Chapter 4

RUNOFF TREATMENT AND CONTROL

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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, hydromodification, and Low Impact Development Approaches (LIDA). 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, unless otherwise noted.

b. Any City operating a local program may adopt stricter design specifications within its jurisdiction than the specifications stated in this chapter.

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

d. The use of development techniques that mimic natural systems, including LIDA and green infrastructure, shall be emphasized.

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
The beginning sections of this Chapter describe the stormwater management requirements that are applicable given a project's characteristics and location.

b. Section 4.06
The middle section of this Chapter provides an overview of stormwater management approaches that may be used on a project to meet applicable stormwater management requirements.

c. Section 4.07- 4.09
The final sections of this Chapter describe 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 on-site 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 on-site 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 On-Site Detention for Conveyance Capacity

On-site 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 which create and/or modify 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 permanent LIDA designed in accordance with this Chapter; or

b. Construction of a permanent stormwater detention facility designed in accordance with this Chapter; or

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

d. 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 modification 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 Reach-Specific Risk Level, 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 which 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 modified 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 current LiDAR bare earth model, determine the slope of the stream channel along the centerline within the Receiving Reach at 50 foot intervals. Determine 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 feet 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 sq. ft. 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 Certified Engineering Geologist or a Geotechnical Engineer that the areas within 135 feet laterally of the stream in the Receiving Reach contains 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 or 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="4">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></tr>
<tr><td>Developed/ Moderate</td><td rowspan="2">Category 2</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 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 Design Considerations

a. Site design which 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 which reduces the amount of new and modified impervious surface may be used as a strategy to reduce the size of water quality and/or detention facilities.

c. If an onsite stormwater management approach cannot be constructed or implemented to manage the runoff from the development's impervious surface, then with District approval, an on- or off-site hydromodification approach may be designed to manage runoff from an equivalent area of existing impervious surface.

d. 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.

e. Per Section 1.06, alternate methods to address hydromodification may be considered for approval.

4.03.7 Criteria for Requiring Implementation of a Hydromodification Approach

a. A Hydromodification Approach shall be implemented on-site 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 on-site 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, on-site 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 on-site 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 modified 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 percent 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 percent 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 4.03.7.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 which create or modify 1,000 square feet or greater of impervious surfaces, or increase the amount of stormwater runoff or pollution leaving the site, are required to implement or fund permanent water quality approaches to reduce contaminants entering the storm and surface water system.

4.04.2 Criteria for Requiring Implementation of a Water Quality Approach

a. A water quality approach shall be implemented on-site unless, in the judgment of the District or City, any of the following conditions exist:

1. Due to topography, soils or other site conditions, implementation of an on-site approach is impractical, ineffective or results in the inefficient use of District or City resources for long-term operations and maintenance; or

2. There is a more efficient and effective regional approach within the subbasin that was designed to incorporate the development, or there is an approach in the subbasin which is demonstrated to have the capacity to treat the site.

b. If construction or implementation of a water quality approach is not required as a result of meeting any condition outlined in Section 4.04.2 (a) (1)-(2), the Owner of the development shall pay a Fee-In-Lieu of construction or implementation of Water Quality Approaches in accordance with District Rates and Charges.

4.04.3 Required Treatment Design Efficiency

a. Stormwater quality approaches shall be designed to remove 65 percent of the total phosphorous from the runoff from the impervious area that is tributary to the facility.

b. The phosphorous removal efficiency specifies only the design requirements and is not intended as a basis for performance evaluation or compliance determination of the stormwater quality control approach installed or constructed pursuant to this Chapter.

c. The following approaches are available for meeting the treatment design efficiency standard in this section:

1. Pretreatment as specified in Section 4.07.1 in combination with one of the following vegetated water quality approaches:
   A) Vegetated Swale
   B) Extended Dry Basin
   C) Constructed Water Quality Wetland
   D) Structural Infiltration Planter
   E) Non-structural Infiltration Planter (rain garden)
   F) Structural Flow-through Planter
   G) Non-Structural Flow-Through Planter/Rain Garden
   H) Street-Side Planter
   I) Landscape Filter Strip
   J) Vegetated Corridor as a Filter Strip

2. Proprietary treatment systems meeting the requirements of Section 4.07.8.

3. Alternative water quality approaches that can be demonstrated, to the satisfaction of the District, to meet the removal efficiency standard in this section.

