Clark County Stormwater Manual 2015

Book 1
Applicability, BMP Selection,
and Submittal

November 24, 2015

The *Clark County Stormwater Manual: Book 1* –is adapted from the *Stormwater Management Manual for Western Washington*, (Ecology, 2014) Volumes I, II, III, and V and the *Clark County Stormwater Manual 2009*.

Illustrations and drawings are courtesy Washington Department of Ecology or redrawn from Washington Department of Ecology, unless otherwise noted. Illustrations are simplified representations of stormwater facilities; they are not to scale and they require detailed engineering for use in design or construction. Design requirements in text take precedence over figures.

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Introduction to Book 1

Book 1 of the *Clark County Stormwater Manual* contains regulatory requirements for applicability and selection of permanent and temporary stormwater controls that apply to new development, redevelopment, and construction sites.

Book 1 describes investigations and selection processes prerequisite to planning for site development and developing a stormwater site plan. It describes nine Minimum Requirements established by Washington Department of Ecology and implemented by Clark County, as well as numerous County requirements. Book 1 also lists submittal requirements for projects.

This book is both regulatory and technical. Use this book in conjunction with Book 2, which has specific requirements for engineering analyses and design of stormwater controls selected for the site.

BMP numbers used in this manual have been modified from those used in the *Stormwater Management Manual for Western Washington* (Ecology, 2014); however, the two often coincide.

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Chapter 1 Minimum Requirements, County Requirements and Submittals

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1.1 Introduction

1.1.1 Purpose

This chapter provides direction on identifying which Department of Ecology Minimum Requirements and Clark County requirements apply to a project. The chapter directs users to the appropriate book and chapter of this manual for meeting requirements. The chapter gives directions for submitting a Stormwater Site Plan to Clark County.

1.1.2 How to Use this Chapter

- Section 1.2 describes projects and activities that are exempt from Clark County Code (CCC) Chapter 40.386 and the *Clark County Stormwater Manual* (CCSM).
- Section 1.3 lists definitions related to the Minimum Requirements. These definitions are essential to understanding the Minimum Requirements.
- Section 1.4 defines thresholds for project type, area, and area of land-disturbance that determine which Minimum Requirements apply.
- Section 1.5 lists and describes the Minimum Requirements.
- Section 1.6 describes County technical requirements that apply to projects in addition to the Minimum Requirements.
- Section 1.7 describes how to submit a Stormwater Site Plan for a small project.
- Section 1.8 describes how to submit a Stormwater Site Plan to Clark County.
- Section 1.9 describes the types of administrative and legal submittals (e.g. easements) that may be required.

1.2 Exemptions

Some projects are exempt from the Minimum Requirements, County Requirements or this manual.

1.2.1 Total Exemptions from this Manual

Publicly-funded linear transportation projects may follow the minimum design requirements and BMPs of the 2014 version of the Washington Department of Transportation's *Highway Runoff Manual* (HRM), except use of the infeasibility criteria used for LID selection in the HRM (both the general criteria in Section 4-5 and the BMP specific criteria in Section 5) is not allowed. Instead, LID infeasibility criteria in this manual must be used for LID selection.

1.2.2 Total Exemptions from the Minimum Requirements

The following activities are exempt from the Minimum Requirements of this manual. Other Clark County, state and federal requirements may apply.

- Forest practices regulated under Title 222 of the Washington Administrative Code (WAC), except Class IV General Forest Practices that are conversions from timberland to other uses.
- Commercial agricultural practices involving working the land for production. However, the conversion from timberland to agriculture and the construction of impervious surfaces are not exempt.
- Construction of agricultural buildings or other hard surfaces for carrying out agricultural activities; provided, that no stormwater is released from the site directly or indirectly to the County's stormwater conveyance system.
- Normal landscape maintenance activities and gardening, except as defined as a land disturbing activity per the definition in Appendix 1-A.
- Oil and gas field activities or operations, including construction of drilling sites, waste management pits, and access roads, as well as construction of transportation and treatment infrastructure such as pipelines, natural gas treatment plants, natural gas pipeline compressor stations, and crude oil pumping stations. Operators are encouraged to implement and maintain best management practices to minimize erosion and control sediment during and after construction activities to help ensure protection of surface water quality during storm events.
- The following pavement maintenance practices:
    - Pothole and square cut patching.
    - Overlaying existing asphalt or concrete pavement without expanding the area of coverage.
    - Shoulder grading.
    - Regrading/reshaping drainage systems.
    - Crack sealing.
    - Resurfacing with in-kind material without expanding the road prism.
    - Pavement preservation activities that do not expand the road prism.
    - Vegetation management.

1.2.2.1 Clarification of Pavement Maintenance Exemptions

The following pavement maintenance practices are not categorically exempt. They are considered redevelopment. The extent to which the Minimum Requirements applies is explained for each circumstance.

- Removing and replacing a paved surface to base course or lower, or repairing the pavement base: If impervious surfaces are not expanded, Minimum Requirements #1 – #5 apply.
- Extending the pavement edge without increasing the size of the road prism, or paving graveled shoulders: These are considered new impervious surfaces and are subject to the Minimum Requirements that are triggered when the thresholds identified for new or redevelopment projects are met.
- Resurfacing by upgrading from dirt to gravel, asphalt or concrete; upgrading from gravel to asphalt or concrete; or upgrading from a bituminous surface treatment ("chip seal") to asphalt or concrete: These are considered new impervious surfaces and are subject to the Minimum Requirements that are triggered when the thresholds identified for new or redevelopment projects are met.

1.2.3 Exemptions to Individual Minimum Requirements

- Drainage projects that are not new development or redevelopment and do not create new stormwater injection wells are exempt from Minimum Requirement #6, Runoff Treatment, and the Responsible Official may waive all or parts of Minimum Requirement #1, Preparation of a Stormwater Site Plan, if the project meets other applicable requirements of this manual.
- Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics are subject only to Minimum Requirement #2, Construction Stormwater Pollution Prevention.
- New development and redevelopment that meet the criteria for a Flow Control-Exempt Surface Water (see Section 1.5.7.1) and all of the following criteria are exempt from Minimum Requirement #7, Flow Control:
    - Project meets the exemption requirements for discharges to one of the following water bodies:
        - Columbia River
        - Lake River
        - Lewis River, downstream of the confluence with Quartz Creek
        - East Fork Lewis River, downstream of the confluence with Big Tree Creek
        - Vancouver Lake
    - Runoff from the site is treated in accordance with the thresholds and requirements of Minimum Requirement #6, Runoff Treatment.
    - The discharge structure is designed to avoid erosion during all storms up to the 100-year storm.
    - If an existing discharge structure is used, then either:

        - The discharge structure and conveyance system leading to it must have adequate capacity to meet the requirements of Chapter 7 of this book; or
        - The project must detain runoff from the project site that exceeds the existing system's capacity.

- New development and redevelopment are exempt from Minimum Requirement #8, Wetlands Protection, provided that:
    - The project does not change the rate, volume, duration, or location of discharges to and from the project site (e.g. where existing impervious surface is replaced with other impervious surface having similar runoff-generating characteristics, or where pipe/ditch modifications do not change existing discharge characteristics), or
    - The project meets the land cover percentage requirements for full dispersion in accordance to this manual for flow control, or
    - The Responsible Official determines based on information in the Preliminary Stormwater Plan, or information submitted for wetland review per CCC 40.450, that the proposed project will not degrade wetland function.

1.2.4 Exemptions from County Requirements

Publicly-funded road-related development and drainage projects are exempt from Section 1.9, Administrative and Legal Requirements.

1.3 Definitions Related to the Minimum Requirements

Approved Continuous Flow Model – Where referenced in this document, this term applies to continuous simulation hydrologic models approved for use in Clark County by the Department of Ecology. The Western Washington Hydrology Model (WWHM) and MGSFlood are the only two approved models for use in Clark County.

Bioretention – Engineered facilities that treat stormwater by passing it through a specified soil profile and either retain or detain the treated stormwater for flow attenuation.

Certified Erosion and Sediment Control Lead (CESCL) – means an individual who has current certification through an approved erosion and sediment control training program that meets the minimum training standards established by the Washington Department of Ecology (Ecology). A CESCL is knowledgeable in the principles and practices of erosion and sediment control. The CESCL must have the skills to assess site conditions and construction activities that could impact the quality of stormwater and, the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges. Certification is obtained through an Ecology approved erosion and sediment control course. Course listings are provided online at Ecology's website.

Commercial Agriculture – means those activities conducted on lands defined in RCW 84.34.020(2) and activities involved in the production of crops or livestock for commercial trade. An activity ceases to be considered commercial agriculture when the area on which it is conducted is proposed for conversion to a nonagricultural use or has lain idle for more than five years, unless the idle land is registered in a federal or state soils conservation program, or unless the activity is maintenance of irrigation ditches, laterals, canals, or drainage ditches related to an existing and ongoing agricultural activity.

Converted Vegetation (areas) – The surfaces on a project site where native vegetation, pasture, scrub/shrub, or unmaintained non-native vegetation (e.g., Himalayan blackberry, scotch broom) are converted to lawn or landscaped areas, or where native vegetation is converted to pasture.

Effective Impervious Surface – Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. Impervious surfaces are considered ineffective if: 1) the runoff is dispersed through use of BMP T5.30A or T5.30B; 2) residential roof runoff is infiltrated in accordance with Downspout Full Infiltration Systems in BMP T5.10A or BMP T5:10B; or 3) modeling with an approved continuous simulation hydrologic model indicate that the entire runoff file is infiltrated.

Erodible or Leachable Materials – Wastes, chemicals, or other substances that measurably alter the physical or chemical characteristics of runoff when exposed to rainfall. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage.

Hard Surface – An impervious surface, a permeable pavement, or a vegetated roof.

Highway – A main public road connecting towns and cities.

Impervious Surface – A non-vegetated surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A non-vegetated surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces for purposes of determining whether the thresholds for application of Minimum Requirements are exceeded. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of runoff modeling.

Land Disturbing Activity – Any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to clearing, grading, filling, and excavation. Compaction that is associated with stabilization of structures and road construction shall also be considered a land disturbing activity. Vegetation maintenance practices, including landscape maintenance and gardening, are not considered land-disturbing activity. Stormwater facility maintenance is not considered land disturbing activity if conducted according to established standards and procedures.

Low Impact Development (LID) – A stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project design.

LID Best Management Practices – Distributed stormwater management practices, integrated into a project design, that emphasize pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration. LID BMPs include, but are not limited to, bioretention/rain gardens, permeable pavements, roof downspout controls, dispersion, soil quality and depth, minimal excavation foundations, vegetated roofs, and water re-use.

LID Principles – Land use management strategies that emphasize conservation, use of on-site natural features, and site planning to minimize impervious surfaces, native vegetation loss, and stormwater runoff.

Maintenance – Repair and maintenance includes activities conducted on currently serviceable structures, facilities, and equipment that involves no expansion or use beyond that previously existing and results in no significant adverse hydrologic impact. It includes those usual activities taken to prevent a decline, lapse, or cessation in the use of structures and systems. Those usual activities may include replacement of dysfunctional facilities, including cases where environmental permits require replacing an existing structure with a different type structure, as long as the functioning characteristics of the original structure are not changed. One example is the replacement of a collapsed, fish blocking, round culvert with a new box culvert under the same span, or width, of roadway. In regard to stormwater facilities, maintenance includes assessment to ensure ongoing proper operation, removal of built up pollutants (i.e. sediments), replacement of failed or failing treatment media, and other actions taken to correct defects as identified in the maintenance standards in Book 4 of this manual. See also Pavement Maintenance exemptions in Section 1.2.2.

Native Vegetation – Vegetation comprised of plant species, other than noxious weeds, that are indigenous to the coastal region of the Pacific Northwest and which reasonably could have been expected to naturally occur on the site. Examples include trees such as Douglas Fir, western hemlock, western red cedar, alder, big-leaf maple, and vine maple; shrubs such as willow, elderberry, salmonberry, and salal; and herbaceous plants such as sword fern, foam flower, and fireweed.

New Development – Land disturbing activities, including Class IV -general forest practices that are conversions from timber land to other uses; structural development, including construction or installation of a building or other structure; creation of hard surfaces; and subdivision, short subdivision and binding site plans, as defined and applied in Chapter 58.17 RCW. Projects meeting the definition of redevelopment shall not be considered new development.

On-site Stormwater Management BMPs – As used in this manual, a synonym for Low Impact Development BMPs.

Permeable Pavement – Pervious concrete, porous asphalt, permeable pavers or other forms of pervious or porous paving material intended to allow passage of water through the pavement section. It often includes an aggregate base that provides structural support and acts as a stormwater reservoir.

Pervious Surface – Any surface material that allows stormwater to infiltrate into the ground. Examples include lawn, landscape, pasture, native vegetation areas, and permeable pavements.

Pollution-generating Hard Surface (PGHS) – Those hard surfaces considered to be a significant source of pollutants in stormwater runoff. See the listing of surfaces under pollution-generating impervious surface.

Pollution-generating Impervious Surface (PGIS) – Those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those which are subject to: vehicular use; industrial activities (as further defined in the glossary of this manual); storage of erodible or leachable materials, wastes, or chemicals, and which receive direct rainfall or the run-on or blow-in of rainfall; metal roofs unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating); or roofs that are subject to venting significant amounts of dusts, mists, or fumes from manufacturing, commercial, or other indoor activities.

Pollution-generating Pervious Surfaces (PGPS) – Any non-impervious surface subject to vehicular use, industrial activities (as further defined in the glossary of this manual); or storage of erodible or leachable materials, wastes, or chemicals, and that receive direct rainfall or run-on or blow-in of rainfall, use of pesticides and fertilizers, or loss of soil. Typical PGPS include permeable pavement subject to vehicular use, lawns, and landscaped areas including: golf courses, parks, cemeteries, and sports fields (natural and artificial turf).

Pre-developed Condition – The native vegetation and soils that existed at a site prior to the influence of Euro-American settlement. The pre-developed condition shall be assumed to be a forested land cover unless reasonable, historic information is provided that indicates the site was prairie prior to settlement.

Project Site – That portion of a property, properties, or right of way subject to land disturbing activities, new hard surfaces, or replaced hard surfaces.

Rain Garden – A non-engineered shallow landscaped depression, with compost-amended native soils and suitable plants. The depression is designed to pond and temporarily store stormwater runoff from adjacent areas, and to allow stormwater to pass through the amended soil profile.

Receiving Waters - Bodies of water or surface water systems to which surface runoff is discharged via a point source of stormwater or via sheet flow. Groundwater to which surface runoff is directed by infiltration.

Redevelopment – On a site that is already substantially developed (i.e., has 35% or more of existing hard surface coverage), the creation or addition of hard surfaces; the expansion of a building footprint or addition or replacement of a structure; structural development including construction, installation or expansion of a building or other structure; replacement of hard surface that is not part of a routine maintenance activity; and land disturbing activities.

Replaced Hard Surface – For structures, the removal and replacement of hard surfaces down to the foundation. For other hard surfaces, the removal down to bare soil or base course and replacement.

Replaced Impervious Surface – For structures, the removal and replacement of impervious surfaces down to the foundation. For other impervious surfaces, the removal down to bare soil or base course and replacement.

Site – The area defined by the legal boundaries of a parcel or parcels of land that is (are) subject to new development or redevelopment. For road projects, the length of the project site and the right-of-way boundaries define the site.

Source Control BMP – A structure or operation that is intended to prevent pollutants from coming into contact with stormwater through physical separation of areas or careful management of activities that are sources of pollutants. This manual separates source control BMPs into two types. Structural Source Control BMPs are physical, structural, or mechanical devices, or facilities that are intended to prevent pollutants from entering stormwater. Operational BMPs are non-structural practices that prevent or reduce pollutants from entering stormwater.

Threshold Discharge Area – An on-site area draining to a single natural discharge location or multiple natural discharge locations that combine within one-quarter mile downstream (as determined by the shortest flow path). The examples in Figure 1.1, below, illustrate this definition. The purpose of this definition is to clarify how the thresholds of this manual are applied to project sites with multiple discharge points.

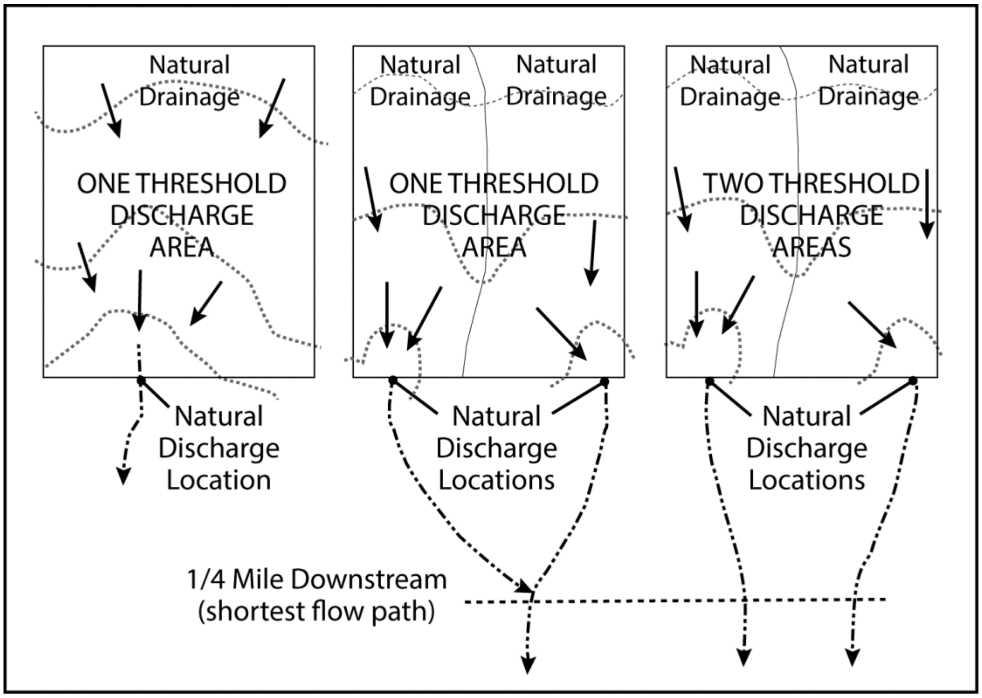

Figure 1.1: Threshold Discharge Area

(Source: modified from Department of Ecology)

1.4 Applicability of the Minimum Requirements

Clark County has other technical requirements and administrative and legal requirements that are not included in the Minimum Requirements. These are identified in Sections 1.6 and 1.9.

