria
iv. Tualatin River Urban Stormwater Tool (TRUST) interface to HSPF or site-specific HSPF model with local climate and geographic data, as approved by the District
v. Others as approved by the District

B) Alternately, a facility may be sized to store the entire runoff volume from the design storm and subsequently drain as described above.

4.08.6 Peak-Flow Matching Hydraulic Design Criteria

a. Peak-flow matching design methodology is used to size facilities when stormwater quantity management or hydromodification mitigation is required. This approach is typically used for projects where the contributing impervious surface is >15,000 square feet.

b. Peak-Flow Matching Detention design shall be assessed by dynamic flow routing through the basin. Documentation of the proposed design shall be included in the drainage report. Acceptable analysis programs include those listed below, as well as others using the SBUH or TR-55 methodology, provided the considerations outlined in Section 5.04.2 are followed.

1. HYD
2. HEC-HMS (or HEC-1)
3. SWMM
4. HYDRA
5. Others as approved by the District

c. When quantity management is required due to a downstream conveyance capacity deficiency, a combination of onsite detention and infiltration approaches may be used when onsite infiltration testing is conducted and is shown to be feasible, as described in Section 4.08.3. Approaches shall

be designed such that the post-development runoff rates from the site do not exceed the pre-development runoff rates in Table 4-7. If the resulting orifice size is less than the minimum diameter listed in under the Design Standards in Section 4.09, then the post-development flow may be permitted to exceed the target to comply with the minimum orifice size requirement.

TABLE 4-7

Post-Development Peak Runoff Rate	**Pre-Development Peak Runoff Rate Target**
2-year, 24-hour	2-year, 24-hour
10-year, 24-hour	10-year, 24-hour
25-year, 24-hour	25-year, 24-hour

d. When quantity management is required as a hydromodification approach, a combination of onsite detention and infiltration approaches may be used. Approaches shall be designed such that the post-development runoff rates from the site do not exceed the pre-development runoff rates in Table 4-8.

TABLE 4-8

Post-Development Peak Runoff Rate	**Pre-Development Peak Runoff Rate Target**
2-year, 24-hour	50% of 2-year, 24-hour
5-year, 24-hour	5-year, 24-hour
10-year, 24-hour	10-year, 24-hour

e. If the resulting design orifice size is less than the minimum diameter listed in Section 4.09, then, with District or City approval, the post-development flow may be permitted to exceed the target design flow to comply with the minimum orifice size requirement.

f. If a proposed project includes Replaced impervious surface (Redevelopment), assume a pre-development curve number (CN) that matches the conditions prior to urban Development. If those conditions cannot be determined, a CN of 75 shall be used as the pre-developed condition for all Replaced impervious surfaces. The CN for new impervious surfaces shall be based on actual pre-development site conditions.

4.08.7 Flow Duration Curve Matching Hydraulic Design Criteria

a. The flow duration curve matching design methodology may be used to size facilities when stormwater quantity management or hydromodification mitigation is required. This sizing methodology is an

acceptable alternative to peak-flow matching detention, though typically not required.

b. Flow Duration Curve Matching Detention design shall be assessed by dynamic flow routing through the basin. Acceptable analysis programs include those listed below.

1. TRUST interface to HSPF

2. Site-specific HSPF model with local climate and geographic data, as approved by the District

c. When using Flow Duration Curve Matching Detention, stormwater discharges shall maintain the duration of high flows at their pre-development levels for all flows greater than one-half of the 2-year peak flow to the 10-year peak flow. Projects that also require detention due to a downstream conveyance capacity deficiency must also maintain the post-development 25-year peak flow rate at the pre-development 25-year peak flow rate. If the resulting orifice size is less than the minimum diameter listed in Section 4.09, then the post-development flow may be permitted to exceed the target to comply with the minimum orifice size requirement.

d. If a proposed project includes Replaced impervious surface (Redevelopment), assume a pre-development curve number (CN) that matches the conditions prior to urban development. If those conditions cannot be determined, a CN of 75 shall be used as the re-developed condition for all Replaced impervious surfaces. The CN for new impervious surfaces shall be based on actual Pre-Development site conditions.