4.04.4 Design Considerations

a. If an onsite water quality approach cannot be constructed or implemented to treat the runoff from the development's impervious surface, then with District or City approval, an on- or off-site water quality approach may be designed to treat runoff from an equivalent area of existing untreated impervious surfaces.

b. Approaches shall be designed so that flow from the development is treated off-line from the storm conveyance system and reconnected to upstream flows following treatment. If an off-line approach is not feasible, additional capacity in the approach may be required for upstream flow.

c. Discharges to sensitive areas shall maintain the hydro period and flows of pre-development site conditions to the extent necessary to protect the characteristic functions of the 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.

d. All water quality approaches shall be designed in accordance with this Chapter.

4.05 Low Impact Development Approach (LIDA) Requirements

4.05.1 Purpose

LIDA provides pollutant reduction associated with urban development. Generally, the first priority for LIDA is to conserve existing resources and minimize stormwater runoff generated from urban development to mimic natural hydrologic processes.

Selection of appropriate LIDA, including surface infiltration, should ensure there are no adverse downstream drainage impacts and an appropriate maintenance program can be developed to sustain the functionality of the LIDA.

4.05.2 LIDA Design Considerations

Through conservation of natural resources, minimization of impervious surface, and mimicking natural hydrologic processes, each development shall reduce its hydrologic impacts through approaches described in Section 4.05.3, unless any of the following criteria apply:

a. Due to topography, soils or other site conditions, implementation of an onsite approach is impractical or inefficient.

b. Hydromodification or stormwater quality treatment requirements are being met by a regional or subbasin approach.

c. The hydromodification and water quality treatment requirements are being met through a Fee-In-Lieu in accordance with Section 4.03.7.b and 4.04.2.b.

4.05.3 LIDA Approvable by the District

a. Vegetated water quality treatment as specified in Section 4.04.3.c.1.

b. Vegetated Corridor preservation and enhancement consistent with the Service Provider Letter issued for the project.

c. Green roofs and green walls.

d. Pervious surfaces such as porous pavement and boardwalks.

e. On-site tree preservation when protecting significant habitat or as a result of City or County plans, programs or requirements.

f. Rainwater catchment and harvesting systems for re-use.

g. When approved by the District or City, other approaches that provide stormwater infiltration, evapotranspiration, runoff re-use, or otherwise mimic natural hydrologic processes.

4.06 Summary of Stormwater Management Approaches

Table 4-3 shows the approaches the City or District may approve to meet the requirements of this Chapter and whether these approaches may be used in a publicly maintained system.

TABLE 4-3
SUMMARY OF APPROVABLE APROACHES

Stormwater Management Approach	May be approved for Public System[2]	Quantity for Conveyance Capacity	Hydromod-ification Approach	Water Quality Treatment Approach	Low Impact Development Approach
Water Quality Manhole[1]	✓	✓	✓	✓	
Detention Pond	✓	✓	✓		✓
Underground Detention	✓	✓	✓		
Vegetated Swale	✓			✓	✓
Extended Dry Basin	✓	✓	✓	✓	✓
Constructed Water Quality Wetland	✓	✓	✓	✓	✓
Structural Infiltration Planter	✓	✓	✓	✓	✓
Non-Structural Infiltration Planter (Rain Garden)	✓	✓	✓	✓	✓
Structural Flow-Through Planter	✓			✓	✓
Non-Structural FlowThrough Planter/Rain Garden	✓			✓	✓
Street-Side Planter	✓	✓	✓	✓	✓
Landscape Filter Strip	✓			✓	✓
Vegetated Corridor as a Filter Strip	✓			✓	✓
Green Roofs		✓	✓		✓
Porous Pavement	✓	✓	✓		✓
Stormwater Tree			✓		✓
Structural Soils	✓		✓		✓
Proprietary Treatment System	✓			✓	
Vegetated Corridor Preservation					✓