Clark County has nine Minimum Requirements for stormwater management. These Minimum Requirements are:

1. Preparation of Stormwater Site Plans
2. Construction Stormwater Pollution Prevention
3. Source Control of Pollution
4. Preservation of Natural Drainage Systems and Outfalls
5. On-site Stormwater Management (Low Impact Development)
6. Runoff Treatment
7. Flow Control
8. Wetlands Protection
9. Operation and Maintenance

Not all of the minimal requirements apply to every project. The applicability varies, depending on the project type, size, and location. To determine which requirements apply to a specific project, see Section 1.4.1 (for new development) or Section 1.4.2 (for redevelopment) and/or consult Figure 1.2 (for new development) and Figure 1.3 (for redevelopment).

Understanding the definitions in Section 1.3 is essential to correctly implementing the Minimum Requirements.

1.4.1 New Development

All new development shall comply with Minimum Requirement #2.

The following new development shall comply with Minimum Requirements #1 – #5 for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet, or greater, of new, replaced, or new plus replaced hard surface area, or
- Has land disturbing activity of 7,000 square feet or greater.

The following new development shall comply with Minimum Requirements #1 – #9 for the new and replaced hard surfaces and the converted vegetation areas:

- Results in 5,000 square feet, or greater, of new plus replaced hard surface area, or
- Converts ¾ acres, or more, of vegetation to lawn or landscaped areas, or
- Converts 2.5 acres, or more, of native vegetation to pasture.

1.4.2 Redevelopment

All redevelopment shall comply with Minimum Requirement #2.

The following redevelopment shall comply with Minimum Requirements #1 – #5 for the new and replaced hard surfaces and the land disturbed:

- Results in 2,000 square feet, or more, of new plus replaced hard surface area, or
- Has land disturbing activity of 7,000 square feet or greater.

The following redevelopment shall comply with Minimum Requirements #1 – #9 for the new hard surfaces and converted pervious areas:

- Adds 5,000 square feet or more of new hard surfaces or,
- Converts ¾ acres, or more, of vegetation to lawn or landscaped areas, or
- Converts 2.5 acres, or more, of native vegetation to pasture.

Clark County may allow the Minimum Requirements to be met for an equivalent (flow and pollution characteristics) area within the same site. For publicly-funded linear transportation projects, the equivalent area does not have to be within the project limits, but must drain to the same receiving water.

1.4.2.1 Additional Requirements for the Redevelopment Project Site

For road-related projects, runoff from the replaced and new hard surfaces (including pavement, shoulders, curbs, and sidewalks) and the converted vegetated areas shall meet Minimum Requirements #1 – #9 if the new hard surfaces total 5,000 square feet or more and total 50% or more of the existing hard surfaces within the project limits. The project limits shall be defined by the length of the project and the width of the right–of-way.

Other types of redevelopment projects shall comply with Minimum Requirements #1 – #9 for the new and replaced hard surfaces and the converted vegetated areas if the total of new plus replaced hard surfaces is 5,000 square feet or more, and the valuation of proposed improvements – including interior improvements – exceeds 50% of the assessed value of the existing site improvements.

The Responsible Official may exempt or institute a stop-loss provision for redevelopment projects from compliance with Minimum Requirements #5, On-site Stormwater Management; Minimum

Requirement #6, Runoff Treatment; Minimum Requirement #7, Flow Control; and/or Minimum Requirement #8, Wetlands Protection as applied to the replaced hard surfaces if Clark County has adopted a plan and a schedule that fulfills those requirements in regional facilities.

The Responsible Official may grant a variance/exception to the application of the flow control requirements to replaced impervious surfaces if such application imposes a severe and unexpected economic hardship. See CCC 40.386.

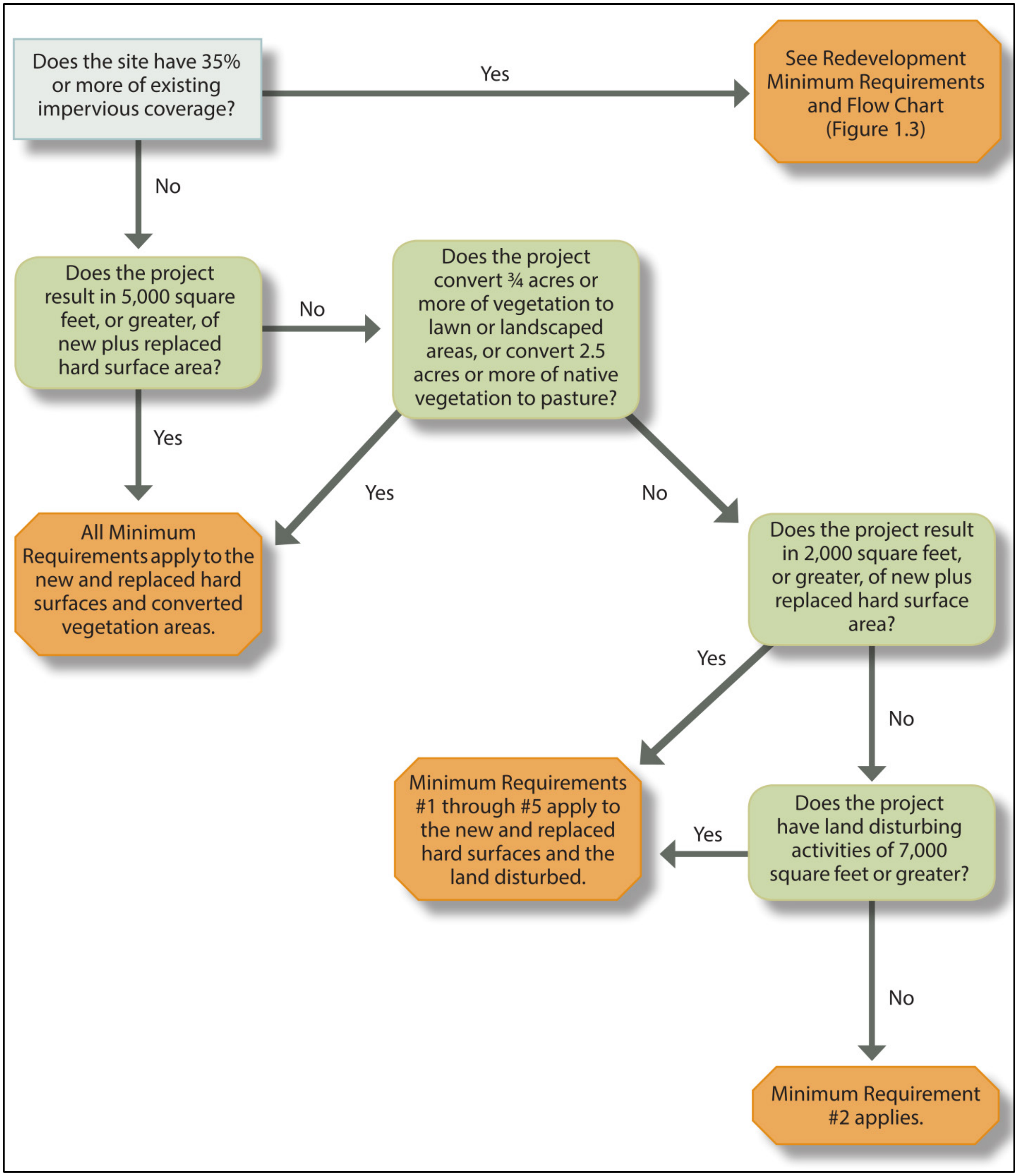

Figure 1.2: New Development Flow Chart

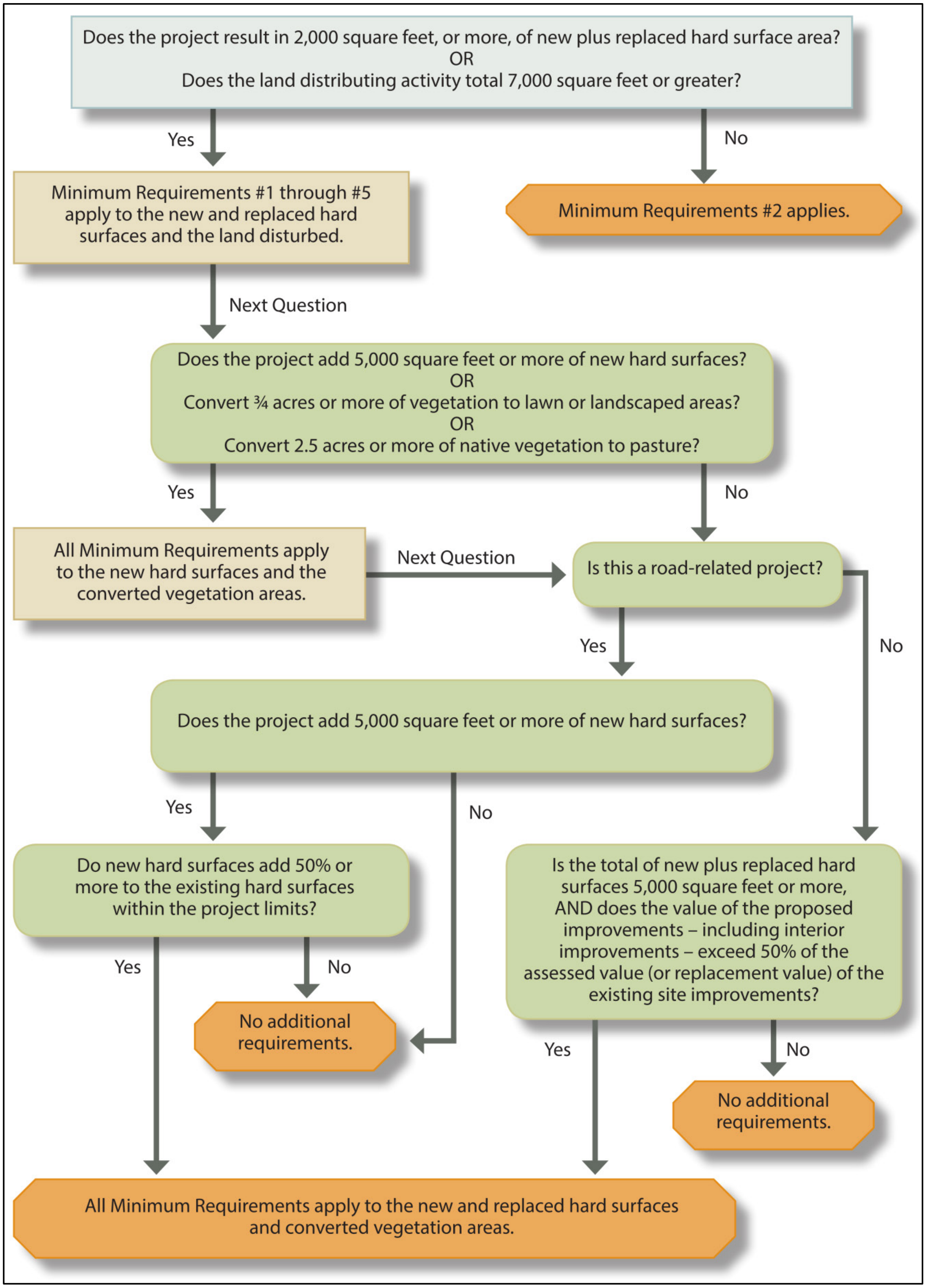

Figure 1.3: Redevelopment Flow Chart

1.4.3 How to Meet the Minimum Requirements

After determining which Minimum Requirements apply to a specific project, read the applicable Minimum Requirements in Section 1.5. Then refer to the list below to determine where to find out how to meet each one.

1: Preparation of Stormwater Site Plans

- Consult **Book 1, Section 1.8** of this manual to fulfill Minimum Requirement #1.
- For sites meeting the definition of a Small Project (see Section 1.7), consult **Book 1, Section 1.7** of this manual to confirm eligibility to use **Stormwater Site Plan Short Form**, in **Appendix 1-I** to fulfill Minimum Requirement #1.

2: Construction Stormwater Pollution Prevention

- Consult **Book 1, Chapter 6** of this manual to fulfill Minimum Requirement #2.

3: Source Control of Pollution

- Consult **Book 3, Source Control** of this manual to fulfill Minimum Requirement #3.

4: Preservation of Natural Drainage Systems and Outfalls

- Consult **Book 1, Section 1.5.4** and **Book 2, Chapter 7** to fulfill Minimum Requirement #4.

5: On-site Stormwater Management

- Consult **Book 1, Chapter 2** and **Book 2, Chapter 2** to fulfill Minimum Requirement #5.

6: Runoff Treatment

- Consult **Book 1, Chapter 3** and **Book 2 Chapters 3** and **4** to fulfill Minimum Requirement #6.

7: Flow Control

- Consult **Book 1, Chapter 4** and **Book 2, Chapters 5** and **6** to fulfill Minimum Requirement #7.

8: Wetlands Protection

- Consult **Book 1, Section 1.5.8** to fulfill Minimum Requirement #8.
- In addition, consult **CCC 40.450** for additional information relating to wetland protection in Clark County.

9: Operation and Maintenance

- Consult **Book 4, Operation and Maintenance** to fulfill Minimum Requirement #9.

1.5 Minimum Requirements

This section describes the Minimum Requirements for stormwater management at development and redevelopment sites. Consult Section 1.4 to determine which requirements apply to any given project and whether the Minimum Requirements apply to new surfaces, replaced surfaces, new and replaced surfaces, or converted vegetation areas.

1.5.1 Minimum Requirement #1: Preparation of Stormwater Site Plans

All projects meeting the thresholds in Section 1.4 shall prepare a Stormwater Site Plan for review by Clark County. Stormwater Site Plans shall use site-appropriate development principles to retain native vegetation and minimize impervious surfaces to the extent feasible. Stormwater Site Plans shall be prepared in accordance with Sections 1.7 and 1.8 of this book.

Stormwater Site Plans shall use appropriate development principles to retain native vegetation and minimize impervious surfaces to the extent feasible. See Preservation of Native Vegetation (BMP T5.40) and Better Site Design (BMP T5.41) in Book 2, Chapter 2 for more information.

1.5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention

1.5.2.1 Thresholds

All new development and redevelopment projects are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters.

Projects which result in 2,000 square feet or more of new plus replaced hard surface area, or which disturb 7,000 square feet or more of land must prepare and submit a Construction Stormwater Pollution Prevention Plan (SWPPP) as part of the Final Stormwater Plan.

Different methods of preparing a SWPPP are discussed in Sections 1.7 and 1.8 of this book.

Projects that result in less than 2,000 square feet of new plus replaced hard surface area or disturb less than 7,000 square feet of land are not required to prepare a Construction SWPPP, but must review the 13 Elements of Construction Stormwater Pollution Prevention and develop controls for each element that pertains to the project site.

The 13 Elements of Construction Stormwater Pollution Prevention are described in Chapter 6.

1.5.2.2 General Requirements

The SWPPP shall include a narrative and drawings. All BMPs shall be clearly referenced in the narrative and marked on the drawings. The SWPPP narrative shall include documentation to explain and justify the pollution prevention decisions made for the project. Each of the 13 elements must be considered and included in the Construction SWPPP unless site conditions render the element unnecessary and the exemption from that element is clearly justified in the narrative.

Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. These permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas shall be delineated on the site plans and the development site.

The SWPPP shall be implemented beginning with initial land disturbance and until final stabilization. Sediment and erosion control BMPs shall be consistent with the BMPs contained in Book 2, Chapter 8.

Seasonal Work Limitations

From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of Clark County that silt-laden runoff will be prevented from leaving the site through a combination of the following:

1. Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters.
2. Limitations on activities and the extent of disturbed areas.
3. Proposed erosion and sediment control measures.

The following activities are exempt from the seasonal clearing and grading limitations:

1. Routine maintenance and necessary repair of erosion and sediment control BMPs.
2. Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil.
3. Activities where there is one hundred percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.
4. Development projects in compliance with the state's Construction Stormwater General Permit.

1.5.3 Minimum Requirement #3: Source Control of Pollution

All known, available, and reasonable source control BMPs must be applied to all projects. Source control BMPs must be selected, designed, and maintained according to Book 3 of this manual.

1.5.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls

Natural drainage patterns shall be maintained, and discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down gradient properties. All outfalls require energy dissipation (see Book 2, Section 7.6).

1.5.5 Minimum Requirement #5: On-site Stormwater Management

Projects shall employ On-site Stormwater Management BMPs in accordance with the following project thresholds, standards, and lists to infiltrate, disperse, and retain stormwater runoff on-site to the maximum extent feasible without causing flooding or erosion impacts.

Projects qualifying as flow control exempt in accordance with Section 1.5.7.1 do not have to achieve the LID Performance Standard, nor consider bioretention, rain gardens, permeable pavement, or full dispersion if using List #1 or List #2. However, those projects must implement the following BMPs, if feasible:

- BMP T5.13, Post-Construction Soil Quality and Depth, in Chapter 2 and Book 2, Chapter 2; and
- BMPs T5.10A or BMP T5.10B, Downspout Full Infiltration; BMP T5.10C, Downspout Dispersion; or BMP T5.10D, Perforated Stub-out Connections, in Chapter 2 and Book 2, Chapter 2; and
- BMPs T5.11, Concentrated Flow Dispersion; or T5.12, Sheet Flow Dispersion, in Chapter 2 and Book 2, Chapter 2.