4.09 Stormwater Management Approach and Facility Standards

4.09.1 Water Quality Maintenance Holes

a. Application

1. Water quality pretreatment, used in combination with other stormwater management approaches to meet the requirements of this Chapter.

b. Hydraulic Criteria

1. Minimum Design Flow: Water Quality Flow per Section 4.08.2

2. Upstream flow splitter may be used to bypass conveyance flows in excess of the Water Quality Flow.

c. Design Criteria

1. Shall conform to Appendix B, Standard Drawing No. 250 & 260 or an equivalent detail approved by the District or City.
2. Minimum Maintenance Hole Diameter: 60-inch
3. Maximum size of incoming pipe: 18-inch
4. Sump Depth: No deeper than 5 feet from invert out to bottom of sump
5. Volume of sump: 20 cubic feet/ 1.0 cfs of flow into the water quality maintenance hole, 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 and maintenance hole walls.
7. Orient access to structure in a clear zone.
8. Flat Top Section shall have two access points and meet ASTM C - 478 and H – 20 Traffic Loading

4.09.2 Detention Pond

a. Applications

1. Quantity control for conveyance capacity
2. Hydromodification
3. LIDA/Green Infrastructure

b. Sizing Criteria

1. Peak-Flow Matching, per Section 4.08.6, is applicable in the following scenarios:

A) Detention is required as a result of conveyance capacity requirements outlined in Section 4.02
B) Peak-Flow Matching Detention is required as a result of Hydromodification Requirements identified in Table 4-2.

2. Flow Duration Curve Matching, per Section 4.08.7, is required when identified as the applicable Hydromodification Requirement in Table 4-2.

c. Design Criteria

1. The facility can be a combined water quality and quantity facility provided design features are included to address all relevant criteria to meet both standards.
2. Interior side slopes up to the Maximum Water Surface: 3H:1V or flatter.

3. If interior slopes need to be mowed side slope: 4H:1V or flatter.

4. Exterior Side Slopes: 2H:1V or flatter, unless analyzed for stability by a geotechnical engineer.

5. Minimum Freeboard:1 foot from 25-year design water surface elevation.

6. Provide an approved outlet structure for all flows.

7. Certain situations require use of multiple orifice plates to achieve desired outflow rates.

8. Minimum orifice size: ½-inch diameter, unless a local jurisdiction has an alternate, but the minimum may be no greater than 1 inch.

9. Maximum ponding depth: 5 feet.

10. 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.

11. Provide an emergency spillway sized to pass the 100-year storm event or an approved hydraulic equivalent. Emergency spillway shall be located in existing soils when feasible and armored with riprap or other approved erosion protection extending to the toe of the embankment.

12. Construction of onsite detention shall not be allowed as an option if such a detention facility would have an adverse effect upon receiving waters in the basin or subbasin in the event of flooding or would increase the likelihood or severity of flooding problems downstream of the site.

13. Landscaping plan

    A) Plant quantities and species selection for stormwater facilities per Appendix A, LIDA Handbook, or approved alternate, must include three or more evergreen species and be suitable for site conditions.
    B) Pond bottom, side slopes, and freeboard must be fully vegetated for erosion protection, with establishment of 90% aerial coverage.

d. Maximum Pond Depth Variance

The City or District may approve a maximum pond depth greater than 5 feet if the design complies with all other standards and design criteria and the following:

1. The ponding depth is not greater than 9 feet.

2. The design does not result in an embankment regulated under dam safety rules. The City or District may require an inundation analysis pursuant to OAR 690-020.

3. The facility is accessible and maintainable with the standard equipment used by the jurisdiction responsible for maintenance.

4. If water quality treatment is colocated with the detention pond, all water quality design criteria must be met.

5. Perimeter walls that are higher than 30 inches (not including footings) shall not surround more than 50% of the facility.

6. The design complies with the local jurisdiction's development codes and design standards.

4.09.3 Underground Detention

a. Applications

1. Quantity control for conveyance capacity

2. Hydromodification

b. Sizing Criteria

1. Peak Flow Matching, per Section 4.08.6, is applicable in the following scenarios:

A) Detention is required as a result of conveyance capacity requirements outlined in Section 4.02.
B) Peak Flow Matching Detention is required as a result of Hydromodification Requirements identified in Table 4-2.