1. Pretreatment only.
2. Approaches in the right-of-way must be approved by the local road authority.

4.07 Stormwater Management Approach Design Considerations

4.07.1 Pretreatment

a. Pretreatment Required

Unless approved by the District, flow from impervious surfaces to stormwater management approaches shall not be allowed without pretreatment or as specified in the design criteria for specific approaches in Section 4.09. Incoming flows to the stormwater management approach shall be pretreated using a water quality manhole in accordance with Subsection 4.09.1 or as specified within the design criteria for specific

approaches. Other pre-treatment methods such as a proprietary device, filter strip, or trapped catch basin may be approved by the District or City.

b. Proprietary Pre-Treatment Devices

1. The use of proprietary pre-treatment 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 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. When a facility is fenced, the fence shall be 4-feet high, vinyl-clad chain link fence conforming to CWS Standard Drawing No. 792. The fence shall include a 12-foot wide lockable gate for maintenance access conforming to CWS Standard Drawing No. 792.

c. If a facility is located adjacent to a Vegetated Corridor, 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 which 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 of 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 Cities. 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”-0” compacted crushed rock;

over six (6) inches of 1½”-0” compacted crushed rock; over subgrade compacted to 95-percent 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-percent with a maximum 3-percent 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, as determined by the District or City, 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-percent with a maximum 3-percent 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 exceed 40 feet in length.

4.07.7 Maintenance Responsibilities

a. Unless otherwise approved by the District, newly constructed stormwater management approaches serving multiple parcels or public roads shall be publicly maintained.

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 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 Systems

a. Proprietary treatment systems shall meet the removal efficiency requirement defined in Section 4.04.3(a) and be approved by the District for use in the situations identified in Subsection (c) below.

b. Maintenance

1. Proprietary treatment systems shall be maintained by the District or Cities except those systems used in the situations specified in

Section 4.07.8(c)(1) and (2) below.

2. Proprietary 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.

c. Proprietary treatment systems shall be allowed in situations meeting one of the following criteria:

1. Treatment of runoff from a single commercial, industrial, multi-family, or condominium parcel.
2. Treatment of runoff from an adjoining commercial, industrial, or multi-family, or condominium parcels which share a common parking lot.
3. 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.
4. Treatment of runoff from new developments in transit-oriented or similar high-density zoning classifications where the development is primarily single-family residential and the average lot size is less than 2,500 square feet.
5. Treatment of runoff as part of a master planned regional facility approved by the District.

4.07.9 Underground Detention

a. Underground detention systems to meet the requirements of quantity control for conveyance capacity or hydromodification must be designed in accordance with sizing requirements outlined in Section 4.08, and be approved by the District for use only in the situations identified in Subsection (c) below.

b. Maintenance

1. Underground detention systems shall be maintained by the District or Cities except systems used in the situations specified in Section 4.07.9(c)(1) and (2).

2. Underground detention 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.

c. Underground detention systems shall be allowed in situations meeting one of the following criteria:

1. Detention of runoff from single commercial, industrial, multi-

family, or condominium parcel.

2. Detention of runoff from adjoining commercial, industrial, or multi-family, or condominium parcels which share a common parking lot.
3. Detention of runoff from new and expanded collector and arterial roadways where no other opportunities exist for detention without necessitating the removal of homes or businesses
4. Detention of runoff from new developments in transit-oriented or similar high-density zoning classifications where the development is primarily single-family residential and the average lot size is less than 2,500 square feet.
5. Detention of runoff as part of a master planned regional facility or retrofit project approved by the District.

4.08 Stormwater Management Approach Sizing

4.08.1 Impervious Area Used In Design

The following apply for development which creates or modifies 1,000 square feet or greater of impervious surface. Development which results in both new and modified impervious surface will result in a combined stormwater management requirement, as described below:

a. For new home construction on a single family or duplex lot of record, the stormwater management approach shall be sized based on 2,640 square feet of impervious surface per dwelling unit. The actual new and modified impervious surface may be utilized when the lot size is less than 3,000 square feet.