1.5.5.1 Project Thresholds

Projects triggering only Minimum Requirements #1 – #5 shall either:

1. Use On-site Stormwater Management BMPs from List #1 for all surfaces within each type of surface in List #1; or

2. Demonstrate compliance with the LID Performance Standard. Projects selecting this option cannot use Rain Gardens. They may choose to use Bioretention BMPs as described in Chapter 2 and Book 2, Chapter 2 to achieve the LID Performance Standard. Projects selecting this option must implement BMP T5.13, Post-Construction Soil Quality and Depth, if feasible.

Projects triggering Minimum Requirements #1 – #9, must meet the requirements in Table 1.1.

Table 1.1: On-site Stormwater Management Requirements for Projects Triggering Minimum Requirements #1 – #9

Project Type and Location	Requirement
New development on any parcel inside the UGA, or new development outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13; or List #2 (applicant option).
New development outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13.
Redevelopment on any parcel inside the UGA, or redevelopment outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13; or List #2 (applicant option).
Redevelopment outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13.

NOTE: This table refers to the Urban Growth Area (UGA) as designated under the Growth Management Act (GMA) (Chapter 26.70A RCW) of the State of Washington. See Clark County Maps Online at http://gis.clark.wa.gov/mapsonline/ for the location of UGA boundaries.

1.5.5.2 Low Impact Development Performance Standard

Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. Refer to Section 1.5.7.3, Standard Flow Control Requirement of Minimum Requirement #7, for information about the assignment of the pre-developed condition. Project sites that must also meet Minimum Requirement #7, Flow Control must match flow durations between 8% of the 2-year flow through the full 50-year flow.

1.5.5.3 List #1: On-site Stormwater Management BMPs for Projects Triggering Minimum Requirements #1 – #5

For each surface, consider the BMPs in the order listed for that type of surface. Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface. Feasibility shall be determined by evaluation against:

1. Limitations and infeasibility criteria identified for each BMP in Chapter 2; and,
2. Competing Needs Criteria listed in Chapter 2.

List #1

Lawn and landscaped areas

- Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Book 2, Chapter 2 of this manual.

Roofs

1. Full Dispersion in accordance with BMP T5.30A or BMP T5.30B in Chapter 2 and Book 2, Chapter 2, or Downspout Full Infiltration Systems in accordance with BMP T5.10A or BMP T5.10B in Chapter 2 and Book 2, Chapter 2.

2. Rain Gardens in accordance with BMP T5.14A in Chapter 2 and Book 2, Chapter 5 of this manual, or Bioretention in accordance with BMP T5.14B Chapter 2 and Book 2, Chapter 2. A rain gardens or bioretention facility must have a minimum horizontally projected surface area below the overflow which is at least 5% of the total surface area draining to it.[1]

3. Downspout Dispersion Systems in accordance with BMP T5.10C in Chapter 2 and Book 2, Chapter 2.

4. Perforated Stub-out Connections in accordance with BMP T5.10D in Chapter 2 and Book 2, Chapter 2.

Other Hard Surfaces

1. Full Dispersion in accordance with BMP T5.30A or BMP T5.30B in Chapter 2 and Book 2, Chapter 2.

2. Permeable pavement[2] in accordance with BMP T5.15 in Chapter 2 and Book 2, Chapter 5 of this manual, or Rain Gardens in accordance with BMP T5.14 in Chapter 2 and Book 2, Chapter 2, or Bioretention in accordance with Chapter 2 and Book 2, Chapter 2.

3. Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 2 and Book 2, Chapter 2.

1.5.5.4 List #2: On-site Stormwater Management BMPs for Projects Triggering Minimum Requirements #1 – #9

For each surface, consider the BMPs in the order listed for that type of surface. Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface. Feasibility shall be determined by evaluation against:

[1] The minimum horizontally projected surface area requirement does not apply to projects meeting the LID Performance Standard.

[2] This is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless full dispersion is employed.

1. Design criteria, limitations, and infeasibility criteria identified for each BMP in Chapter 2 and Book 2, Chapter 2; and

2. Competing Needs Criteria listed in Chapter 2.

List #2

Lawn and landscaped areas

- Post-Construction Soil Quality and Depth in accordance with BMP T5.13 in Chapter 2 and Book 2, Chapter 2.

Roofs

1. Full Dispersion in accordance with BMP T5.30A or BMP T5.30B in Chapter 2 and Book 2, Chapter 5 of this manual, or Downspout Full Infiltration Systems in accordance with BMP T5.10A or BMP 5.10B in Chapter 2 and Book 2, Chapter 2.

2. Bioretention in accordance with BMP T5.14B in Chapter 2 and Book 2, Chapter 2. Bioretention facilities must have a minimum horizontally projected surface area below the overflow which is at least 5% of the total surface area draining to it.[3]

3. Downspout Dispersion Systems in accordance with BMP T5.10C in Chapter 2 and Book 2, Chapter 2.

4. Perforated Stub-out Connections in accordance with BMP T5.10D in Chapter 2 and Book 2, Chapter 2.

Other Hard Surfaces

1. Full Dispersion in accordance with BMP T5.30A or BMP T5.30B in Chapter 2 and Book 2, Chapter 2.

2. Permeable pavement[4] in accordance with BMP T5.15 in Chapter 2 and Book 2, Chapter 2.

3. Bioretention BMPs (See Chapter 2 and Book 2, Chapter 2) that have a minimum horizontally projected surface area below the overflow which is at least 5% of the total surface area draining to it.

4. Sheet Flow Dispersion in accordance with BMP T5.12, or Concentrated Flow Dispersion in accordance with BMP T5.11 in Chapter 2 and Book 2, Chapter 2.

[3] The minimum horizontally projected surface area requirement does not apply to projects meeting the LID Performance Standard.
[4] This is not a requirement to pave these surfaces. Where pavement is proposed, it must be permeable to the extent feasible unless full dispersion is employed.

1.5.6 Minimum Requirement #6: Runoff Treatment

1.5.6.1 Thresholds

When assessing a project against the following thresholds, only consider those hard and pervious surfaces that are subject to this Minimum Requirement as determined in Section 1.4.

The following require construction of stormwater treatment facilities:

- Projects in which the total of pollution-generating hard surface (PGHS) is 5,000 square feet or more in a threshold discharge area of the project, or
- Projects in which the total of pollution-generating pervious surfaces (PGPS) – not including permeable pavements – is three-quarters (3/4) of an acre or more in a threshold discharge area, and from which there will be a surface discharge in a natural or man-made conveyance system from the site.

The following sites require phosphorus treatment stormwater treatment facilities:

- Projects located in the Lacamas watershed above the dam at the south end of Round Lake.

1.5.6.2 Treatment Facility Sizing

Size stormwater treatment facilities for the entire area that drains to them, even if some of those areas are not pollution-generating, or were not included in the project site threshold decisions (Section 1.4) or the treatment threshold decisions of this Minimum Requirement (Section 1.5.6.1).

Water Quality Design Storm Volume

The water quality design storm volume is the volume of runoff predicted from a 24-hour storm with a 6-month return frequency (a.k.a., 6-month, 24-hour storm). Wetpool facilities are sized based upon the volume of runoff predicted through use of the Natural Resource Conservation Service curve number equations in Appendix 2-A, for the 6-month, 24-hour storm. Alternatively, when using an approved continuous simulation hydrologic model, the water quality design storm volume shall be equal to the simulated daily volume that represents the upper limit of the range of daily volumes that accounts for 91% of the entire runoff volume over a multi-decade period of record.

Water Quality Design Flow Rate

Preceding Detention Facilities or when Detention Facilities are Not Required

The water quality design flow rate is the flow rate at or below which 91% of the runoff volume, as estimated by an approved continuous simulation hydrologic model, will be treated. Design criteria for treatment facilities are assigned to achieve the applicable performance goal (e.g. 80% TSS removal) at the water quality design flow rate. At a minimum, 91% of the total runoff volume, as estimated by an approved continuous flow model, must pass through the treatment facility(ies) at or below the approved hydraulic loading rate for the facility(ies).

Downstream of Detention Facilities

The water quality design flow rate is the full 2-year release rate from the detention facility.

1.5.6.3 Treatment Facility Selection, Design, and Maintenance

Stormwater treatment facilities shall be:

- Selected in accordance with the process identified in Chapter 3;
- Designed in accordance with the design criteria in Book 2, Chapters 3 and 4;
- Maintained in accordance with the maintenance schedules in Minimum Requirement #9 and Book 4 of this manual.

1.5.6.4 Additional Requirements

Direct discharge of untreated stormwater from pollution-generating hard surfaces to groundwater is prohibited, except for the discharge achieved by infiltration or dispersion of runoff through use of On-site Stormwater Management BMPs, in accordance with Chapter 2 and Book 2, Chapter 2; or by infiltration through soils meeting the soil suitability criteria in Book 2, Section 3.1.5.3.

1.5.7 Minimum Requirement #7: Flow Control

1.5.7.1 Applicability

The requirement below to provide flow control applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a surface waterbody.

Flow control is not required for projects that discharge directly to, or indirectly to, a waterbody listed in Section 1.2.3 subject to the following restrictions:

- Direct discharge to the exempt receiving water does not result in the diversion of drainage from any perennial stream classified as Types 1, 2, 3, or 4 in the State of Washington Interim Water Typing System, or Types "S", "F", or "Np" in the Permanent Water Typing System, or from any category I, II, or III wetland; and
- Flow splitting devices or drainage BMPs are applied to route natural runoff volumes from the project site to any downstream Type 5 stream (seasonal non-fish bearing) or category IV wetland:
    - o Design of flow splitting devices or drainage BMPs will be based on continuous hydrologic modeling analysis. The design will assure that flows delivered to Type 5 stream reaches will approximate, but in no case exceed, existing condition durations ranging from 50% of the 2-year to the 50-year peak flow.

    - Flow splitting devices or drainage BMPs that deliver flow to category IV wetlands will also be designed using continuous hydrologic modeling to preserve pre-project wetland hydrologic conditions unless specifically waived or exempted by regulatory agencies with permitting jurisdiction; and
- The project site must be drained by a conveyance system that is comprised entirely of manmade conveyance elements (e.g., pipes, ditches, outfall protection, etc.) and extends to the ordinary high water line of the exempt receiving water; and
- The conveyance system between the project site and the exempt receiving water shall have sufficient hydraulic capacity to convey discharges from future build-out conditions (under current zoning) of the site, and the existing condition from non-project areas from which runoff is or will be collected; and
- Any erodible elements of the manmade conveyance system must be adequately stabilized to prevent erosion under the conditions noted above.

If the discharge is to a stream that leads to a wetland, or to a wetland that has an outflow to a stream, both this requirement and Minimum Requirement #8 apply. In these cases the point of compliance is at the wetland.

1.5.7.2 Thresholds

When assessing a project against the following thresholds, consider only those impervious, hard, and pervious surfaces that are subject to this Minimum Requirement as determined in Section 1.4.

The following circumstances require achievement of the standard flow control requirement for western Washington:

- Projects in which the total of effective impervious surfaces is 10,000 square feet or more in a threshold discharge area, or
- Projects that convert ¾ acres or more of vegetation to lawn or landscape, or convert 2.5 acres or more of native vegetation to pasture in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site, or
- Projects that through a combination of effective hard surfaces and converted vegetation areas cause a 0.10 cubic feet per second increase in the 100-year flow frequency from a threshold discharge area as estimated using an approved continuous flow model and one-hour time steps (or a 0.15 cfs increase using 15-minute time steps). The 0.10 cfs (one-hour time steps) or 0.15 cfs (15-minute time steps) increase shall be a comparison of the post-project runoff to the existing condition runoff. For the purpose of applying this threshold, the existing condition is the pre-project land cover.

1.5.7.3 Standard Flow Control Requirement

Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. The pre-developed condition to be matched shall be a forested land cover unless one of the following conditions is met:

- Reasonable, historic information is provided that indicates the site was prairie prior to settlement (see Appendix 1-D). These areas are modeled as "pasture" in the approved continuous flow model.
- The drainage area of the immediate stream and all subsequent downstream basins has had at least 40% total impervious area since 1985[5]. In this case, the pre-developed condition to be matched shall be the existing land cover condition. Where basin-specific studies determine a stream channel to be unstable, even though the above criterion is met, the pre-developed condition assumption shall be the "historic" land cover condition, or a land cover condition commensurate with achieving a target flow regime identified by an approved basin study.
- The development site TDA drains to a reach of a stream where an Ecology approved basin plan has been developed that includes an alternative pre-development standard. See Appendix 1-B for these areas.

This standard requirement is waived for sites that will infiltrate all the runoff from hard surfaces and converted vegetation areas.

The Western Washington Hydrology Model provides ways to represent On-site Stormwater Management BMPs. Using those BMPs reduces the predicted runoff rates and volumes and thus also reduces the size of the required flow control facilities. See Book 2, Chapter 2 and Appendix 2-C for more on modeling On-site Stormwater Management BMPs in WWHM.

1.5.7.4 Flow Control Selection, Design and Maintenance

Flow control BMPs shall be

- Selected according to Chapter 4;
- Designed according to Book 2, Chapters 5 and 6;
- Maintained according to Book 4 of this manual.

Stormwater shall be infiltrated to the maximum extent feasible under the design standards of this manual. Areas or watersheds where alternative flow control standards have been approved for use in Clark County can be found in Appendix 1-B.

[5] No areas in Clark County meet this criterion.

1.5.8 Minimum Requirement #8: Wetlands Protection

1.5.8.1 Applicability

The requirements of this section apply to projects proposing to discharge stormwater into a wetland, either directly or indirectly through a conveyance system. See Figure 1.4.

1.5.8.2 Thresholds

The thresholds identified in Minimum Requirement #6, Runoff Treatment and Minimum Requirement #7; Flow Control shall be applied to determine the applicability of Minimum Requirement #8 to discharges to wetlands.

Use the flow chart in Figure 1.4 to determine if Minimum Requirement #8 is applicable. Fill out the checklist in Appendix 1-H and submit it with the Preliminary and Final Development Plan. If Minimum Requirement #8 is applicable, meet the requirements in Section 1.5.8.3.

1.5.8.3 Standard Requirements for Protecting Wetlands from Stormwater Flows

If the standards in Minimum Requirement #8 are triggered, the hydrologic analysis shall use the existing (not pre-developed) land cover condition to determine the existing hydrologic conditions unless directed otherwise by a regulatory agency with jurisdiction.

Use an approved continuous flow model for estimating the increases or decreases in total flows (volume) into a wetland that can result from the development project. These total flows can be modeled for individual days or on a monthly basis. Compare the results from this modeling to the following two criteria.

Criterion 1

The total volume of water into a wetland during a single precipitation event shall not be more than 20% higher or lower than the pre-project volumes.

Modeling algorithm for Criterion 1

1. Daily Volumes can be calculated for each day over 50 years for Pre- and Post-project scenarios. Volumes are to be calculated at the inflow to the wetland or the upslope edge where surface runoff, interflow, and groundwater are assumed to enter.

2. Calculate the average of Daily Volume for each day for Pre- and Post-project scenarios. There will be 365 values for the Pre-project scenario and 365 for the Post-project.

Example calculation for each day in a year (e.g., April 1):

- If you use 50 years of precipitation data, there will be 50 values for April 1. Calculate the average of the 50, April 1, Daily Volumes for Pre- and Post-project scenarios.
- Compare the average Daily Volumes for Pre- versus Post-project scenarios for each day. The average Post-project Daily Volume for April 1 must be within +/- 20% of the Pre-project Daily Volume for April 1.

3. Check compliance with the 20% criterion for each day of year. Criterion 1 is met/passed if none of the 365 post-project daily volumes varies by more than 20% from the pre-project daily volume for that day.

Criterion 2

- The total volume of water into a wetland on a monthly basis shall not be more than 15% higher or lower than the pre-project volumes.

This needs to be calculated based on the average precipitation for each month of the year. This criterion is especially important for the summer months when a development may reduce the monthly flows rather than increase them because of reduced infiltration and recharging of groundwater.

<u>Modeling algorithm for Criterion 2</u>

1. Monthly Volumes can be calculated for each calendar month over 50 years for Pre- and Post-project scenarios. Volumes are to be calculated at the inflow to the wetland or the upslope edge where surface runoff, interflow, and groundwater are assumed to enter.

2. Calculate the average of Monthly Volume for each calendar month for Pre- and Post-project scenarios.

Example calculation for each calendar month in a year (e.g., April):

- If you use 50 years of precipitation data, there will be 50 values for the month of April. Calculate the average of the 50, April, Monthly Volumes for Pre- and Post-project scenarios.
- Compare the Monthly Volumes for Pre- versus Post-project scenarios. Post- project Monthly Volume for April must be within +/- 15% of the Pre- project Monthly Volume for April.

3. Check compliance with the 15% criterion for each calendar month of year. Criterion 2 is met/passed if none of the post- project Monthly Volume varies by more than 15% from the pre- project Monthly Volume for every month.

- Provide the results of both of these analyses in the Final Technical Information Report

1.5.8.4 Additional Requirements

- Stormwater discharges to Category I or Category II wetlands, or to a wetland that contains habitat for threatened or endangered species, must be treated before discharged.
- Refer to Guide Sheets 1 and 2 in Appendix 1-H to determine if wetlands can serve as treatment or flow control facilities.
- Stormwater treatment and flow control facilities shall not be built within a natural vegetated buffer, except for:
    - Necessary conveyance systems as approved by the Responsible Official; or
    - As allowed in wetlands approved for hydrologic modification and/or treatment in accordance with Guide Sheet 2 in Appendix 1-H of this book.
- Protecting a wetland from pollutants generated by a development should include the following measures:
    - Use effective erosion control at construction sites in the wetland's drainage catchment.
    - Institute a program of source control BMPs and minimize the pollutants that will enter storm runoff that drains to the wetland.
    - For wetlands the meet the criteria in Guide Sheet 1, provide a water quality control facility consisting of one or more treatment BMPs to treat runoff entering the wetland.
    - If the wetland is a Category I wetland because of special conditions (forested, bog, estuarine, Natural Heritage, costal lagoon), the facility should include a BMP with the most advanced ability to control nutrients.