2. Flow Duration Curve Matching, per Section 4.08.7, is required when identified as the applicable Hydromodification Requirement in Table 4-2.

c. Design Criteria

1. The facility can be used to meet water quantity requirements provided it meets all relevant criteria.

2. The following criteria must be demonstrated through design alternatives, calculations, details, and specifications:

A) Material design life of minimum 100 years;
B) Meets access 4.07.06 access road requirements;
C) Apply standard trench backfill/compaction methods for the entire trench/pipe section;
D) Provide an inspection port every 50 feet, or as approved by the District and City.

E) Provide maintenance access points every 200 feet, and maintenance holes at the upstream and downstream terminus, or as approved by the District and City;
F) A pretreatment water quality maintenance hole (CWS detail 250/260 or equivalent) shall be provided prior to the detention system;
G) Provide an approved outlet structure for all flows. Certain situations require use of multiple orifice plates to achieve desired outflow rates;
H) Construct outlet invert of detention system no lower than the discharge stream's 10-year storm event water surface elevation; Facilities designed at or below the 100-year flood elevation shall include additional analysis of backwater effects during the 10-, 25-, and 100-year storms; and
I) Design of the detention system shall provide a minimum 1-foot freeboard between the hydraulic grade line and the top of the structure or finish grade above pipe for 25-year post-development peak rate of runoff.

3. Underground detention systems may only be used in the street right-of-way if the road authority and the agency responsible for maintenance approve the system in writing.

4.09.4 Vegetated Swale

a. Applications

1. Treatment Approach
2. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Design Flow: Water Quality Flow per Section 4.08.5
2. Minimum Hydraulic Residence Time: 9 minutes
3. Maximum Water Design Depth: 0.5 feet
4. Minimum Freeboard: 1.0 foot (for facilities not protected from high flows)
5. Manning "n" Value: 0.24
6. Maximum Velocity: 2.0 fps based on 25-year flow

c. Design Criteria

1. Provide an energy dissipater at the entrance to the swale, with a minimum length of 4 feet. It will be designed to reduce velocities and spread the flow across the treatment cross section.

2. The use of intermediate flow spreaders may be required.

3. Minimum Length: 100 feet

4. Minimum Slope: 0.5%

5. Minimum Bottom Width: 2 feet

6. Maximum Treatment Depth (measured from top of media): 0.5 feet

7. Maximum Ponding Depth (measured from top of media): 3 feet

8. Side Slope:

   A) In Treatment Area: 4H:1V or flatter
   B) Above Treatment Area: 2.5H:1V or flatter

9. The treatment area shall have coconut matting over 12 inches of amended topsoil or base stabilization method as approved by the District or City. District or City may require 2 inches - ¾ inch river run rock in areas where sustained flow is anticipated to occur. Extend amended topsoil and coconut matting to the top of the slope.

10. Provide an approved outlet structure for all flows.

11. Where swales wrap 180 degrees forming parallel channels, freeboard shall be provided between each of the parallel channels. A 1-foot (above ground surface) wall may be used above the treatment area to provide freeboard while enabling a narrower system. As an alternative, a soil-based berm may be used. The berm shall have a minimum top width of 1 foot and 2.5H:1V or flatter side slopes.

12. Where swales are designed with ditch inlets and outlet structures and design of maintenance access to such structures may be difficult due to swale location, swales may be designed as flow-through facilities with unsumped structures. Maintenance access to one end of the facility will still be required.

13. Landscaping plan

    A) Treatment area: 6 herbaceous plants (1-inch plugs or equivalent) per square foot. Plant species selection per Appendix A, LIDA Handbook, or approved alternate; must include three or more evergreen species and be suitable for site conditions.
    B) Freeboard area: Low grow seed mix per Standard Detail, Appendix B.