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 modified impervious area, up to a maximum of 2,640 square feet.

c. For single family and duplex 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 for existing impervious area proposed to remain on site.

    2. An assumed rate of 2,640 square feet of impervious surface area for lots greater than 3,000 square feet.

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

A. The maximum allowed impervious area per lot, including driveways and buildings, as calculated using the local jurisdiction's development code, or

B. An assumed rate of 2,640 square feet of impervious surface area per lot.

d. For all developments and re-development, other than single family and duplex, stormwater management approaches shall be sized based on the following:

1. Quality:

All new impervious surfaces and three times the modified impervious surface, up to the total existing impervious surface on the site. The area requiring treatment is shown in the formula below:

Area = New Impervious + 3(Modified Impervious)

When modification results in the permanent removal of 1,000 square feet or greater of impervious surface, the treatment approach shall be sized for three times the replaced impervious surface, in addition to the new impervious surface. In this case, the area requiring treatment is shown in the formula below:

Area = New Imp. + 3(Modified Imp. - Permanently Removed Imp.)

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

2. Quantity required for conveyance capacity or hydromodification: All new and modified impervious area created by the development.

4.08.2 Storm Events Used in Design

a. Design Storms to be used in Water Quality Evaluation

Stormwater quality approaches shall be designed for a dry weather storm event totaling 0.36 inches of precipitation falling in 4 hours with an average storm return period of 96 hours.

b. Design storms to be used in Peak Flow Hydrologic Analysis

TABLE 4-4

Recurrence Interval	**Total 24-Hour Precipitation Depth (water equivalent inches)**
2-year	2.5
5-year	3.10
10-year	3.45
25-year	3.90

4.08.3 Infiltration-based Design

a. For purposes of sizing infiltration-based facilities, the following apply:

1. Soil data should be obtained from either:

A) Soil series data as mapped on the NRCS WebSoil Survey . The more common soil series within the District, and key data for design purposes, are listed in Table 4-5.

B) 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 depth of the base of the infiltration facility.

2. Where required, infiltration testing of native soil shall use either open pit or encased falling head infiltration methods, or a double-ring infiltrometer. For medium and large projects, these tests must be performed by a qualified civil engineer (PE) or certified engineering geologist (CEG). A factor of safety of 2 shall be used.

3. The following conditions will be assumed to preclude infiltration, and will require appropriate documentation of site conditions:

A) "High" or "very high" landslide susceptibility. (Note: areas with moderate landslide susceptibility require dispersed infiltration unless accompanied by a geotechnical report describing conditions under which infiltration can be safely implemented.)

B) Depth to seasonal high groundwater, persistent restrictive layer, or competent bedrock < 36 inches below ground surface.

C) Presence of subsurface contamination, such as would be documented in a "no further action" determination following site cleanup or listing as an active cleanup site by Oregon Department of Environmental Quality.

D) Slopes across the site >25%. (Note: slopes consistently across the site ≥15% but ≤25% require dispersed infiltration unless accompanied by a geotechnical report describing conditions under which infiltration can be safely implemented.)