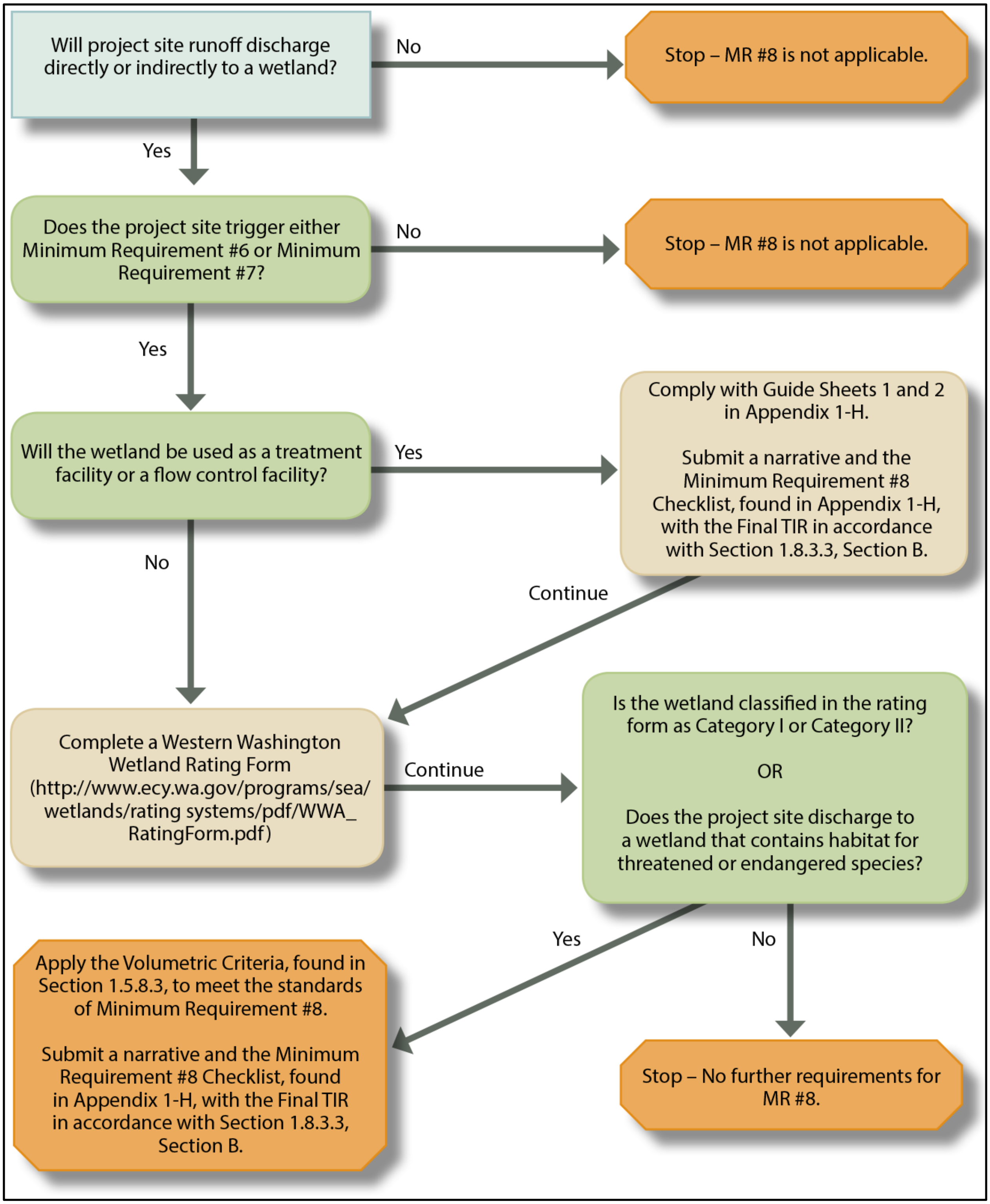

Figure 1.4: Minimum Requirement #8 Flow Chart

1.5.9 Minimum Requirement #9: Operation and Maintenance

A stormwater facility maintenance manual that includes the appropriate elements consistent with the provisions in Book 4 of this manual shall be submitted for proposed stormwater facilities and BMPs. The applicant shall identify the party (or parties) responsible for stormwater facility operation and maintenance. For privately owned facilities, a copy of the stormwater facility maintenance manual shall be retained on site or within reasonable access to the site and shall be transferred with the property to the new owner. For publicly owned facilities not maintained by the Clark County Public Works Department, a copy of the stormwater facility maintenance manual shall be retained in the appropriate department. A log of maintenance activity that indicates what maintenance activities were performed shall be kept and be available for inspection by Clark County.

1.6 Clark County Requirements

Clark County requirements in this section apply to all projects in addition to the Minimum Requirements described above.

1.6.1 Specifications

Stormwater facilities shall be constructed in accordance with the latest edition of the *Standard Specifications for Road, Bridge, and Municipal Construction* as prepared by the Washington Department of Transportation, with exception of Clark County standards as noted in the Clark County Standard Details listed in Book 2, Chapter 9 of this manual.

1.6.2 Facility Signage and Markers

All stormwater facilities, including catch basins and manholes, capable of accepting stormwater shall be signed or marked as described below. Locations of medallions and signs shall be shown on the Final Development Plan (see Section 1.8.2.2).

Inlets must be marked with a permanently-affixed "Protect water – Only Rain in the Drain" medallion near the inlet.

Figure 1.5: Stormwater Medallion (4" diameter)

Stormwater treatment and flow control facilities, including On-site Stormwater Management BMPs, must be marked with a sign specific to the type of facility, as shown in Figures 1.6 through 1.14, below. For Permeable Pavement BMPs, place once sign every 200' at a minimum. Signs for facilities in right of way must adhere to sign placement requirements in CCC 40.350.

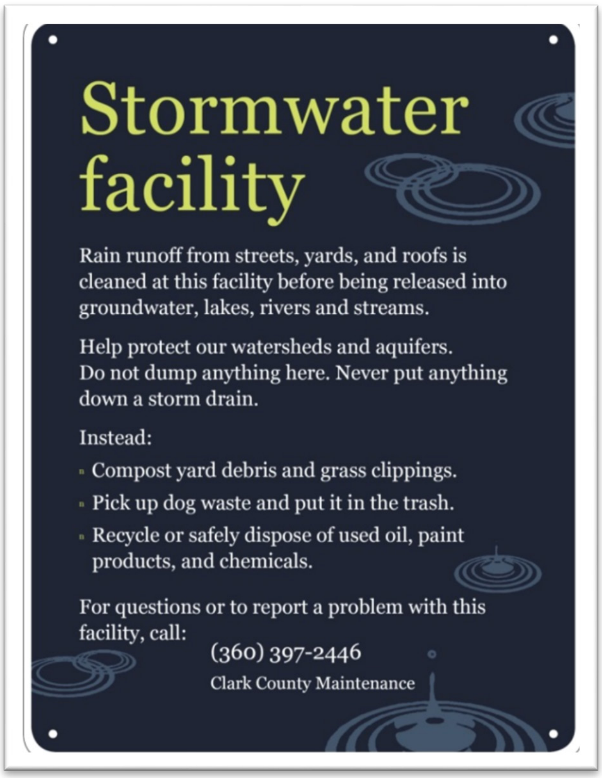

Figure 1.6: Standard Clark County Stormwater Sign (18" x 24")

Figure 1.7: Standard Clark County Bioretention Sign (18" x 24")

Figure 1.8: Standard Clark County Rain Garden Sign (18" x 24")

Figure 1.9: Standard Clark County Pervious Concrete Sign (18" x 24")

Figure 1.10: Standard Clark County Porous Asphalt Sign (18" x 24")

Figure 1.11: Standard Clark County Permeable Pavers Sign (18" x 24")

Figure 1.12: Standard Clark County Native Plantings Sign (18" x 24")

Figure 1.13: Standard Clark County Vegetated Roof Sign (18" x 24")

Figure 1.14: Standard Clark County Vegetation Preservation Sign (9"x 11.75")

1.6.3 Off-site Drainage Impacts

If the Responsible Official determines based on information in the Preliminary Stormwater Plan (see Section 1.8.1) that the proposed project will adversely impact off-site drainage systems, then the applicant shall implement additional flow control or other measures to mitigate those adverse impacts.

1.6.4 Erosion Control

1.6.4.1 General Standards

- All outfalls require energy dissipation (See Book 2, Section 7.6).
- Permanent infiltration BMPs shall not be used as temporary erosion control devices.
- Vehicles not performing a construction activity shall not be permitted off-street. Worker personal vehicles shall be parked on adjacent streets or other approved areas.

1.6.4.2 Underground Utility Construction

The construction of underground utility lines shall be subject to the following:

- BMPs shall be used to control erosion during and after construction.
- BMPs damaged during construction shall be replaced or repaired.

1.6.4.3 Signage

- Erosion control signage approved by the Responsible Official shall be installed at each point of entry on any development or redevelopment site subject to Minimum Requirement #2, as shown below.
- Removal of signage shall occur when either certificates of occupancy have been issued for seventy percent (70%) of the lots or there are less than ten (10) unoccupied lots remaining within the project site, whichever is later, or as determined by the Responsible Official.

Figure 1.15: Standard Clark County Erosion Control Sign (4' x 8')

1.6.5 On-going Maintenance

Maintenance of stormwater facilities shall be to the standards in Book 4 of this manual pursuant to CCC 13.26A.

1.6.6 Stormwater Facility Access

All stormwater facilities must allow for access by standard maintenance equipment and vehicles needed to remove sediment and maintain structures in accordance with the standards of this manual. Maintenance access must be provided using a minimum of a 10-foot wide roadway constructed using an all-weather surface or an alternative surface type approved by the county; the responsible office may waive this requirement where a road is not necessary for accessing the facility. Access criteria for specific BMPs are given in Book 2.

1.7 Submittals for Small Projects

A Stormwater Site Plan is required for all new development and redevelopment projects that must comply with Minimum Requirement #1. The submittal requirements described in this section apply to development and redevelopment sites that qualify as small projects. A small project is defined as a development or redevelopment site that meets all of the following criteria:

1. Triggers Minimum Requirements #1 – #5.
2. Is less than one acre.
3. Does not construct a public road.
4. Does not require an Engineering Approval.

These are generally projects that:

- Are residential or other buildings that do not require an Engineering Approval from Clark County; and
- Replace or add between 2,000 and 4,999 square feet of impervious and hard surfaces; and/or
- Disturb between 7,000 square feet and one acre of land.

Applicants with qualifying small projects may use the Stormwater Site Plan Short Form located in Appendix 1-I to meet submittal requirements.

For detailed information about the applicability of Minimum Requirements to a specific project, see Section 1.4.

Applicants with qualifying small projects are not required to use the instructions in the remainder of this manual and should refer to Appendix 1-I for guidance and submittal requirements.

1.8 Submittals for Large and Engineered Projects

A Stormwater Site Plan is required for all new development and redevelopment projects that must comply with Minimum Requirement #1. The submittal requirements described in this section apply to projects that must meet Minimum Requirements #1 – #9 and to projects that must meet Minimum Requirements #1 – #5 and require an Engineering Approval from Clark County.

A Stormwater Site Plan is defined as the Preliminary Stormwater Plan, and its components; the Final Stormwater Plan, and its components; and the Construction Stormwater Pollution Prevention Plan. The Stormwater Site Plan must be approved by the Responsible Official before land-disturbing activity may begin.

The purpose of the submittal is to allow Clark County to determine whether the stormwater management plan proposed for the project will meet the requirements of CCC 40.386.

Plans and reports must be prepared by a licensed engineer in the state of Washington or another qualified professional as designated in this manual.

1.8.1 Preliminary Stormwater Plan

The Preliminary Stormwater Plan shall identify how stormwater runoff that originates on the site or flows through the site is currently controlled and how this will change with the proposed development or redevelopment project. The Preliminary Stormwater Plan shall be submitted with the land use application.

The goal of the Preliminary Stormwater Plan process is to develop and provide a preliminary stormwater report describing the design strategies that will be used to meet stormwater management requirements. A primary objective of the stormwater plan is to manage runoff created by the project to evaporate, transpire, and infiltrate stormwater, and to achieve the goal of mimicking the pre-development natural hydrologic conditions on the site.

The project engineer shall include a statement that all the required information is included in the Preliminary Stormwater Plan and that the proposed stormwater facilities are feasible. All plans, studies, and reports that are part of the Preliminary Stormwater Plan shall be signed and dated by the professional civil engineer(s) (licensed in the state of Washington), or other qualified professional as designated in this manual, responsible for the preparation of the Preliminary Stormwater Plan and its components.

The Preliminary Stormwater Plan submittal shall consist of:

1) Existing Conditions Plan (Section 1.8.1.2)

2) Preliminary Development Plan (Section 1.8.1.3)

3) Off-site Areas Map (Section 1.8.1.4)

4) Preliminary Technical Information Report (TIR) (Section 1.8.1.5)

5) Soils Report (Section 1.8.3)

At the applicant's option, the applicant may submit a Final Stormwater Plan in accordance with the requirements of Section 1.8.2 in lieu of the Preliminary Stormwater Plan.

1.8.1.1 Modification of Content Requirements

The Responsible Official may waive in writing some or all of the content requirements in the Preliminary Stormwater Plan if:

- The project is included in an approved Stormwater Site Plan that meets the requirements of this manual; or
- The project is located in an area with an approved basin plan that makes some of the information irrelevant.

The waiver of some or all of the content requirements of the Preliminary Stormwater Plan does not relieve the applicant of the requirement to prepare a Final Stormwater Plan.

1.8.1.2 Existing Conditions Plan

The Existing Conditions Plan shall consist of 22-inch x 34-inch or 24-inch x 36-inch drawings; single family residence plans may be at 11-inch x 17-inch. Electronic submittals (in PDF) are encouraged. The Existing Conditions Plan shall include:

1. Existing property boundaries, easements, and rights-of-way.
2. Location of the 100-year floodplain and floodways and shoreline management areas on the site.
3. Existing contours with a 2-foot maximum contour interval, unless the Responsible Official determines a lesser interval is sufficient to show drainage patterns and basin boundaries. Contours with 10-foot or greater intervals are often sufficient for areas with slopes greater than 20%.
4. Natural drainage features on and adjacent to the site, including streams, wetlands, springs, and closed depressions.
5. Manmade drainage features on and adjacent to the site, including existing water quality or flow control BMPs and conveyance systems.
6. Areas of the site identified as geologic hazards as defined in CCC 40.430.
7. Existing on-site water wells, known agricultural drain tiles, structures, utilities, and septic tanks and drain fields.
8. Existing drainage flow routes for each threshold discharge area (TDA) to and from the site, including bypass flows.
9. Locations of existing hard surfaces.
10. Locations of existing pervious surfaces.
11. Existing areas of the site predominantly covered by native vegetation as defined in Appendix 1-A (e.g. native trees, shrubs, and herbaceous plants).
12. The delineated wetland boundary (for sites that discharge stormwater to a wetland, either directly or indirectly through a conveyance system, and that must meet Minimum Requirement #8, Wetlands Protection).

1.8.1.3 Preliminary Development Plan

The Preliminary Development Plan shall consist of 22-inch x 34-inch or 24-inch x 36-inch drawings; single family residence plans may be 11-inch x 17-inch. Electronic submittals (in PDF) are encouraged. The Preliminary Development Plan shall include:

1. Proposed property boundaries, easements, and rights-of-way.
2. Location of the 100-year floodplain and floodways and shoreline management area limits on the site.
3. Proposed contours with a 2-foot maximum contour interval, unless the Responsible Official determines a lesser interval is sufficient to show drainage patterns and basin boundaries.
4. Show the limits of the developed threshold discharge areas (TDAs). If the site will have more than one TDA, then label each one with a unique name. [Note: TDA names must be cross-referenced in the Technical Information Report, computer models, calculation sheets, and other pertinent submittals.]
5. Proposed drainage flow routes for each threshold discharge area (TDA) to and from the site, including bypass flows.
6. Locations of proposed hard surfaces.
7. Locations of proposed pervious surfaces. Locations of proposed structural source control BMPs in accordance with Minimum Requirement #3.
8. Locations of proposed points of discharge from the project site that preserve the natural drainage patterns and existing outfall locations in accordance with Minimum Requirement #4.
9. Areas of the project site where on-site stormwater management BMPs will be located in accordance with Minimum Requirement #5. This includes, but is not limited to, areas of retained native vegetation, location of retained or new trees to be used for surface reduction credit, and required flow paths and lengths of dispersion BMPs.
10. Approximate location and size of proposed runoff treatment and flow control facilities.
11. Include a conceptual grading plan that verifies the constructability of the proposed stormwater facilities.
12. The delineated on-site wetland boundary, and off-site wetland boundaries where stormwater is being discharged to a wetland, either directly or indirectly through a conveyance system.

13. Proposed detention/retention facilities, infiltration facilities, conveyances, discharges, and dispersion flow paths that intersect or are within 50 feet of a geologic hazard as defined in CCC 40.430.

The Responsible Official may require additional site or vicinity information before deeming an application "fully complete" if needed to determine the feasibility of the stormwater proposal.

1.8.1.4 Off-site Areas Map

The off-site areas map shall be a 8-1/2-inch x 11-inch or 11-inch x 17-inch map. Electronic submittals (in PDF) are encouraged. The map shall delineate the off-site areas contributing runoff to the site.

1.8.1.5 Preliminary Technical Information Report (TIR)

The preliminary TIR shall contain all technical information and analyses necessary to determine how applicable Minimum Requirements are being met and that the proposed stormwater facilities are feasible. The required contents of the preliminary TIR are identified below.

Section A – Project Overview

<u>Section A.1: Site Information</u>

Site information shall include:

- The location of the site, either with a parcel number, an address, or adjacent streets and distance to the nearest cross street.
- A description of the topography, natural drainage patterns, vegetative ground cover, and presence of critical areas, which include Critical Aquifer Recharge Areas (CCC 40.410), Flood Hazard Areas (CCC 40.420), Geologic Hazard Areas (CCC 40.430), Habitat Conservation Areas (CCC 40.440), Wetland Protection Areas (CCC 40.450) and Shoreline Master Program Areas (CCC 40.460). Critical areas that receive runoff from the site shall be described to a minimum of ¼ mile away from the site boundary.
- A description of existing on-site stormwater systems and their functions, including drainage patterns to and from adjacent properties. Identify the primary discharge point or points from the site, and the suitability of the use of these BMPs on the site.
- A general description of proposed site improvements, including the size of improvements and proposed methods of mitigating stormwater runoff quantity and quality impacts.