4.09.5 Extended Dry Basin

a. Applications

1. Infiltration Approach
2. Treatment Approach
3. Quantity Control for Conveyance Capacity
4. Hydromodification Approach
5. LIDA/Green Infrastructure

b. Hydraulic Design Criteria:

1. Permanent Pool Depth: 0.2 feet
2. Permanent pool is to cover the entire bottom of the basin.
3. Minimum Water Quality Detention Volume: 1.0 x Water Quality Volume (WQV)
4. Water Quality Drawdown Time: 48 hours
5. Orifice Size:

   USE: $D = 24 * [(Q/ (C[2gH]^{0.5})) / \pi]^{0.5}$
   Where:
   D (in) = diameter of orifice
   Q(cfs) = WQV(cf) /(48*60*60)
   C = 0.62
   H(ft) = 2/3 x temporary detention height to centerline of orifice.
6. Minimum orifice size: ½-inch diameter, unless a local jurisdiction has an alternate, but the minimum may be no greater than 1 inch.
7. Maximum Depth of Water Quality Pool (not including Permanent Pool): 5 feet or as limited by issuing jurisdiction.

c. Design Criteria

1. Provide a stilling basin designed to dissipate outfall energy and spread flows.
2. Inlet and outlet structures shall be designed to avoid direct flow between structures without receiving treatment (i.e., short-circuiting of flow).
3. Minimum Bottom Width: 4 feet
4. Side Slopes in Basin Treatment Area: 3H:1V
5. Minimum Freeboard: 1 foot from the design water surface elevation.
6. The treatment area shall have coconut matting over 12 inches of amended topsoil or base stabilization method as approved by the District or City. Extend amended topsoil and coconut matting to the top of the slope.

7. Provide an approved outlet structure for all flows.

8. The Engineer shall certify that the pond storm sewer design is in compliance with Chapter 5 and that at normal design water surface, the upstream storm sewer will not be in a surcharged condition for longer than 24 hours.

9. Landscaping plan

   A) Treatment area: Six herbaceous plants (1-inch plugs or equivalent) per square foot. Plants per Appendix A, LIDA Handbook, or approved alternate; plant selection must include three or more evergreen species.
   B) Freeboard area: Low grow seed mix per Standard Detail, Appendix B.

4.09.6 Constructed Water Quality Wetland

a. Applications

1. Treatment Approach

2. Quantity Control for Conveyance Capacity

3. Hydromodification

4. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Permanent Pool Volume: 0.55 x Water Quality Volume (WQV)

2. Water Quality Detention Volume: 1.0 x Water Quality Volume (WQV)

3. Water Quality Drawdown Time: 48 hours

4. Orifice Size:

   USE: $D = 24 * [(Q/ (C[2gH]^{0.5})) / \pi]^{0.5}$
   Where:
   D (in) = diameter of orifice
   Q(cfs) = WQV(cf) /(48*60*60)
   C = 0.62
   H(ft) = 2/3 x temporary detention height to centerline of orifice.

5. Minimum orifice size: ½-inch diameter, unless a local jurisdiction has an alternate, but the minimum may be no greater than 1 inch.

6. Maximum Depth of Permanent Pool: 2.5 feet or as limited by issuing jurisdiction

7. Maximum velocity through the wetland should average less than 0.01-fps for the water quality flow. Design should distribute flows uniformly across the wetland.

8. Provide for a basin dewatering system with a 24-hour maximum drawdown time.

c. Design Criteria

1. Provide a stilling basin designed to dissipate outfall energy and spread flows.

2. Permanent pool depth to be spatially varied throughout wetland.

3. Provide a perimeter zone 10 to 20 feet wide, which is inundated during storm events.

4. Side Slopes for Wetland Planting: 5H:1V or flatter

5. Side Slopes for Non-Wetland Planting: 3H:1V or flatter

6. Over-excavate by a minimum of 20% to allow for sediment deposition.

7. Minimum Freeboard:1 foot from the design water surface elevation.

8. The treatment area and exposed side slopes shall be stabilized with coconut matting to the top of the slope.

9. Provide an approved outlet structure for all flows.

10. Landscaping Plan

Plant species selection per Appendix A, LIDA Handbook, or approved alternate.