TABLE 4-5
HYDROLOGIC PROPERTIES OF COMMON SOILS IN URBAN WASHINGTON COUNTY

Soil Series	Hydrologic Soil Group	Drainage Class	Depth to Restrictive Layer (inches)	Depth to Ground-water (inches)	Infiltration Rates For Simplified Sizing (inches/ hour)
Aloha silt loam	C/D	somewhat poorly drained	>80	18-24	0.2
Amity silt loam	C/D	somewhat poorly drained	>80	6-18	0.2
Briedwell stony silt loam	B	well drained	25	>80	2
Cascade silt loam	C	somewhat poorly drained	20-30*	18-30	0.5
Cascade-Urban complex	C	somewhat poorly drained	20-30	18-30	0.5
Chehalis silty clay loam	B	well drained	>80	48-80	2
Cornelius & Kinton silt loams	C	moderately well drained	30-40*	27-37	0.5
Cornelius variant silt loam	C	moderately well drained	30-40*	27-37	0.5
Cove clay	D	poorly drained	>80	0-12	0.1
Cove silty clay loam	D	poorly drained	>80	0-12	0.1
Dayton silt loam	D	poorly drained	0-24	0-24	0.1
Delena silt loam	D	poorly drained	20-30*	0-18	0.1
Helvetia silt loam	C	moderately well drained	>80	36-72	0.5
Hillsboro loam	B	well drained	>80	>80	2
Huberly silt loam	C/D	poorly drained	38*	0-8	0.2
Laurelwood silt loam	B	well drained	>80	>80	2
McBee silty clay loam	C	moderately well drained	>80	24-36	0.5
Quatama loam	C	moderately well drained	>80	24-36	0.5
Saum silt loam	C	well drained	20-30*	18-30	0.5
Urban land	Not specified; site-specific infiltration testing required				
Verboort silty clay loam	D	poorly drained	12-26	0-8	0.1
Wapato silty clay loam	C/D	poorly drained	>80	0-12	0.2
Willamette silt loam	B	well drained	>80	>80	2
Woodburn silt loam	C	moderately well drained	>80	25-32	0.5
Xerocrepts & Haploxerolls	B	well drained	>80	>80	2
Xerocrepts-rock outcrop	B	well drained	>80	>80	2

* indicates presence of fragipan below which infiltration increases
Source: USDA/NRCS National engineering Handbook, Chapter 7, "Hydrologic Soil Groups" (2009), City of Gresham Stormwater Manual Appendix D (2018), and Web Soil Survey
Note: data for soil series not listed in this table are available from Web Soil Survey, except for Assumed Infiltration Rate, which can be determined from Hydrologic Soil Group.

4.08.4 Simplified Sizing

a. Simplified sizing may be used for facilities where the contributing impervious area to an individual water quality approach is no greater than 15,000 square feet per facility inlet or contributing drainage area.

b. Water Quality Sizing

A 6% sizing factor shall be used to calculate the required water quality surface area of the selected treatment facility. A sizing factor of 6% assumes the site infiltration rate is less than 2 inches/hour.

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. Alternative Sizing

1. The vegetated surface area of the facility may be reduced by 25% when the growing media depth is increased to 30 inches or more.

2. A site specific design with a reduced sizing factor may be considered if on-site infiltration tests are performed at the soil depth of the proposed base of a facility, and the result of those tests show an infiltration rate that exceeds 2 inches per hour.

3. A site specific design with an alternate sizing factor may be considered when the impervious area contributing to an individual water quality approach is greater than 15,000 square feet.

e. Water Quality for Vegetated Corridor as a Filter Strip (applies to Section 4.04.3.c.1(J)).

The sizing of a Vegetated Corridor as a Filter Strip must meet all of the following criteria:

1. The maximum contributing impervious surface is 2,640 square feet, distributed uniformly across 50 feet of adjacent Vegetated Corridor.

2. The contributing impervious surface must be adjacent to the Vegetated Corridor, or within the outer 40% and approved as an allowed use consistent with the Service Provider Letter.

3. The minimum depth is three times the depth of the contributing impervious surface, or one single family residence. The depth of the Vegetated Corridor treatment area shall be measured from the edge of the Sensitive Area and in the direction of stormwater flow.

4.08.5 Standard Sizing

a. Water Quality Volumes and Flows (applies to approaches in Section 4.04.3.c.1 (A)-(C))

1. Water Quality Storm
The water quality storm is the storm required by regulations to be treated. The storm defines both the volume and rate of runoff. The water quality storm is defined in Subsection 4.08.2.

2. Water Quality Volume (WQV)
The WQV is the volume of water that is produced by the water quality storm. The WQV equals 0.36 inches over the impervious area that is required to be treated as shown in the formula below:

$$\text{Water Quality Volume (cu.ft.)} = \frac{0.36\text{ (in.)} \times \text{Area (sq.ft.)}}{12\text{ (in./ft.)}}$$

3. Water Quality Flow (WQF)
The WQF is the average design flow anticipated from the water quality storm as shown in the formulas below:

$$\text{Water Quality Flow (cfs)} = \frac{\text{Water Quality Volume (cu.ft.)}}{14{,}400\text{ seconds}}$$

or

$$\text{Water Quality Flow (cfs)} = \frac{0.36\text{ (in.)} \times \text{Area (sq.ft.)}}{12\text{(in/ft)}(4\text{ hr})(\text{ 60 min/hr})(60\text{ sec/min})}$$

b. Sizing Infiltration facilities for Hydromodification

1. Hydromodification Storm and Drawdown

A) Infiltration facilities shall 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.