<u>Section A.2 – Determination of Applicable Minimum Requirements</u>

Based upon the preliminary site layout, determine whether Minimum Requirements #1 – #5 or #1 – #9 apply to the project. Include the following information in table format:

- The amount of existing hard surface.
- The amount of new hard surface.
- The amount of replaced hard surface.
- The amount of native vegetation converted to lawn or landscaping.
- The amount of native vegetation converted to pasture.
- The total amount of land-disturbing activity.
- If a redevelopment project, a cost basis.
- The amount of pollution generating hard surface (PGHS); this includes pollution-generating impervious surfaces (PGIS).
- The amount of pollution-generating pervious surfaces (PGPS).
- The total amount of pollution-generating surfaces.
- The total amount of non-pollution generating surfaces.

Provide a statement that confirms which Minimum Requirements apply to the development activity. Trace on the flowchart (Figure 1.2 or Figure 1.3) to show how applicable Minimum Requirements were determined.

For development or redevelopment where Minimum Requirements #1 – #9 must be met:

- Provide the amount of effective impervious area in each TDA, and document through an approved continuous flow model the increase in the 100-year flood frequency from pre-developed to developed conditions for each TDA.
- List the TDAs that must meet the runoff treatment requirements listed in Minimum Requirement #6.
- List the TDAs that must meet the flow control requirements listed in Minimum Requirement #7.
- List the TDAs that must meet the wetlands protection requirements listed in Minimum Requirement #8.

Section B – Minimum Requirements

This section shall discuss how each Minimum Requirement applicable to the project (as identified in Section A.2) will be met.

Minimum Requirement #1 – Preparation of Stormwater Site Plans

All projects meeting the thresholds in Section 1.4 shall submit a Stormwater Site Plan for review by Clark County. Stormwater Site Plans shall use site-appropriate development principles to retain native vegetation and minimize impervious surfaces to the extent feasible.

Minimum Requirement #3 – Source Control of Pollution

If the development activity includes any of the activities listed in Book 3, Appendix 3-A, identify the source control BMPs to be used with the land-disturbing activity. See Book 3 for source control BMPs.

Minimum Requirement #4 – Preservation of Natural Drainage Systems and Outfalls

Describe how natural drainage patterns are being maintained, and how discharges from the project site shall occur at the natural location, to the maximum extent practicable. The manner by which runoff is discharged from the project site must not cause a significant adverse impact to downstream receiving waters and down gradient properties. All outfalls require energy dissipation.

See Book2, Chapter 7 for more information on energy dissipation designs.

Minimum Requirement #5 – On-site Stormwater Management BMPs

Describe how on-site stormwater management BMPs, including LID BMPs, will be effectively implemented on the site, in accordance with this Minimum Requirement.

1. General
    - Describe the suitability of the site for the selected BMPs, including hydrologic soil groups, geologic media, infiltration rates, slopes, and groundwater elevations.
    - Summarize the pertinent results from geotechnical studies or other information used to complete the design of each on-site stormwater BMP.
    - Identify the design criteria in this manual for each on-site stormwater management BMP selected, and describe how the criteria will be met.

2. LID
    - Indicate whether a mandatory list is being used to select LID BMPs or if the LID Performance Standard will be met.
    - If using List #1 or List #2, provide written justification, including citation of site conditions identified in the soils report, for any on-site stormwater management BMPs that are determined to be infeasible for the project site. Complete the LID Feasibility Checklist (see Appendix 1-E), and include it in the TIR.
    - If meeting the LID Performance Standard, provide:
        - Design details of all BMPs that are used to achieve the standard.
        - A complete computer model report including input files and output files. Projects taking an impervious surface reduction credit for newly planted or retained trees must provide those calculations and show the locations of the trees on the preliminary development plan. Projects using full dispersion or

full downspout infiltration BMPs must provide information to confirm conformance with design requirements that allow removal of the associated drainage areas from computer model input.

Minimum Requirement #6 – Runoff Treatment Analysis and Design

For land-disturbing activities where the thresholds within Minimum Requirement #6 (see Section 1.5.6) indicate that runoff treatment facilities are required:

- Document the level of treatment required (basic, enhanced, phosphorus, oil/water separation), based on procedures in Chapter 3.
- Identify the BMPs used in the design, and list the reference or design manual used to design them.
- Include an analysis of initial construction costs and long-term maintenance costs.
- Show the approximate location and size of proposed runoff treatment facilities on the preliminary development plan.

Minimum Requirement #7 – Flow Control Analysis and Design

For land-disturbing activities where the thresholds within Minimum Requirement #7 indicate that flow control facilities are required:

- Summarize the site's suitability for infiltration, including tested infiltration rates, logs of soil borings, and other information provided in the Soils Report.
- If infiltration is infeasible for flow control, provide the following additional information:
    - Identify the areas where flow control credits can be obtained for dispersion, LID, or other measures, in accordance with the requirements in Chapter 2, Book 2, Chapter 2, and the guidance in Appendix 2-C.
    - Provide the approximate sizing and location of flow control facilities for each TDA, per Chapter 4.
    - Identify the criteria (and their sources) used to complete the analyses, including pre-developed and post-developed land use characteristics.
    - For sites considered to be historic prairie, submit a project site report prepared by a wetland scientist or horticulturist experienced in identifying soils, plant, and other evidence associated with historic prairies that demonstrates the existence of historic prairie on the project site. Areas within Clark County that were historically prairie are identified in Appendix 1-D. Historic prairie areas include Bear Prairie, Fourth Plain, Mill Plain, and Lacamas Prairie, among others. The map may be used only as an indicator of historic prairie, not for specific prairie boundaries.
    - Complete a hydrologic analysis for historic and developed site conditions, in accordance with the requirements of CCC 40.386 and Book 2, Chapter 1, using an

approved continuous flow model. Compute historic and developed flow durations for all TDAs. Provide an output table from the approved continuous flow model.

- Include and reference all hydrologic computations, equations, graphs, and any other aids necessary to clearly show the methodology and results.
- Include all maps, exhibits, graphics, and references used to determine pre-developed and developed site hydrology.

Minimum Requirement #8 – Wetlands Protection

For projects with stormwater discharges to a wetland, either directly or indirectly through a conveyance system, the preliminary TIR shall describe the analysis performed per Section 1.5.8 and the wetland protection measures to be implemented in accordance with Minimum Requirement #8. Complete and submit the Wetlands Checklist in Appendix 1-H.

Minimum Requirement #9 – Operation and Maintenance

Provide information on who will own, operate, and maintain the stormwater facilities, including LID BMPs that are considered in the design of treatment and flow control facilities meeting Minimum Requirements #5, #6 or #7.

Appendices

Map Submittals

The following maps shall be included with the TIR. All maps shall contain a scale and north arrow.

- **Vicinity Map**: All vicinity maps shall clearly show the project site.
- **Soils Map**: This map shall show soils mapped by the Natural Resources Conservation Service (NRCS) within the contributing area that drains to the site itself. Soils maps may be obtained from the following sources:
    - Updated version of the Soil Survey of Clark County, Washington, originally published in 1972, and updated by the NRCS.
    - Geographic information system (GIS) maps of soils from Clark County GIS.
    - Washington soil survey data as available on the NRCS website (http://websoilsurvey.nrcs.usda.gov).
    - If the maps do not appear to accurately represent the soils for the site, the applicant's geologist or geotechnical engineer is responsible for verifying the actual soils for the site.
- Other Maps

The following additional maps shall be required in the situations noted:

- Critical Aquifer Recharge Areas. If the site lies within a Category I or II critical aquifer recharge area (CARA), a map is required showing the extent of these areas in relation to the site. See CCC 40.410 for CARA regulations.
- Floodplains. If a floodplain mapped by the Federal Emergency Management Agency (FEMA) exists on or adjacent to the site, a map showing the floodplain is required. See CCC 40.420 for Flood Hazard Areas regulations.
- Shoreline Management Area. If the site contains or is adjacent to a water body regulated under the Washington Shorelines Management Act, a map showing the boundary of the shoreline management area in relation to the site is required. See CCC 40.460 for Shoreline Management Area regulations.

Other Submittals

1. Soils Report: See Section 1.8.3.

1.8.2 Final Stormwater Plan

In accordance with Minimum Requirement #1, the Final Stormwater Plan provides final engineering design and construction drawings for the stormwater aspects of a proposed new development or redevelopment project. The Final Stormwater Plan shall be submitted and approved by the Responsible Official before construction of the development can begin.

All plans, studies, and reports that are part of the Final Stormwater Plan shall be signed and dated by the professional civil engineer(s) (registered in the state of Washington), or other qualified professional as designated in this manual, responsible for the preparation of the Preliminary Stormwater Plan and its components.

The goal of the Final Stormwater Plan submittal is to allow the Responsible Official to review the following:

1. Any easements, covenants, or agreements necessary to permit construction and maintenance, including for each on-site stormwater management BMP.
2. Design details, figures, and maintenance instructions for each post construction Stormwater Management BMP. These documents must be suitable to serve as a recordable document that can be attached to a declaration of covenant and grant of easement associated with each lot.
3. Final engineering plans that provide sufficient detail to allow construction of the stormwater facilities. These plans shall be stamped, signed, and dated by the engineer(s), registered in the state of Washington, responsible for hydrologic, hydraulic, geotechnical, structural and general civil engineering design and by the project engineer responsible for the preparation

of the Final Stormwater Plan. The final engineering plan shall show all utilities to ensure that conflicts between proposed utility lines do not exist.

4. The approved Preliminary Stormwater Plan, with an explanation of any differences between the design concepts included in the preliminary and Final Stormwater Plans. If a Final Stormwater Plan differs from the approved Preliminary Stormwater Plan in a manner that, in the opinion of the Responsible Official, raises significant water quality or quantity control issues, it shall require another SEPA determination (if subject to the State Environmental Policy Act [SEPA]) and a post-decision review, in accordance with CCC Section 40.520.060.

5. A final development plan (which may be a part of the final engineering plans or a separate plan). See the requirements identified below.

6. A final technical information report (TIR). See the requirements identified below.

7. For a subdivision, short plat, or development project on which individual sites or pads will be sold or built under different responsibility, an individual stormwater lot plan is required for each lot or pad. This plan must show the details of all stormwater facilities planned for the site to meet requirements pertaining to and for each specific lot. The project applicant will need to complete all required forms and participate in all required meetings (including on-site inspections) to ensure that lot plans meet stormwater requirements. The plan shall be to a scale that is readable as determined by the Responsible Official. [Note: subsequent construction on the lot(s) will require conformance to the submitted stormwater lot plan.]

The Final Stormwater Plan shall consist of:

1. Final Development Plan (Section 1.8.2.2)

2. Final Technical Information Report (TIR) (Section 1.8.2.3)

3. Soils Report (Section 1.8.3)

4. Administrative and Legal Submittals (Section 1.9)

1.8.2.1 Modification of Content Requirements

The Responsible Official may waive in writing some or all of the content requirements in the Final Stormwater Plan if:

- The project is included in an approved Stormwater Site Plan that meets the requirements of this manual; or
- The project is located in an area with an approved basin plan that makes some of the information irrelevant.

1.8.2.2 Final Development Plan

The Final Development Plan shall be consistent with the Preliminary Development Plan and may be combined with the final engineering plans. In addition to the information required in the Preliminary Development Plan, the final plan requires the following information:

1. Threshold discharge area (TDA) delineations, and hard surface and pervious area delineations and area by TDA.
2. The acreage of pollution-generating pervious surfaces (PGPS) and pollution-generating hard surfaces (PGHS) used in the hydraulic/hydrologic calculations both on-site and off-site that contribute surface runoff.
3. Directions and lengths of overland, pipe, and channel flow.
4. Outfall points from each TDA and overflow routes for the 100-year storm.
5. Onsite conveyance systems, including pipes, catch basins, channels, ditches, swales, and culverts.
6. Energy dissipation designs for all outfalls.
7. Primary flow path arrows for drainage under developed conditions, with the calculated flow rates. Cross-reference the flow rates to the hydrological model output file used to calculate the flow rates.
8. The site's Point of Compliance (POC).
9. Locations of required signs and markers.
10. The Responsible Official may require additional site or vicinity information if needed to determine the feasibility of the stormwater proposal.

1.8.2.3 Final Technical Information Report (TIR)

The final TIR shall be a comprehensive report, supplemental to the final engineering plans, that contains all technical information and analyses necessary to complete final engineering plans based on sound engineering practices and appropriate geotechnical, hydrologic, hydraulic, and water quality design.

The final TIR shall be stamped, signed, and dated by the professional engineer(s), registered in the state of Washington, responsible for hydrologic, hydraulic, geotechnical, structural and general civil engineering design.

The required contents of the final TIR, which is part of the Final Stormwater Plan, are identified below.

Section A – Project Overview

Provide the information from the preliminary TIR, with the following additional elements:

1. Reference the conceptual design proposed in the Preliminary Stormwater Plan, and identify revisions contained within the final engineering plans.

Section B – Minimum Requirements

Provide the information from Section B of the preliminary TIR, revised as necessary for the final design. Confirm the applicable Minimum Requirements identified in the preliminary TIR. For land-disturbing activities where Minimum Requirements #1 – #9 must be met, provide the required information listed in Section B of the preliminary TIR, revised to reflect the final design.

<u>Minimum Requirement #2 – Construction Stormwater Pollution Prevention</u>

All projects are required to comply with Minimum Requirement #2. Provide a statement declaring that a Construction Stormwater Pollution Prevention Plan meeting the requirements of Minimum Requirement #2 will be submitted, with the Erosion Control Inspection fee.

<u>Minimum Requirement #3 – Source Control</u>

See the preliminary TIR requirements.

<u>Minimum Requirement #4 – Preservation of Natural Drainage Systems and Outfalls</u>

See the preliminary TIR requirements.

<u>Minimum Requirement #5 – On-site Stormwater Management BMPs</u>

Provide the information from the preliminary TIR, with the following additional elements:

1. Reference the conceptual design proposed in the Preliminary Stormwater Plan, and identify revisions contained within the final engineering plans.

2. For Post-Construction Soil Quality and Depth, provide details on the method used to meet the criteria given in the Design Installation and Specifications section of BMP T5.13 in Book 2, Chapter 2.

3. For Full Dispersion, Provide an analysis that demonstrates standards are met for BMP T5.30A or BMP T5.30B.

4. For bioretention systems and rain gardens, provide the following:

a. The proposed soil matrix for the facility.

b. The planting plan, listing proposed plant types and locations.

c. Detail drawings, including the following:

- If an underdrain is used, show drain rock, pipe, and filter fabric specifications.
- All stormwater piping associated with the facility, including manholes, catch basin, pipe materials, sizes, slopes, and invert elevations.
- Width, length, side slopes, and maximum design water depth for all facilities.
- Irrigation system, if installed.
- Designs for any retaining walls proposed. Structural walls shall meet County building permit requirements.

5. For porous pavements, provide supporting design calculations showing adequate infiltration rates to accommodate flows from all impervious surfaces directed onto any porous pavement. Reference standard details used in the design.
6. For reversed slope sidewalks, provide details on the planting plan for areas receiving water from reversed slope sidewalks.
7. Tree retention and planting.
8. Preserving native vegetation.
9. Rainwater harvesting if used as a flow reduction BMP.
10. Vegetated roof if used as a flow reduction BMP

<u>Minimum Requirement #6 – Runoff Treatment Analysis and Design</u>

For land-disturbing activities where the thresholds within Minimum Requirement #6 indicate that runoff treatment facilities are required, provide the information from the preliminary TIR, with the following additional elements:

1. Reference the conceptual runoff treatment design proposed in the Preliminary Stormwater Plan.
2. Identify revisions to the conceptual runoff treatment design contained in the Preliminary Stormwater Plan.

3. Complete a detailed analysis and design of all proposed runoff treatment system elements, in accordance with Book 2, Chapters 3 and 4. Reference runoff treatment system elements to labeled points shown on the site location map or final development plan.

4. Include and reference all computations, equations, charts, nomographs, detail drawings, and other tabular or graphic aids used to design water quality system elements in the technical appendix.

5. Summarize the results of the runoff treatment design and describe how the proposed design meets the requirements of CCC Chapter 40.386 and this manual.

Treatment System Plan

1. Provide an illustrative sketch of the treatment facilities and appurtenances.

2. The sketch shall correspond with the final engineering plans. Alternatively, a final site grading plan that incorporates the above information may be included as an attachment to the Final Stormwater Plan.

3. Provide electronic copies of the drawings used for analysis, measurement, and design inputs for the hydrologic analysis submitted with the final drawing in Portable Document Format (PDF) format.

Minimum Requirement #7 – Flow Control

For land-disturbing activities where the thresholds within Minimum Requirement #7 indicate that flow control facilities are required:

1. Identify revisions to the conceptual design proposed in the Preliminary Stormwater Plan.

2. Identify initial conditions, including stream base flows, beginning water surface elevations, hydraulic or energy grade lines, initial groundwater elevations, beginning storage volumes, and other data or assumptions used to complete the analyses of initial conditions. Reference the sources of information.

3. Describe any assumptions used to complete the analysis, including flow credits through the use of on-site stormwater BMPs or LID measures.

4. Complete a detailed hydrologic analysis for existing and developed site conditions, in accordance with the requirements of Book 2, Chapter 1, using an approved continuous flow model. Compute pre-developed and developed flow durations for all sub-basins. Provide an output table from the model, including the following:

    a. Flow rates for the 2-, 10-, and 100-year return periods for pre-developed and developed conditions.

b. A table listing the pass/fail rates for each flow level where duration statistics were calculated.

c. A graph showing the flow rate on the y axis and percent time exceeding on the x axis for pre-developed conditions and post-developed mitigated conditions, from 50 percent of the 2-year flow rate through the 50-year flow rate.

d. Written justification for any manual changes to model parameters (e.g. changes to LSUR, SLSUR, NSUR, etc. for the PERLND or IMPERLND parameters in WWHM).