4.09.7 Structural Planter

a. Applications

1. Infiltration Approach

2. Treatment Approach

3. Quantity Control for Conveyance Capacity

4. Hydromodification

5. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Sizing: Simplified Sizing per Section 4.08.4 or Standard Sizing per Section 4.08.5

2. Maximum Water Design Depth: 0.5 feet.

3. Minimum Freeboard: 2 inches.

c. Design Criteria

1. Provide pretreatment when contributing impervious area is greater than 15,000 square feet.
2. Provide an energy dissipater at the outfall designed to reduce scour.
3. Minimum Bottom Width: 30 inches regardless of shape.
4. Minimum Length: to be calculated based on incoming flows.
5. Maximum Slope: 0.5% in any direction.
6. Minimum Cross-sectional Depths:
   A) Growing Medium: 18 inches
   B) Choker Course: 3 inches
   C) Drain Rock: 9 inches
7. Provide an approved outlet (overflow) structure for all flows. Piping to a minimum of the plumbing code or to convey the 25-year storm.
8. If using the native soil infiltration for sizing, the rate shall be determined by ASTM standard testing methods.
9. Construction practices must be used to protect the infiltration capacity of native soils or reestablish native infiltration capacity through soil amendment or mechanical means.
10. Rain drains and overflow structures to maintain maximum linear separation.
11. Minimum of 4 feet of 8-inch perforated drain pipe required to direct flows to overflow conveyance.
    A) Unlined infiltration facilities: bottom of pipe shall be set at 6 inches above subgrade.
    B) Lined treatment facilities: Bottom of pipe shall be set at the base of the drain rock layer
12. Building jurisdiction approval required for building setback distance and impermeable liners.
13. Landscaping Plan. Vegetation quantities per 100 square feet:
    A) 115 herbaceous plants, 1 foot on center spacing, ½-gallon container size; or
    B) 100 herbaceous plants, 1 foot on center, and four shrubs, 1-gallon container size, 2 feet on center.
    C) Or approved alternate.

4.09.8 Non-Structural Planter (Rain Garden)

a. Applications

1. Infiltration Approach
2. Treatment Approach
3. Quantity Control for Conveyance Capacity
4. Hydromodification
5. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Sizing: Simplified Sizing per Section 4.08.4 or Standard Sizing per Section 4.08.5
2. Minimum Freeboard: 6 inches

c. Design Criteria

1. Provide pretreatment when contributing impervious area is greater than 15,000 square feet.
2. Minimum length: Facility length to be calculated based on incoming flows and facility width, and on shape of facility.
3. Maximum slope: Planters are designed to evenly distribute and infiltrate and/or filter flows. Surface longitudinal slopes should be less than 0.5%.
4. Minimum Bottom Width: 30 inches
5. Maximum Treatment Depth (measured from top of soil medium): 0.5 foot.
6. Minimum Cross-Sectional Depths:

   A) Growing medium: 18 inches
   B) Choker course: 3 inches
   C) Drain rock: 9 inches

7. Maximum Side Slopes: 3H:1V
8. Flow dissipaters should be used if entry slope to the basin is greater than 3:1 or for sheet flow in landscape filter strips. Flow dissipaters shall be constructed out of rock or gravel per design flow velocity at entry of the facility.
9. Provide an approved outlet (overflow) structure for all flows. Piping to a minimum of the plumbing code or to convey the 25-year storm.

10. If using the native soil infiltration for sizing, the rate shall be determined by ASTM standard testing methods.

11. Construction practices must be used to protect the infiltration capacity of native soils or reestablish native infiltration capacity through soil amendment or mechanical means.

12. Rain drains and overflow structures to maintain maximum linear separation.

13. Minimum of 4 feet of 8-inch perforated drain pipe required to direct flows to overflow conveyance.

    A) Unlined infiltration facilities: Bottom of pipe shall be set at 6 inches above subgrade.
    B) Lined treatment facilities: Bottom of pipe shall be set at the base of the drain rock layer

14. Building jurisdiction approval required for building setback distance and impermeable liners.

15. Vegetation quantities per 100 square feet:

    A) 115 herbaceous plants, evergreen, 1 foot on center spacing, ½-gallon container size; or
    B) 100 herbaceous plants, evergreen, 1 foot on center, and four shrubs, 1-gallon container size, 2 feet on center.
    C) Or approved alternate.