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.b.

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.

1. HEC-HMS (or HEC-1)
2. SWMM
3 City of Portland's Presumptive Approach Calculator (PAC): facility must pass the Flow Control criteria
4. 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
5. 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 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

b. When quantity management is required due to a downstream conveyance capacity deficiency, a combination of on-site 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 the table below. 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 4-6

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

c. When required as a hydromodification approach, a combination of on-site 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 the table below. 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	50% of 2-year, 24-hour
5-year, 24-hour	5-year, 24 hour
10-year, 24-hour	10-year, 24-hour

d. If a proposed project includes modified impervious surface (Redevelopment), a curve number (CN) of 75 shall be used as the pre-developed condition for all modified 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. 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 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.

c. If a proposed project includes modified impervious surface (Redevelopment), assume a curve number (CN) of 75 shall be used as the pre-developed condition for all modified 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 Manholes

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 Manhole 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 manhole, up to the 25-year flow. Flow calculations shall include the effect of an upstream flow splitter.
   6. Maintain a 3-foot clear access zone between the inside structure and manhole walls.
   7. Orient access to structure in a clear zone.
   8. Flat Top Section shall have 2 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

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 it meets all relevant criteria.
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 on-site 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 species selection per Appendix A, LIDA Handbook, or approved alternate; must include 3 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 co-located 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 manhole at the upstream and downstream terminus, or as approved by the District and City;
    f. A pre-treatment water quality manhole (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 approves the system in writing.

4.09.4 Vegetated Swale

a. Applications
    1. Water Quality

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"-¾" 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 3 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. Water Quality

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 that the upstream storm sewer will not be in a surcharged condition for longer than 24 hours.
   9. Landscaping plan
      A) Treatment area: 6 herbaceous plants (1-inch plugs or equivalent) per square foot. Plants per Appendix A, LIDA

Handbook, or approved alternate; plant selection must include 3 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. Water Quality

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 de-watering 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 percent 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.

4.09.7 Structural Infiltration Planter

a. Applications
   1. Water Quality
   2. Hydromodification
   3. LIDA

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 re-establish native infiltration capacity through soil amendment or mechanical means.
   10. Rain drains and overflow structure to maintain maximum linear separation.
   11. Building jurisdiction approval required for building setback distance and impermeable liners.
   12. 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 4 shrubs, 1-gallon container size, 2 feet on center.

4.09.8 Non-Structural Infiltration Planter (Rain Garden)

a. Applications
   1. Water Quality
   2. Hydromodification
   3. LIDA

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 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 re-establish native infiltration capacity through soil amendment or mechanical means.
   12. Rain drains and overflow structure to maintain maximum linear separation.
   13. Building jurisdiction approval required for building setback distance and impermeable liners.
   14. 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 4 shrubs, 1-gallon container size, 2 feet on center.

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

4.09.9 Flow-through Planter

a. Applications
1. Water Quality
2. LIDA

b. Hydraulic Design Criteria

1. Sizing: Simplified LIDA Sizing per Section 4.08.4
2. Minimum Freeboard: 2 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.
3. Maximum slope: Planters are designed to evenly distribute and filter flows. Surface longitudinal slopes should be less than 0.5%.
4. Minimum Width: 30 inches
5. Maximum Treatment Depth (measured from top of soil medium): 0.5 feet
6. Minimum Cross-Sectional Depths:
A) Growing medium: 18 inches
B) Choker course: 3 inches
C) Drain rock: 9 inches
7. Provide an energy dissipater at the entrance to the planter. It will be designed to reduce velocities and prevent scour.
8. Provide an approved outlet (overflow) structure for all flows.
9. Rain drains and overflow structure to maintain maximum linear separation.
10. Building jurisdiction approval required for: building setback distance, impermeable liner, structural wall and when depth of the facility is below the building footing.
11. A perforated pipe system under the planter drains water that has filtered through the topsoil to prevent long-term ponding.
12. 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 4 shrubs, 1-gallon container size, 2 feet on center.