5. Provide a hydraulic analysis of pipes and/or channels that lead to and/or from the outlet structure. The analysis should confirm the capacity of pipes and channels to convey the peak flow rates for the 2-, 10-, 50-, and 100-year return period flow rate with the water surface elevation of the pond at the elevation for those return period flow rates.

6. Submit electronic copies of the approved continuous flow model project files to allow reviewers to run the model and confirm the model results.

7. Include and reference all hydrologic and hydraulic computations, equations, rating curves, stage/storage/discharge tables, graphs, and any other aids necessary to clearly show the methodology and results.

8. Include all maps, exhibits, graphics, and references used to determine pre-development and developed site hydrology.

Flow Control System Plan

1. Provide an illustrative sketch of the flow control facilities and appurtenances.

2. Show basic measurements necessary to confirm storage volumes.

3. Show all orifice, weir, and flow restrictor dimensions and elevations.

4. The sketch shall correspond with final engineering plans. Alternatively, a final site grading plan that incorporates the above information may be included as an attachment to the Final Stormwater Plan.

5. Provide electronic copies of the drawings used for analysis, measurement, and design inputs for the hydrologic analysis submitted with the final drawing in Portable Document Format (PDF) format.

Minimum Requirement #8 – Wetlands Protection

For projects that discharge stormwater to a wetland, either directly or indirectly through a conveyance system, the TIR shall describe wetland protection measures to be implemented in accordance with Minimum Requirement #8. The narrative shall describe the analysis performed (See Section 1.5.8) to define the measures that will maintain the hydrologic conditions and hydrophytic vegetation.

Minimum Requirement #9 – Operation and Maintenance

Provide information on who will own, operate, and maintain the permanent stormwater facilities.

Submit an operation and maintenance manual that includes O&M procedures for each stormwater control or treatment facility that will be privately maintained.

The manual shall be written in an orderly and concise format that clearly describes the design and operation of the facility. The manual shall also provide an outline of required maintenance tasks, with recommended frequencies at which each task should be performed. The manual shall contain or reference procedures from Book 4, *Stormwater Facility Operations and Maintenance*.

See Section 1.9 for details on legal documents such as covenants and plat information.

Section C – Conveyance Systems Analysis and Design

1. Reference the conceptual drainage design proposed in the Preliminary Stormwater Plan.
2. Identify revisions to the conceptual drainage design contained in the Preliminary Stormwater Plan.
3. Include and reference in the technical appendix all computations, equations, charts, nomographs, detail drawings, and other tabular or graphic aids used to design conveyance system elements.
4. Identify and discuss initial conditions, including water surface elevations, hydraulic or energy grade lines, beginning storage elevations, and other data or assumptions used to complete the analyses of initial conditions. Reference the sources of information.
5. Describe any assumptions used to complete the analyses.
6. Complete a detailed hydraulic analysis of all proposed collection and conveyance system elements, including flow splitters, outfall structures, and outlet protection in accordance with Book 2, Chapter 7, Conveyance Design. Compute and tabulate the following:
7. Identify design flows and velocities and conveyance element capacities for all conveyance elements within the development.

8. Identify the 10-year recurrence interval stage for detention facility outfalls (See Book 2, Chapter 7). Provide stage-frequency documentation from an approved continuous flow model.

9. Compute existing 100-year floodplain elevations and lateral limits for all channels, and verify no net loss of conveyance or storage capacity from development.

10. Reference conveyance system elements to labeled points shown on the site location map or development plan.

11. Verify the capacity of each conveyance system element to convey design flow and discharge at non-erosive velocities. Verify the capacity of the on-site conveyance system to convey design flows that result from ultimate build-out of upstream areas.

12. Include and reference all hydraulic computations, equations, pipe flow tables, flow profile computations, charts, nomographs, detail drawings, and other tabular or graphic aids used to design and confirm the performance of conveyance systems.

13. Summarize the results of system analyses, and describe how the proposed design meets the requirements of this manual.

Section D Additional Requirements

Section D.1 – Off-site Analysis

If applicable, provide the results of an off-site analysis prepared in accordance with Chapter 5.

Off-site analysis is required when a project that must meet Minimum Requirements #1 – #9 meets any of the following criteria:

- Adds 35,000 square feet or more of new pervious surface.
- Constructs or modifies a drainage pipe or ditch that is 12 inches or more in size/depth or that receives runoff from a drainage pipe or ditch that is 12 inches or more in size/depth.
- Contains or lies adjacent to a landslide, steep slope, or erosion hazard area.
- Is not exempt from Minimum Requirement #8.
- The project changes the rate, volume, duration, or location of discharges to and from the project site.

Section D.2 - Closed Depression Analysis

If applicable, provide the results of a closed depression analysis prepared in accordance with Book 2, Chapter 1.

Section D.3 – Other Permits

Construction of roads and stormwater facilities may require additional permits from other agencies. These permits may contain requirements that affect the design of the stormwater system. This section lists the titles of other possible required permits, the agencies that require the permits, and the permit requirements, if known, that may affect the Final Stormwater Plan. Approved permits that are critical to the feasibility of the stormwater facility design shall be included in this section.

1. Onsite sewage disposal: Clark County Public Health or Washington Department of Health
2. Developer/local agency agreement: Washington State Department of Transportation (WSDOT) (connection license)
3. Temporary exceedance of State Surface Water Quality Standards – Turbidity Mixing Zone: Washington Department of Ecology (WAC 173-201A)
4. An Ecology general construction stormwater permit for projects that disturb over an acre
5. An Ecology general stormwater permit for industrial activities
6. Hydraulic project approval: Washington Department of Fish and Wildlife (WDFW)
7. Dam safety permit: Ecology
8. Section 10, 404, and 103 permits: U.S. Army Corps of Engineers
9. Surface mining reclamation permits: Washington Department of Natural Resources
10. Clark County critical aquifer recharge area (CARA) permit: CCC Chapter 40.410
11. Clark County floodplain permit: CCC Chapter 40.420
12. Clark County geohazard permit: CCC Chapter 40.430
13. Clark County habitat permit: CCC Chapter 40.440
14. Clark County wetland permit: CCC Chapter 40.450
15. Clark County shoreline management permit: CCC Chapter 40.460
16. Underground injection control (UIC) well registration: Ecology (Clark County requires registration through the Washington State Department of Ecology for all UICs)

Section D.3—Approval Conditions Summary

List each preliminary approval condition related to stormwater control, wetlands, floodplains, and other water-related issues, and describe how the final design addresses or conforms to each condition.

Section D.4 – Special Reports and Studies

Where site-specific characteristics, such as steep slopes, wetlands, and sites located in floodplains or wellhead protection areas, present difficult drainage and water quality design problems, the Responsible Official may require additional information or the preparation of special reports and studies that further address the specific site characteristics, describe the potential for impacts associated with the development, and demonstrate the proposed measures to mitigate impacts. Special reports shall be prepared by professionals with expertise in the particular area of analysis, who shall date, sign, stamp, and otherwise certify the report. Subjects of special reports may include, but are not be limited to:

1. Geotechnical
2. Wetlands
3. Floodplains and floodways
4. Groundwater
5. Structural design
6. Fluvial geomorphology (erosion and deposition).

All special reports and studies shall be included in the technical appendix.

Appendices

Map Submittals

See the preliminary TIR requirements.

Technical Data

All TIRs shall contain a technical appendix that includes all computations completed in the preparation of the TIR, together with copies of referenced data, charts, graphs, nomographs, hydrographs, stage-storage discharge tables, maps, exhibits, and all other information required to clearly describe the stormwater flow control and runoff treatment design for the proposed development activity. The format of the technical appendix shall follow as closely as possible the section format of the TIR and shall be adequately cross-referenced to ensure that the design may be easily followed, checked, and verified. The technical appendix shall also contain all special reports and studies.

1.8.3 Soils Report

For projects subject to engineering review triggering Minimum Requirements #1 – #5 or Minimum Requirements #1 – #9, a soils report is required. This report must be prepared by a certified soil scientist, professional engineer, geologist, hydrogeologist or engineering geologist registered in the State of Washington or suitably trained persons working under the supervision of the above professionals or, for projects meeting Minimum Requirements #1 – #5, the report may be prepared by a licensed on-site sewage designer.

The report must include information gathered in the soil assessments and characterization studies described in Chapters 2 and 4, and include the information presented below.

The requirements for this report differ, depending upon which Minimum Requirements are triggered. For sites triggering Minimum Requirements #1 – #5, the following is required.

- The report shall identify:
  - Underlying soils on the site utilizing soil surveys, soil test pits, soil borings, or soil grain analyses (see http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm for soil survey information).
  - The results of infiltration testing using a Clark County approved method (see Chapter 4) to assess infiltration capability and the feasibility of rain gardens, bioretention, and permeable pavement, if applicable. Grain size analyses may substitute for infiltration tests.
  - Submit justification for the number of infiltration tests conducted and the correction factors used per Chapters 2 and 4, if applicable.
  - The results of testing for an hydraulic restriction layer (groundwater, soil layer with less than 0.3 in/hr Ksat, bedrock, etc.) under possible sites for a rain garden, bioretention facility, or permeable pavement.

For sites triggering Minimum Requirements #1 – #9, include the above information, plus the following additional items:

- Soil stratigraphy shall be assessed for low permeability layers, highly permeable sand/gravel layers, depth to groundwater, and other soil structure variability necessary to assess subsurface flow patterns. Soil characterization for each soil unit (soil strata with the same texture, color, density, compaction, consolidation and permeability) shall include:
  - Grain size distribution
  - Textural class
  - Percent clay content

  - Cation exchange capacity
  - Color/mottling
  - Variations and nature of stratification
- Site characterization information as described in Chapter 4.
- The results of infiltration testing to assess infiltration capability and the feasibility of bioretention, and permeable pavement. Use Clark County approved soil testing methods (see Section 4.3.1.3). Grain size analyses may substitute for infiltration tests on sites underlain by unconsolidated sediment.
- The results of testing for an hydraulic restriction layer (groundwater, soil layer with less than 0.3 in/hr Ksat, bedrock, etc.) under possible sites for a bioretention facility, or permeable pavement.
- Results from the groundwater assessment as described in Section 2.3.1.5.

1.8.4 Construction Stormwater Pollution Prevention Plan (SWPPP)

The Construction SWPPP is a required component of the Stormwater Site Plan and must be approved by the Responsible Official prior to land-disturbing activity.

The Construction SWPPP shall be submitted to the Responsible Official at the applicant's discretion at any time between submittal of the Final Stormwater Plan and 10 working days prior to the pre-construction conference.

Chapter 6 describes requirements for preparation of the Construction SWPPP. Those projects that will disturb less than one acre of land may use the Abbreviated Construction SWPPP in Appendix 1-J in lieu of the instructions in Chapter 6.

The Construction SWPPP shall be prepared by a licensed engineer in the state of Washington or, if preparation of the SWPPP does not require the practice of engineering, by a person who holds a valid Certified Erosion and Sediment Control Lead (CESCL) certification.

Clark County recommends applicants prepare and submit the Construction SWPPP as part of the Final Stormwater Plan submittal for Final Engineering Review.

If the Construction SWPPP is not received as part of the Final Stormwater Plan submittal for Final Engineering Review, the Final Engineering Approval will be conditioned on review and approval of the Construction SWPPP before land-disturbing activity will be permitted.

1.8.5 Stormwater Plan Revisions

If the applicant must make changes or revisions to the Final Stormwater Plan after approval, the proposed revisions shall be submitted to Clark County for review and approval. The submittal shall include the following:

1. Substitute pages from the originally approved Final Stormwater Plan, and identify the proposed changes.

2. Revised drawings, showing any structural changes.

3. Any other supporting information that explains and supports the reason for the change.

All revisions shall be stamped, signed, and dated by the professional engineer(s), registered in the state of Washington, responsible for hydrologic, hydraulic, geotechnical, structural and general civil engineering design.

1.8.6 Record Drawings

Record drawings which completely and accurately represent the project site as constructed shall be provided to the Responsible Official prior to:

1. The issuance of building permits for single-family/duplex residential subdivisions;

2. Provisional acceptance of stormwater facilities to be owned by the county; and

3. The issuance of occupancy permits for development subject to site plan review.

The record drawings shall include corrected engineering plans for the stormwater facilities, showing constructed dimensions and elevations. In addition, revisions to the Final Stormwater Plan shall be submitted with the record drawings where changes during construction significantly alter the calculations and assumptions contained in the plan.

All record drawings shall be submitted on Mylar (or acceptable media per Community Development) and clearly reproducible. The record drawing submittal shall be stamped, signed and dated by an engineer licensed in the state of Washington.

Record drawings shall also be submitted on computer disk in the following approved file formats: Portable Document Format (.pdf), derived directly from the electronic design software (scans of paper as-builts may be accepted on a case-by-case basis).

Record drawings shall clearly indicate the ownership of any stormwater facilities and who is responsible for the maintenance of each component.

1.9 Administrative and Legal Requirements

All project proponents are required to submit administrative and legal documents as described in this section when applicable to the project.

1.9.1 Documentation of Ownership and Maintenance Responsibilities

1.9.1.1 Authority of Applicant; Obligations of Developer

Each project applicant (Applicant) must submit documentation demonstrating the legal authority to bind the owner and developer of the subject property, and their successors in interest with respect to the subject property (all of which are referred to as Developer), to comply with the requirements and conditions of this manual. The Developer must comply with the requirements, conditions, and any other obligations of this manual.

1.9.1.2 Required Documents

The Applicant shall obtain approval by the Responsible Official of the documented allocation of long-term ownership and maintenance responsibility for stormwater facilities as part of county approval of the Final Stormwater Plan. There are up to five separate documents that describe stormwater facility ownership and maintenance responsibility. These are (1) the final engineering plan; (2) the approved subdivision plat or site plan; (3) the developer covenant to Clark County; (4) the subdivision covenants, conditions and restrictions (CC&R's); and (5) any deed necessary to convey ownership of an easement across property or the property itself. The persons responsible for stormwater facility ownership and maintenance must be clearly identified in each document, and each other document must be consistent with the approved final engineering plan and record drawings.

The Final Stormwater Plan must clearly indicate the owner of and persons responsible for ongoing maintenance of each element of the project stormwater facilities. Plats must include notes specifying the owner and the person or entity responsible for long-term maintenance of every component of the stormwater facilities, including components in easements.

See Appendix 1-G for developer covenant example forms.

1.9.2 County Ownership of Stormwater Facilities

County ownership of stormwater facilities is required for all such facilities located within a public right-of-way or on a legal tract conveyed to the county.

Clark County will accept ownership only of stormwater treatment and flow control facilities, including low impact development BMPs, that are built as part of single-family residential subdivisions or facilities that include elements of the county storm sewer system that convey stormwater through an easement granted to Clark County.

Permeable pavement, bioretention facilities and enclosed underground systems including UIC regulated structures in residential subdivisions may be placed in public right-of-way subject to the standards of Chapter 40.350 CCC. Except as provided below in this paragraph, all other stormwater treatment and flow control facilities that serve residential subdivisions and short plats must be located on separate lots or tracts. Clark County recommends that these tracts meet minimum zoning lot size requirements. Stormwater conveyance systems that are not on-site stormwater management facilities, treatment facilities or flow control facilities may be placed on easements.

1.9.2.1 County Stormwater Facility Acceptance Process

For stormwater facilities that will be owned by the county, the county will provisionally accept ownership upon (1) approval of the record drawings; (2) approval of a facility inspection; and (3) receipt of a workmanship and materials and maintenance bond (or other secure method) in the amount of 10 percent (10%) of the construction cost (as prepared by the project engineer) acceptable to the Responsible Official. Provisional acceptance of the facilities does not relieve the Developer from any obligation to undertake any remedial measures to correct deficiencies in the design, construction, maintenance, or operation of the facilities.

No sooner than 18 months after the provisional acceptance of the facilities, the Applicant or Developer shall notify the Responsible Official that the facilities are eligible for final acceptance. The Developer shall continue to maintain the facilities until the county inspects and subsequently accepts the facilities.

The county may accept new stormwater facilities for single family residential development that are constructed under a preliminary plat approval that meets all of the following conditions:

1. Improvements in residential plats have been completed for at least 80 percent of the lots, unless this requirement is waived by the county.

2. All stormwater facilities have been tested as required by this manual, inspected, and have been approved by Clark County, and have been in satisfactory operation for at least 2 years.

3. All stormwater facilities reconstructed or repaired during the maintenance period have been approved by Clark County. For facilities that required modification, the Responsible Official may require extension of the maintenance period for an additional 1-2 years.

4. The stormwater facilities, as designed and constructed, conform to the provisions of this manual and to Chapters 13.26A and 40.386 of the Clark County Code.

5. All easements, lots and tracts required under this manual that the county must own or have access across in order to operate, inspect, maintain and repair stormwater facilities have been conveyed to Clark County, and all required conveyances have been recorded with the Clark County Auditor.

6. The Applicant or Developer has provided to Clark County a complete and accurate set of reproducible Mylar as-built (record) drawings from black and white reproductions may be produced without losing information and detail.

7. The Applicant or Developer has provided to Clark County a complete and accurate set of the as-built (record) drawings on computer disk in the following approved file format: Portable Document Format (.pdf) derived directly from the electronic design software (scans of paper as-builts may be accepted on a case-by-case basis).

1.9.2.2 Warranty Period for Maintenance of Stormwater Facilities

For stormwater facilities that will be conveyed to the county, for a period of at least two (2) years following the provisional acceptance of stormwater facilities, or thereafter until the facilities are finally accepted by the county, the Developer shall operate, inspect, maintain, repair, redesign, and reconstruct the facilities as necessary to ensure that they meet this manual's standards. Elements of facility construction that are most likely to cause problems which may extend the warranty period beyond two years include marginal soil conditions for the facility design; unusual, complex or experimental design elements; unusual maintenance requirements; and potential for failing walls, slopes, or discharge points. This obligation shall extend to remedying any damage caused to the facilities by accident, acts of nature, other builders or third parties during the warranty period. The required maintenance shall be performed according to the *Clark County Stormwater Manual* pursuant to Chapter 13.26A CCC.