16. Treatment area shall have coconut matting over the entire surface, or District approved equivalent.

4.09.9 Street-Side Planter

a. Applications

1. Infiltration Approach
2. Treatment Approach
3. Quantity Control for Conveyance Capacity
4. Hydromodification Approach
5. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Sizing: Simplified Sizing per Section 4.08.4 or Standard Sizing per Section 4.08.5
2. Minimum Freeboard: 2 inches

c. Design Criteria

1. Provide minimum 18-inch sumped inlet with a minimum 18-inch diameter drain basin for pretreatment.
2. Minimum length: Facility length to be calculated based on incoming flows and facility width.
3. Maximum slope: Planter shall be flat bottom in all directions to within 1 inch. Check dams shall be placed according to individual project plans per standard detail.
4. Minimum Bottom Width: 30 inches.
5. Minimum Treatment Depth: 4-inch pond depth
6. Maximum Facility Depth (measured from the finished grade adjacent to the facility to the top of the soil medium): 18 inches
7. Minimum Cross-Sectional Depths:
   A) Growing medium: 18 inches
   B) Choker course: 3 inches
   C) Drain rock: 15 inches
8. Inflow structure to be provided per approved District structure types.
9. Provide minimum 6-inch-wide splash rock around inlet structure to reduce velocities and spread flow across the treatment cross section.
10. Provide an approved overflow structure sized per standard detail.
11. Inlet/outlet elevations to allow overflow to drain to street or piped overflow system as applicable.
12. Minimum of 4 feet of 8-inch perforated drain pipe required to direct flows to overflow conveyance.
    A) Infiltration facilities: Bottom of pipe shall be set at 6 inches above subgrade.
    B) Flow through facilities: Bottom of pipe shall be set at the base of the drain rock layer.
13. Vegetation quantities per 100 square feet:
    A) 115 herbaceous plants, evergreen, 1 foot on center spacing, ½-gallon container size; or
    B) 100 herbaceous plants, evergreen, 1 foot on center, and four shrubs, 1-gallon container size, 2 feet on center.
    C) Or approved alternate.

4.09.10 Constructed Filter Strip

a. Applications

1. Treatment Approach
2. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Sizing: Simplified Sizing per Section 4.08.4
2. Flows must be distributed in uniform sheet flow that will not cause channelization or erosion.

c. Design Criteria

1. Provide pretreatment when contributing impervious area is greater than 15,000 square feet, or when flows are concentrated within conveyance system prior to sheet flow distribution.
2. Slope: At least 0.5% and no more than 6%
3. Minimum Width: 5 feet, measured in direction of flow.
4. Minimum Growing Medium Depth: 18 inches
5. A concrete spreader or gravel trench may be required to disperse the runoff evenly across the filter strip to prevent point of discharge/channelization.
6. Check dams shall be placed according to the facility design and:
   A) Equal to the width of the filter
   B) Placed every 10 feet where slope exceeds 5%, 2.5 to 3 inches deep.
7. Collection and conveyance of overflow from filter strip shall be specified on plans to the approved public conveyance system.
8. Entire filter strip must have 100% coverage by approved grasses, wildflower blends, ground covers, or any combination thereof.
9. Coconut matting shall cover the growing medium except in check dam and flow spreader locations.

4.09.11 Vegetated Filter Strip

a. Applications

1. Treatment Approach
2. LIDA/Green Infrastructure

b. Hydraulic Design Criteria

1. Sizing: Simplified Sizing per Section 4.08.4.

2. Flows must be distributed in uniform sheet flow that will not cause channelization or erosion.

c. Design Criteria

1. A concrete spreader or gravel trench may be required to disperse the runoff evenly across the vegetated area

2. Slope: At least 0.5% and no more than 6%

3. Entire filter strip must have 100% coverage by approved grasses, wildflower blends, ground covers, or any combination thereof.

4. If the filter strip is Vegetated Corridor, it must be enhanced to Good Corridor condition in accordance with Appendix A, Planting Requirements.

4.09.12 Green Roofs

a. Applications

1. LIDA/Green Infrastructure

2. Reduction in impervious surface, which results in reduction in sizing for Water Quality, Quantity control for conveyance capacity, and Hydromodification.

b. Sizing: Green Roofs replace conventional impervious roof area at a 1:1 ratio.

c. Design Criteria

1. Growing Medium: 3-4 inches or more lightweight mix designed for plant growth. Typical components include pumice, perlite, organic fiber, expanded slate, diatomaceous earth, or polymers.

2. Drainage: Collection and conveyance of excess water shall be specified on plans with connection to an approved discharge location.

3. Slope: 4:12 (3H:1V slope) maximum roof pitch, unless alternate design addresses runoff retention and erosion control.

4. Vegetation: 90% plant coverage, with at least 70% evergreen species within two years of establishment. Typical species include sedum, ice plant, blue fescue, sempervivum, and creeping thyme.