4.09.10 Non-Structural Flow-Through Planter/Rain Garden

a. Applications
   1. Water Quality
   2. LIDA

b. Hydraulic Design Criteria

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

c. Design Criteria

   1. Provide minimum 18 inch sumped inlet with a minimum 18 inch diameter drain basin for pretreatment.
   2. Minimum length: 15 feet.
   3. Slope: no greater than 6%. Sloped facilities must demonstrate adequate distribution of flow throughout treatment area.
   4. Minimum Bottom Width: 24 inches
   5. Maximum Treatment Depth (measured from top of soil medium): 0.5 feet
   6. Side Slope
      A) With 1 foot shelf: 3H:1V
      B) Without 1 foot shelf: 4H:1V
   7. Minimum Cross-Sectional Depths:
      A) Growing medium: 18 inches
      B) Choker course: 3 inches
      C) Drain rock: 9 inches
   8. Inflow structure to be provided per location jurisdiction and approved District structure types.
   9. Provide an energy dissipater at the entrance to the swale. It will be designed to reduce velocities and spread flow across the treatment cross section.
   10. Provide an approved overflow structure sized to jurisdictional plumbing code or to convey the 25-year storm.
   11. Check dams will be provided for slopes in excess of 5%.
   12. Street-side swales will have a 30 mil impermeable liner, or approved equivalent per jurisdictional road authority, along the street-side.
   13. Vegetation quantities per 100 square feet:
      A) Treatment Area: 115 herbaceous plants, evergreen, 1 foot on center spacing, ½-gallon container size; or 100 herbaceous plants, 1 foot on center, evergreen, and 4 shrubs, 1-gallon container size, 2 feet on center.

B) Vegetation to be used in the swale bottom conforms to plantings approved for the wet moisture regime.
C) Vegetation to be used along the swale side conforms to plantings approved for the moist moisture regimes.

14. Treatment area shall have high density jute or coconut matting over the entire surface or other base stabilization method as approved by the District.

4.09.11 Street-side Planter

a. Applications
1. Water Quality
2. LIDA

b. Hydraulic Design Criteria
1. Sizing: Simplified Sizing per Section 4.08.4
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 Treatment Depth (measured from top of 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 sizedper 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 2 ½ inches above subgrade.

B) Flow through facilities: Bottom of pipe shall be set at the base of the drain rock layer

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13. Vegetation quantities per 100 square feet: 115 herbaceous plants, evergreen, 1 foot on center spacing, ½-gallon container size; or 100 herbaceous plants, evergreen, 1 foot on center, and 4 shrubs, 1-gallon container size, 2 feet on center.

4.09.12 Landscape Filter Strip

a. Applications
   1. Water Quality
   2. LIDA

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 native 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.

4.09.13 Vegetated Corridor as a Filter Strip

a. Applications
   1. Water Quality
   2. LIDA

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 a conveyance system prior to sheet flow distribution.
   2. A Concrete spreader, or gravel trench may be required to disperse the runoff evenly across the vegetated area
   3. Slope: At least 0.5% and no more than 6%
   4. Vegetation: the vegetated corridor shall be enhanced to Good Corridor condition in accordance with Appendix A, Planting Requirements.

4.09.14 Green Roofs

a. Applications
   1. LIDA
   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 2 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.

4.09.15 Porous Pavement

a. Applications
   1. LIDA
   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" minimum depth layer of clean, crushed ¾" to ¼" drain rock between surface material and aggregate base.
   3. Aggregate Base: Clean, crushed 3/4" to 2" 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 retention 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.

4.09.16 Stormwater Tree

a. Applications
   1. LIDA
   2. Retention or planting of a Stormwater Tree, which results in reduction of impervious area for the purposes 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.

4.09.17 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.

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 -1-½: 20% by weight clay loam (>20% clay). Additives to improve water retention 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.