1. During the warranty period, the Developer shall be responsible for and shall complete prior to acceptance all remedial work to correct deficiencies, including design deficiencies. Required remedial work to correct design, maintenance and construction deficiencies shall be completed by the Developer prior to final acceptance and may result in the extension of the maintenance period.

2. Following final acceptance for county ownership, the county shall maintain stormwater facilities.

1.9.3 Private Ownership and Maintenance Responsibility for Stormwater Facilities

If the county does not accept ownership of stormwater facilities, the Applicant shall ensure the assumption of ongoing responsibilities for stormwater facilities according to 1.9.3.1 through 1.9.3.5, below. Prior to county approval of the Final Stormwater Plan, the Responsible Official shall certify that the Developer has established procedures to satisfy each of the following obligations regarding ongoing maintenance of stormwater facilities.

1.9.3.1 Initial Responsibility

The Developer shall be responsible to maintain the stormwater facilities for two years following the recording of a final plat. During this period, the Developer shall operate, inspect, maintain, repair, redesign, and reconstruct the facilities as necessary to ensure that they meet this manual's standards.

1.9.3.2 Stormwater Covenant

The Applicant for a residential subdivision or a site plan review shall submit a "Covenant Running With the Land" (Stormwater Covenant) to Clark County that specifies the responsibility for stormwater facility maintenance, and the Responsible Official shall review and approve the Stormwater Covenant, after which it shall be recorded with the Clark County Auditor. The template for the Stormwater Covenant can be found in Appendix 1-G.

The purposes of the Stormwater Covenant shall be to ensure that all privately owned stormwater facilities are inspected and maintained in compliance with this manual, Chapter 13.26A CCC, and Title 32 CCC.

Pursuant to the Stormwater Covenant, the property owner(s) and all successors, heirs and assigns shall agree to maintain all private facilities and shall grant Clark County irrevocable rights routinely to access and inspect the facilities, and to perform maintenance and repair in an emergency or when required to meet County obligations under its Phase I NPDES Municipal Stormwater Permit, Chapter 13.26A CCC and Title 32 CCC.

If the parties responsible for long-term maintenance fail to maintain their facilities to standards of this manual, the county shall issue a written notice specifying required actions to be taken in order to bring the facilities into compliance. If these actions are not performed in a timely manner, the county shall take enforcement action against parties responsible for the maintenance in accordance with Title 32 CCC. The county shall be entitled to recover its costs associated with repairs or maintenance in accordance with Title 32 CCC.

1.9.3.3 Plat Note

All final plats shall include a note specifying the party(ies) responsible for long-term maintenance of stormwater facilities. Plats must include notes specifying the stormwater facility owner and the person or entity responsible for long-term maintenance of every component of the stormwater facilities, including components in easements.

1.9.3.4 Residential Subdivision

Prior to submitting the final plat for recording, the Applicant shall create a homeowners' association as a legal entity. The documents that create the homeowners' association, or accompanying bylaws, shall, at a minimum, include the following:

a. Members of the homeowners' association shall be jointly and severally responsible for maintenance of stormwater facilities.

b. The homeowners' association shall have the power and duty to assess fees in the amounts necessary to maintain stormwater facilities, and the members shall be liable for assessed fees.

c. The homeowners' association shall be responsible for payment of financial penalties or reimbursements if the county has conducted repairs or other maintenance activities because of hazardous conditions or to bring stormwater facilities into compliance with maintenance standards.

d. When recording the final plat, the Applicant shall record the Stormwater Covenant against the plat, and also against each lot within the subdivision or short division. See Appendix 1-G for an example covenant.

e. When recording the final plat, the Applicant shall record every deed necessary to convey to the homeowners' association the ownership of or easements over the platted property on which stormwater facilities are located.

f. The operation and maintenance manual prepared by the project engineer in accordance with this manual shall be recorded as part of the subdivision CC&R's.

g. The operation and maintenance manual prepared by the project engineer in accordance with this manual, or pertinent section(s) thereof as approved by the Responsible Official, shall be recorded against each lot that is proposed in the Final Stormwater Plan to contain a Rain Garden BMP, a Bioretention BMP, or a Permeable Pavement BMP.

1.9.3.5 Other Land Use

If the project is other than a residential subdivision, the Applicant and Developer shall comply with manual section 1.9.3.2, and if applicable, section 1.9.1.2. The Applicant shall describe in the Final Stormwater Plan, the person or entity that will own and maintain the stormwater facilities, shall convey the interest in real property that will enable that person or entity to maintain the facilities as require, and shall ensure that maintenance activities will be financed.

1.9.4 Easement Standards

1.9.4.1 Stormwater Facilities

Publicly Owned Systems

The property owner shall by plat or deed convey to Clark County an easement for access, inspection, maintenance, repair, and reconstruction of each stormwater facility within the site that will be maintained by the county, including streams (natural drainage ways), if used. The minimum widths of easements must allow for access by standard maintenance equipment vehicles to all areas within the stormwater facilities in accordance with the standards of this manual. Maintenance access must be provided using an all-weather surface or an alternative surface type approved by the county.

Privately Owned Systems

The property owner shall convey to Clark County an easement for access, inspection, maintenance, repair and ability to control discharges to the county storm sewer system, on each stormwater conveyance system within the development site that will be privately owned and maintained, including streams (natural drainage ways), if used. The minimum widths of easements must allow for access by standard maintenance equipment vehicles to all areas within the stormwater facilities in accordance with the standards of this manual.

1.9.4.2 Conveyance Systems

Publicly Owned Systems

Minimum easement widths for conveyance systems shall be at least as wide as indicated in Table 1.2, although the Responsible Official may require increased widths when necessary to ensure adequate area for equipment access and maintenance.

Table 1.2: Easement Widths for Publicly Owned Conveyance Systems

Easement Widths for Publicly Owned Conveyance Systems	
Pipe Diameter	**Easement Width**
<= 36 inches	20 feet
> 36 inches	20 feet plus the pipe's inside diameter
Open conveyances	Top width of channel plus 15 feet on one side and at least 2 feet to property line
Each pipe shall be located with its center line no closer than one-quarter the easement width from an abutting property line.	

Privately Owned Systems

Minimum easement widths shall be at least as wide as indicated in Table 1.2, except under the following conditions:

- For pipes used for rear and side lot drainage collection systems, where the inside diameter of the pipes is less than or equal to 12 inches and the pipes are less than or equal to 5 feet deep at the invert, the easement shall be 10 feet or equal to the lot setback if the pipe is located within the setback.to a minimum of 5 feet.
- No buildings, structures, hard surfaces, or vegetation that would prevent access are permitted within pipe drainage easements.

1.9.4.3 Full Dispersion and Preserving Native Vegetation BMPs

The preserved area(s) for BMP T5.30A Full Dispersion and BMP T5.40 Preserving Native Vegetation shall be placed in a separate tract or protected through recorded easements for individual lots.

1.9.5 Deeds and Easements

The following deeds and easements shall be used, as appropriate, to convey property or rights necessary for ownership and maintenance of stormwater facilities:

- Statutory Warranty Deed: Conveys ownership of real property.
- Stormwater Easement:
    - Conveys to Clark County the rights to access across the easement to inspect, maintain, construct, repair, reconstruct, and enforce maintenance standards for any part of a stormwater facility on a specified property. A stormwater easement must be conveyed to Clark County by plat or by deed.
    - Conveys to the private entity responsible for ownership, operation, inspection, maintenance and repair of a private stormwater facility the rights to access across the easement for location, construction, reconstruction, operation, inspection, maintenance and repair for any part of a stormwater facility on a specified property. A stormwater easement must be conveyed to a homeowner's association or other private entity that is responsible long-term maintenance of the facilities by deed.

1.9.6 Performance Security

In lieu of completing required stormwater facilities within a preliminary plat prior to recording, the Applicant may, with the approval of the Responsible Official, post a performance bond or other security acceptable to the Responsible Official in the amount of one hundred fifty percent (150%) of the estimated cost (prepared by the project engineer), as approved by the Responsible Official, of completing construction of the facilities per the approved stormwater plan.

The estimated construction cost shall be calculated to include all stormwater facilities to be constructed under the approved stormwater plan. Costs shall reflect all labor, materials and other costs associated with constructing the stormwater facilities. The costs shall be documented using the most current version of the County's Cost Breakdown Sheet maintained by the County Engineer.

After the Responsible Official determines that all stormwater facilities are constructed in compliance with the approved stormwater plan, that they are performing as designed, and that the maintenance bonding requirements of this manual are met, the performance bond or security shall be released. Other than as allowed under CCC 40.260.175, no building permits shall be issued until the stormwater facilities are completed and provisionally accepted.

New development, redevelopment and drainage projects undertaken by governmental agencies are exempt from posting a performance bond or security.

1.9.7 Maintenance Security

In order to ensure adequate funding is available so that the Applicant will satisfy financial obligations of manual section 1.9.2.2, the Applicant shall post a materials and maintenance bond or other security acceptable to the Responsible Official, in the amount of ten percent (10%) of the estimated costs (prepared by the project engineer), as approved by the Responsible Official. The bond or other security shall be maintained throughout the two- (2-) year initial maintenance period for stormwater facilities and until final acceptance by Clark County.

1.9.8 Late-Comers Agreement

The following costs associated with stormwater facilities may be recoverable through latecomer's agreements (Chapter 35.91 RCW):

1. The costs to over-size facilities on the site above their existing capacity or the capacity required for the proposed new development;

2. A proportionate share of the total cost of off-site facilities; and

3. Compliance with the provisions of RCW 35.91.010 *et seq*.

1.9.9 Regional Stormwater Facilities

Clark County encourages the use of regional stormwater facilities.

1.9.9.1 Conditions of Use

If regional stormwater facilities are used to meet some or all of the requirements of this manual, the following conditions shall be met:

1. Stormwater runoff shall be transported from a project site to a regional stormwater facility through a pipe or manmade open channel conveyance system.

2. The facility must have sufficient capacity to meet the Minimum Requirements specified in this manual at the time of each connection.

3. If mandatory LID BMPs are not planned and installed where feasible in the area draining to the regional facility, the facility must meet the LID Performance Standard in Minimum Requirement #5.

4. If stormwater facilities are required for project sites draining to the facility, the facility design must specify the design requirements to meet each Minimum Requirement of this manual.

5. The Developer shall pay the owner of the regional facility reasonable compensation for the use of the regional facility.

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Chapter 2 On-Site Stormwater Management

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2.1 Introduction

2.1.1 Purpose

This chapter presents methods, criteria, and details for analysis and selection of On-site Stormwater Management BMPs as specified in Minimum Requirement #5.

The primary purpose of On-site Stormwater Management BMPs is to reduce the disruption of the natural site hydrology for vegetated sites and partially restore natural hydrology on development sites lacking natural vegetation. Clark County requires projects to use these BMPs to comply with Minimum Requirement #5. These BMPs can also contribute to compliance with Minimum Requirements #6 and #7.

> *The Low Impact Development Technical Guidance Manual for Puget Sound (Puget Sound Partnership, 2013) is an excellent source of information about LID site planning and BMPs. The requirements in this manual take precedence where conflicts may occur.*

Most On-site Stormwater Management BMPs are intended primarily to reduce runoff volume and flow rates and secondarily to provide some level of stormwater treatment benefits.

2.1.2 How to Use this Chapter

- Section 2.2 describes how to determine which LID BMPs the site designer must consider.
- Section 2.3 describes how to assess the soil and infiltration capacity of the site for LID BMPs.
- Section 2.4 describes competing needs.
- Section 2.5 describes selection and infeasibility criteria for On-site Stormwater Management BMPs.

2.1.3 Minimum Requirements

Projects shall employ On-site Stormwater Management BMPs in accordance with the project thresholds, standards, and lists in Section 1.5.5 to infiltrate, disperse, and retain stormwater runoff on-site to the maximum extent feasible without causing flooding or erosion impacts. The full text of Minimum Requirement #5 is contained in Section 1.5.5.

Clark County accepts the use of Full Dispersion BMP T5.30A and BMP T5.30B as meeting Minimum Requirements #6 and #7. Bioretention and Permeable Pavements may be capable of meeting treatment and flow control requirements for their tributary drainage areas depending upon site conditions and sizing. Full dispersion can also be applied to meet Minimum Requirement #8.

Minimum Requirements #6 and #7 are described in Sections 1.5.6 and 1.5.7.

2.2 BMP Selection Process

The following process is required for selecting and planning for LID BMPs and demonstrating compliance with Minimum Requirement #5:

1. Use site design principles to retain native vegetation and minimize impervious surfaces to the extent feasible, including using site design BMPs and vegetation retention BMPs, per Minimum Requirement #1.

2. Determine applicable BMPs per Section 2.2.

3. Perform the Soils Assessment per Section 2.3.

4. Evaluate the feasibility of required BMPs using information in Sections 2.4 and 2.5.

5. Refer to BMP Information Sheets in Book 2, Chapter 2 to design selected BMPs.

Projects subject to Minimum Requirement #5 must consider LID BMPs from one of three tables based on the thresholds and criteria in Minimum Requirement #5. Each table lists the required LID BMPs and the order of use to meet Minimum Requirement #5.

Use Figure 2.1 to determine which LID table the project site designer is required to use. If the flowchart in Figure 2.1 requires:

- The use of BMPs from List #1, then use Table 2.1 to find out which LID BMPs the site designer must consider. Follow instructions in the table.
- The use of BMPs from List #2, then use Table 2.2 to find out which LID BMPs the site designer must consider. Follow instructions in the table.
- If the project drains to a flow exempt water body, then use Table 2.3 to find out which LID BMPs the site designer must consider.
- Meeting the LID Performance Standard, then select any combination of LID and traditional flow control and treatment BMPs that achieve the performance objective in accordance with Minimum Requirement #5 and apply BMP T5.13 Post-Construction Soil Quality and Depth.

Clark County accepts and encourages the use of other on-site stormwater management BMPs that are not listed in the selection process for required BMPs. These BMPs are described in Sections 2.5.6 and 2.5.7, and include Better Site Design (BMP T5.41), Tree Retention and Tree Planting (BMP T5.16), and others.

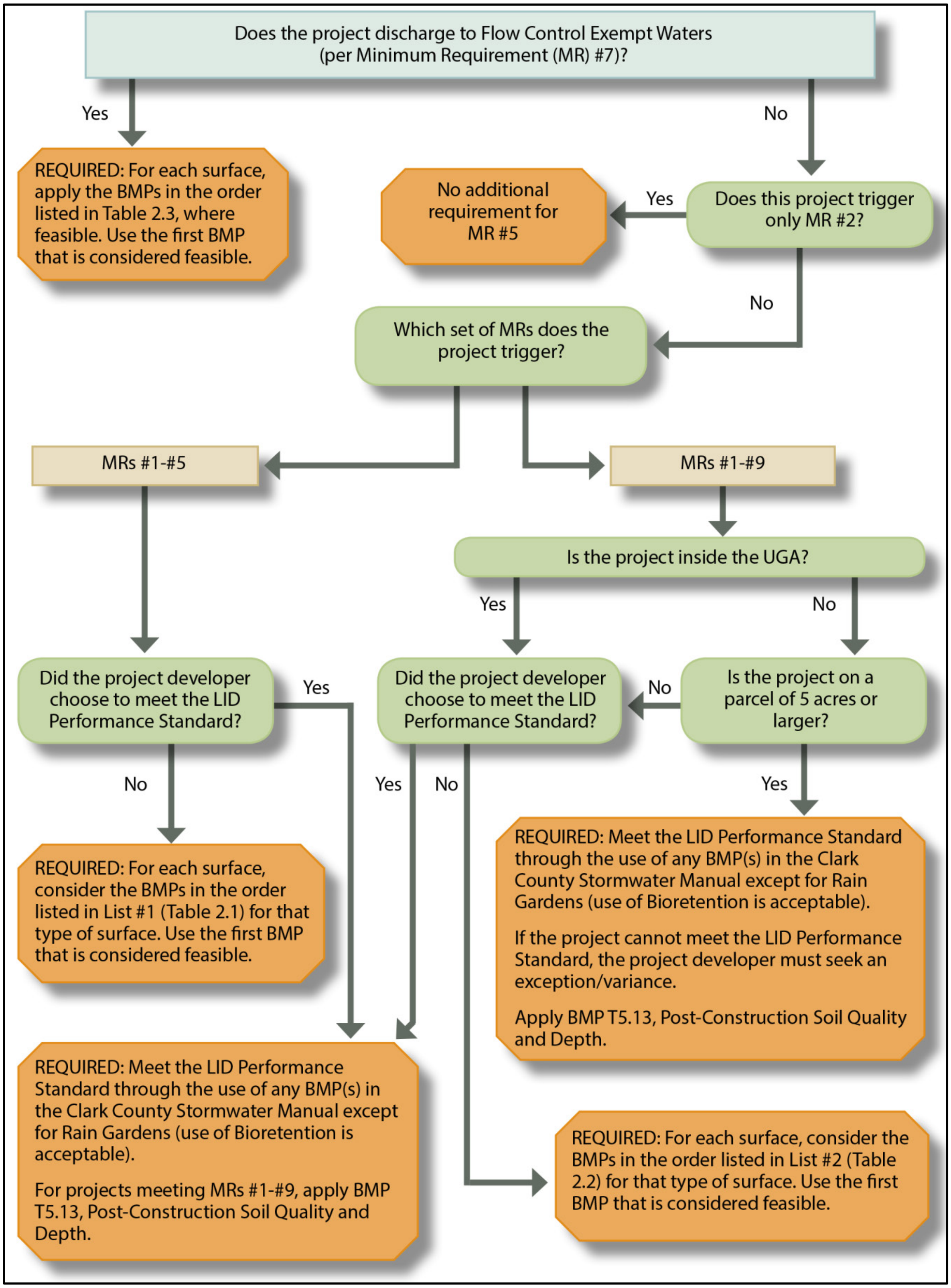

Figure 2.1: Flow Chart for Determining LID Minimum Requirement #5 Requirements

Table 2.1: Required Table of LID BMPs for Projects Subject only to Minimum Requirements #1 – #5

This table is equivalent to List #1 in Minimum Requirement #5.				
For each surface, consider BMPs in the sequence indicated for that type of surface. If a sequence number appears on more than one BMP for a surface, then the BMPs labeled with that sequence number may be considered in any order before moving on to the next number in the sequence. Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface.				
BMP #	**BMP Name**	**Lawn and Landscape Areas**	**Roofs**	**Other Hard Surfaces**
T5.13	Post-Construction Soil Quality and Depth	1		
T5.30A/B	Full Dispersion		1	1
T5.10A/T5.10B	Downspout Full Infiltration		1	
T5.15	Permeable Pavement			2
T5.14A	Rain Garden		2	2
T5.14B	Bioretention		2	2
T5.10C	Downspout Dispersion		3	
T5.10D	Perforated Stub-out Connections		4	
T5.12	Sheet Flow Dispersion			3
T5.11	Concentrated Flow Dispersion			3

Table 2.2: Required Table of LID BMPs for Projects Subject to Minimum Requirements #1 – #9 that discharge to a water body that is not flow control exempt per Minimum Requirement #7

This table is equivalent to List #2 in Minimum Requirement #5.