5. Structural Design: Site-specific evaluation of the facility, saturated weight of all components, waterproof membrane, and root barrier must be complete and is subject to approval by appropriate building department.

4.09.13 Porous Pavement

a. Applications

1. LIDA/Green Infrastructure
2. Reduction in impervious surface, results in reduction in sizing for Water Quality, Quantity control for conveyance capacity, and Hydromodification.

b. Sizing: Porous Pavement replaces conventional impervious pavement area at a 1:1 ratio.

c. Design Criteria

1. Surface Material: Porous asphalt, concrete, or pavers may be used.
2. Choker Course: Place 2-inch minimum depth layer of clean, crushed ¾ inch to ¼ inch drain rock between surface material and aggregate base.
3. Aggregate Base: Clean, crushed ¾ inch to 2 inch uniformly graded aggregate must be designed to provide a subsurface reservoir for infiltration and detention storage.
4. Drainage: Collection and conveyance of excess water shall be specified on plans with connection to an approved discharge location.
5. Slope: 20H:1V maximum slope, unless alternate design addresses runoff infiltration and erosion control.
6. Subgrade: Avoid compaction of the subgrade and scarify soils to promote infiltration.
7. Structural Design: Site-specific design of the pavement cross section based on site conditions and loading requirements must be complete and approved by appropriate building or transportation authority.

4.09.14 Stormwater Tree

a. Applications

1. LIDA/Green Infrastructure
2. Preservation or planting of a Stormwater Tree, which results in reduction of impervious area for the purposes of sizing reductions for hydromodification.

b. Sizing

1. Retained Evergreen Tree: At least 6-inch Diameter at Breast Height (DBH), providing an area credit of 20% of the canopy area or a minimum of 100 sq. ft.
2. Planted Evergreen Tree: At least 5-feet tall at planting, providing area credit of 50 sq. ft.
3. Retained Deciduous Tree: At least 6-inch DBH, providing an area credit of 10% of the canopy area or a minimum of 50 sq. ft.
4. Planted Deciduous Tree: At least 1.5 inch DBH, providing area credit of 20 sq. ft.
5. Canopy area shall be measured as the area within the tree drip line. Overlapping canopy areas shall be apportioned between multiple trees to avoid double counting of canopy area.

c. Eligibility Criteria

1. Trees protected and described as Stormwater Tree on approved plans.
2. Trees located in non-buildable tracts.
3. Street trees, as approved by the road authority.

d. Non-eligibility List

1. Trees located within the Sensitive Area or Vegetated Corridor.
2. Trees on individual residential lots.

4.09.15 Structural Soils

a. Applications

1. Hydromodification, if subsurface infiltration is allowable and post-construction infiltration rates are at least 0.2 inches/hour.
2. LIDA/Green Infrastructure

b. Hydraulic Criteria

1. Sizing: Larger of 1) as needed to support any intended vegetation or 2) to manage the 10-year 24-hour storm such that post-development peak flow is less than or equal to pre-development peak flow.
2. Assume porosity: 20%.

c. Design Criteria

1. Structural soil shall be composed of 80% by weight crushed gravel graded to ¾ inch -1½ inches: 20% by weight clay loam (>20% clay). Additives to improve water infiltration properties may substitute for <2% of clay loam. Loam may be used in portions of the structure that are not load bearing (e.g., to cover tree roots at the surface of a tree well.
2. Provide pretreatment when contributing impervious area is greater than 15,000 square feet.
3. Provide an energy dissipater at the inflow and outfall designed to reduce scour.
4. Minimum Bottom Width: 30 inches.
5. Minimum Length: Facility length to be calculated based on hydraulic criteria and facility width.
6. Minimum Depths:

   A) Supporting trees: 36 inches
   B) Supporting pervious surface: 15 inches
7. Bed and sides of structural soil well to be scarified before placement of structural soils as needed to maintain post-construction infiltration rate of 0.2 in/hr.
8. Provide an approved outlet (overflow) structure for all flows. Piping to a minimum of the plumbing code or to convey the 25-year storm.
9. Building jurisdiction approval required for building setback distance and impermeable liners.