For each surface, consider BMPs in the sequence indicated for that type of surface. If a sequence number appears on more than one BMP for a surface, then the BMPs labeled with that sequence number may be considered in any order before moving on to the next number in the sequence.

Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface.

BMP #	BMP Name	Lawn and Landscape Areas	Roofs	Other Hard Surfaces
T5.13	Post-Construction Soil Quality and Depth	1		
T5.30A/B	Full Dispersion		1	1
T5.10A/T5.10B	Downspout Full Infiltration		1	
T5.15	Permeable Pavement			2
T5.14B	Bioretention		2	3
T5.10C	Downspout Dispersion		3	
T5.10D	Perforated Stub-out Connections		4	
T5.12	Sheet Flow Dispersion			4
T5.11	Concentrated Flow Dispersion			4

Table 2.3: Required Table of LID BMPs for Projects Subject to Minimum Requirements #1 – #9 that discharge to a flow control exempt water body per Minimum Requirement #7

Implement the following BMPs where feasible.				
For each surface, consider BMPs in the sequence indicated for that type of surface. If a sequence number appears on more than one BMP for a surface, then the BMPs labeled with that sequence number may be considered in any order before moving on to the next number in the sequence. Use the first BMP that is considered feasible. No other On-site Stormwater Management BMP is necessary for that surface.				
BMP #	**BMP Name**	**Lawn and Landscape Areas**	**Roofs**	**Other Hard Surfaces**
T5.13	Post-Construction Soil Quality and Depth	1		
T5.10A/T5.10B	Downspout Full Infiltration		1	
T5.10C	Downspout Dispersion		2	
T5.10D	Perforated Stub-out Connections		3	
T5.12	Sheet Flow Dispersion			1
T5.11	Concentrated Flow Dispersion			1

2.3 Soils Assessment

Low impact development requires soil and possibly groundwater analysis to determine infiltration rates and soil storage capacity. These analyses are needed for three primary reasons:

1. LID emphasizes storage and infiltration of stormwater in smaller-scale facilities distributed throughout the site.

2. On sites with mixed soil types, areas with permeable soils should be preserved and utilized for infiltration, and impervious areas should be located over less permeable soils.

3. Determining feasibility of LID BMPs.

Soil and subsurface characterization relies to a large extent on infiltration testing and soil testing. The type and number of these tests for site assessments is variable and specific to the site and site design; however some general guidelines are appropriate. Test locations should consider site features such as topography, mapped soil type, hydrologic characteristics and other site features.

A soil and infiltration capacity assessment is necessary to complete the preliminary Stormwater Site Plan once the layout and location of LID stormwater BMPs has been determined. If traditional infiltration BMPs will be used on the site, see requirements in Chapter 4 in addition to this chapter.

The site designer must provide sufficient information to confirm the feasibility of the proposed BMPs to meet Minimum Requirement #5. Information should also be gathered to provide a basis for estimating the facilities' contribution to meeting Minimum Requirements #6 and #7, where applicable.

Document the results of the Soils Assessment in the Soils Report described in Section 1.8.3. For projects qualifying to use the Stormwater Site Plan Short Form, follow the instructions in the in Appendix 1-I to document the results.

2.3.1.1 Qualified Professionals

Soil and subsurface characterization shall be conducted by a certified soil scientist, professional engineer, geologist, hydrogeologist or engineering geologist registered in the State of Washington or suitably trained persons working under the supervision of the above professionals. For projects meeting Minimum Requirements #1 – #5, a licensed on-site sewage designer can be used to complete the soil description (Section 2.3.1.2) and to conduct infiltration tests (Section 2.3.1.4) where necessary.

2.3.1.2 Soil Description

Perform the following to describe the underlying soils on the site:

- Soil test pits
- Soil borings
- Soil grain size analysis

Provide boring logs and other detailed information to characterize the soil profile. Provide a review of existing geotechnical and geological information from published geology maps, Natural Resource Conservation Service soil surveys, and past geotechnical information. Identify the appropriate hydrologic soil group, and provide a summary of seasonal groundwater elevation information and topsoil depth.

Where downspout infiltration systems are proposed, the soils description must demonstrate that soils suitable for infiltration are present on the site. Prepare at least one soils log at the location of each downspout infiltration system, a minimum of 4 feet in depth from the proposed grade and at least 1 foot below the expected bottom elevation of the infiltration trench or drywell. Identify the NRCS series of the soil, the hydrologic soil group per Appendix 2-A, and the USDA textural class of the soil horizon through the depth of the log. Note any evidence of high groundwater level, such as mottling.

Applicants proposing to meet Minimum Requirement #5 solely with one of the following listed BMPs are not required to complete the remaining aspects of the Soils Assessment described in Sections 2.3.1.3 through 2.3.1.5:

BMP T5.30A/B, Full Dispersion.

BMP T5.10A/B, Roof Downspout Full Infiltration.

BMP T5.10C, Downspout Dispersion.

BMP T5.10D, Perforated Stub-out Connection.

2.3.1.3 Soil Stratigraphy

For projects subject to Minimum Requirements #1 – #9, the soils report should include a description of the soil stratigraphy and groundwater elevations at the site.

Soil stratigraphy must be assessed for low permeability layers, highly permeable sand/gravel layers, depth to groundwater, and other soil structure variability necessary to assess subsurface flow patterns. Soil characterization for each soil unit (soil strata with the same texture, color, density, compaction, consolidation and permeability) should include:

- Grain size distribution
- Textural class
- Percent clay content
- Cation exchange capacity
- Color/mottling
- Variations and nature of stratification

2.3.1.4 Infiltration Rate (Coefficient of Permeability)

Determine the measured infiltration rate for subgrade soil profile (existing soils) beneath areas proposed to have bioretention, rain gardens and permeable pavement. Conduct infiltration tests using one of the methods in Section 4.3.1.3. Conduct tests in locations and at adequate frequency capable of producing a soil profile characterization that fully represents the infiltration capability where the LID infiltration BMPs are proposed.

Prepare detailed logs for each test pit or test hole and a map showing the location of the test pits or test holes. Logs must include, at a minimum: depth of pit or hole, soil descriptions, depth to water, and presence of stratification. Logs must substantiate whether stratification does or does not exist. The qualified professional may consider additional methods of analysis to substantiate the presence of stratification that may influence the design or successful operation of the facility.

Projects Subject Only to Minimum Requirements #1 – #5 and Not Meeting LID Performance Standard

Perform an infiltration test at each rain garden location to determine if the minimum measured coefficient of permeability of 0.3 in/hr is exceeded.

For proposed permeable pavement locations, perform an infiltration test for every 5,000 sq. ft. of permeable pavement.

The depth and number of infiltration tests and soil samples should be increased if, in the judgment of the qualified professional, conditions are highly variable and such increases are necessary to accurately estimate the performance of the infiltration system. The professional can also consider a reduction in the extent of infiltration testing if, in their judgment, information exists confirming that the site is unconsolidated sediment with high infiltration rates, and there is one foot of separation from the bottom of the base course for permeable pavement to groundwater and site soils are found to be homogeneous and consistent.

In high water table sites, the subsurface exploration sampling need not be conducted lower than two feet below the groundwater table. For all proposed locations of LID infiltration BMPs, determine whether the location has at least one foot minimum clearance to the seasonal high groundwater or other hydraulic restriction layer.

Projects Subject to Minimum Requirements #1 – #9 or Meeting LID Performance Standard

Bioretention

For proposed bioretention locations, infiltration tests shall be conducted as follows:

- On a single, smaller commercial property where one bioretention facility is proposed, one test must be performed at the proposed bioretention location. Tests at more than one site could reveal the advantages of one location over another.
- On larger commercial sites, a test per Section 4.3.1.3 must be performed every 5,000 square feet of PGIS.
- On residential developments where the proposed bioretention facility will receive runoff from one or two lots and less than ¼ acre of impervious surface, conduct one infiltration test at the proposed bioretention location.
- For bioretention facilities proposed to receive runoff from more than two lots or greater than ¼ acre of impervious surface, an infiltration test is required at each potential bioretention site.
- Long, narrow bioretention facilities or bioretention swales, such as one following the road right-of-way, should have a test location at least every 200 lineal feet, and within each length of road with significant differences in subsurface characteristics.
- The qualified professional can exercise discretion concerning the need for and extent of infiltration rate testing:

- o The depth and number of infiltration tests should be increased if, in the judgment of the qualified professional, conditions are highly variable and such increases are necessary to accurately estimate the performance of the infiltration system.
- o The depth and number of infiltration tests can be decreased, if in the judgement of the qualified professional, information exists confirming that the site is unconsolidated coarse gravel with high infiltration rates, and there is one foot or three foot minimum separation to groundwater from the bottom of a bioretention installation depending upon drainage area size (per BMP T5.14B Infeasibility Criteria; See Section 2.5.4.3).

After conducting an infiltration test, test sites should be over-excavated three feet below the projected infiltration facility's bottom elevation to determine if there are restrictive layers or groundwater. Observations through a winter season can also be used to assist in identifying a seasonal groundwater restriction.

Correction Factors

Correction factors are applicable to projects subject to Minimum Requirements #1 – #9 and to projects that must or choose to demonstrate compliance with the LID Performance Standard of Minimum Requirement #5. Note that this is separate design issue from the assignment of a correction factor to the overlying, designed bioretention soil mix. See the bioretention design section in Book 2, Chapter 2 for information on those correction factors. Correction factors are shown in Table 2.4.

Table 2.4: Correction Factors to Infiltration Rate for Bioretention

This table gives correction factors for coefficient of permeability values to estimate the design (long-term) infiltration rates of subgrade soils underlying Bioretention.	
Site Analysis Issue	**Correction Factor**
Site variability and number of locations tested	CF_V =0.50
Degree of influent control to prevent siltation and bio-buildup	No correction factor required

<u>Permeable Pavement</u>

For sites proposing permeable pavement, infiltration tests shall be conducted as follows:

- On commercial property, conduct an infiltration test for every 5,000 sq. ft. of permeable pavement, but not less than one test per section of contiguous permeable pavement.
- On residential developments, conduct infiltration tests at every proposed lot, at least every 200 feet of roadway and within each length of road with significant differences in subsurface characteristics.
- The qualified professional may exercise discretion concerning the need for and extent of

infiltration rate testing. The professional may consider a reduction in the extent of infiltration testing if, in their judgment, information exists confirming that the site is unconsolidated sediment material with high infiltration rates, that the soils are homogeneous and consistent, and that there is one foot of separation from the bottom of the base course for permeable pavement to groundwater.

Unless seasonal high groundwater elevations across the site have already been determined, upon conclusion of the infiltration testing, infiltration sites should be over-excavated three feet to see any restrictive layers or groundwater. Observations through a winter season can identify a seasonal groundwater restriction.

Perform infiltration testing in the soil profile at the estimated bottom elevation of base materials for the permeable pavement. If no base materials, (e.g., a permeable concrete sidewalk), perform the testing at the estimated bottom elevation of the pavement.

Correction Factors

Correction factors are applicable to projects subject to Minimum Requirements #1 – #9 and to projects that must or choose to demonstrate compliance with the LID Performance Standard of Minimum Requirement #5.

Tests should be located and be at adequate frequency capable of producing a soil profile characterization that fully represents the infiltration capability where the permeable pavement is located. A correction factor of one (1) for the quality of pavement aggregate base material may be used if the aggregate base is clean washed material with 1% or less fines passing the 200 sieve. Otherwise use a factor of 0.9, as shown in Table 2.5.

Table 2.5: Correction Factors to Infiltration Rate for Permeable Pavement

This table gives correction factors for coefficient of permeability values to estimate design (long-term) infiltration rates of the subgrade for Permeable Pavement.	
Site Analysis Issue	**Correction Factor**
Site variability and number of locations tested	$CF_v = 0.50$
Quality of pavement aggregate base material	$CF_m = 0.9$ to 1

Total correction factor (CF_T) = $CF_v \times CF_m$

2.3.1.5 Groundwater Assessment

For facilities serving over one acre, groundwater monitoring wells or test pits must be installed and monitored in each bioretention facility through at least one winter season (December 21 through March 21) unless:

- GIS groundwater data from Clark County or available field information describing water table elevations within 500 feet of the site indicate that the seasonal high groundwater elevation is at least 15 feet below the base of the proposed facility. Examples of field information that can be used include public well records and groundwater monitoring reports from other development sites.
- The seasonal high groundwater elevation has been found to be at least 15 feet below the facility base from monitoring wells installed at the site where monitoring was conducted during at least one winter season in the preceding three years.

For facilities serving a drainage area less than one acre, establish that the depth to groundwater or other hydraulic restriction layer will be at least 10 feet below the base of the facility. This can be done through the use groundwater monitoring wells as described above, through subsurface explorations or through information from nearby wells (500 feet or closer).

If a single bioretention facility serves a drainage area exceeding one acre and the depth to a hydraulic restricting layer or groundwater from the bottom (subgrade) of the bioretention area is less than 15 feet, a groundwater mounding analysis must be done in accordance with Book 2, Section 5.1.1.2.

2.4 LID Infeasibility due to Competing Needs

The use of On-site Stormwater Management BMPs can be superseded or reduced where they are in conflict with:

- Requirements of the following federal or state laws, rules, and standards:
    - Historic Preservation Laws and Archaeology Laws as listed at http://www.dahp.wa.gov/learn-and-research/preservation-laws.
    - Federal Superfund (general information at: http://www.epa.gov/superfund/about.htm) or Washington State Model Toxics Control Act (RCW Chapter 70.105D and WAC 173-340).
    - Federal Aviation Administration requirements for airports. See WSDOT's *Airport Stormwater Design Manual*.
    - Americans with Disabilities Act. See the 2010 ADA Standards for Accessible Design.
- Where an LID requirement has been found to be in conflict with special zoning district design criteria adopted and being implemented pursuant to a community planning process, the existing local codes may supersede or reduce the LID requirement.
- Public health and safety standards.
- Transportation regulations to maintain the option for future expansion or multi-modal use of public rights-of-way.

Document the use of Competing Needs criteria to supersede or reduce use of BMPs contained in the Required Table (see Section 2.2) in the preliminary and final Technical Information Reports (Sections 1.8.1.5 and 1.8.2.3).

2.5 Onsite Stormwater Management BMPs

2.5.1 Roof Downspout Control BMPs

2.5.1.1 Purpose and Description

Roof downspout controls include a mix of simple pre-engineered designs for infiltrating and/or dispersing runoff from roof areas. The pre-engineered downspout controls – Downspout Full Infiltration Drywell, Downspout Full Infiltration Trench, Downspout Dispersion, and Perforated Stub-out Connection – are intended only for use in infiltrating runoff from roof downspout drains on individual residential lots; however they may also be applied to commercial lot developments when the pollutant characteristics are comparable to those from residential lots.

Roof Downspout Controls include:

- BMP T5.30 A/B Full Dispersion
- BMP T5.10A Downspout Full Infiltration – Drywells
- BMP T5.10B Downspout Full Infiltration –Trenches
- BMP T5.10C Downspout Dispersion
- BMP T5.10D Perforated Stub-out Connection
- BMP T5.14A Rain Gardens (for projects that must meet MRs #1 - #5)
- BMP T5.14B Bioretention (for projects that must meet MRs #1 - #9)

These BMPs are mandated where feasible under Lists #1 and #2 in Minimum Requirement #5.

Other innovative downspout control BMPs such as rain barrels, ornamental ponds, downspout cisterns, or other downspout water storage devices may be used to supplement any of the above BMPs.

BMP T5.30A/B, Full Dispersion, BMP T5.14A, Rain Gardens, and BMP T5.14B, Bioretention, may be used to control runoff from other types of surfaces besides roof runoff and are not classified solely as roof downspout controls. See more information in Sections 2.5.3 and Section 2.5.4.

2.5.1.2 Roof Downspout Selection Process

The following types of roof downspout controls must be considered in descending order of preference, as shown in Figure 2.2:

1. Full Dispersion in accordance with BMP T5.30A and/or BMP T5.30B. [Note: Full Dispersion is not exclusively a roof downspout control and can be used to control runoff from other surfaces. See more information on this BMP in Section 2.5.3.]

2. Downspout Full Infiltration Systems in accordance with BMP T5.10A or BMP T5.10B.

3. Rain Gardens in accordance with BMP T5.14A; or if the project area is subject to Minimum Requirements #1 – #9, Bioretention in accordance with BMP T5.14B. [Note: Rain Gardens and Bioretention are not exclusively roof downspout controls and can be used to control runoff from other surfaces. See more information on these BMPs in Section 2.5.4.]

4. Downspout Dispersion Systems in accordance with BMP T5.10C.

5. Perforated Stub-out Connections in accordance with BMP T5.10D.

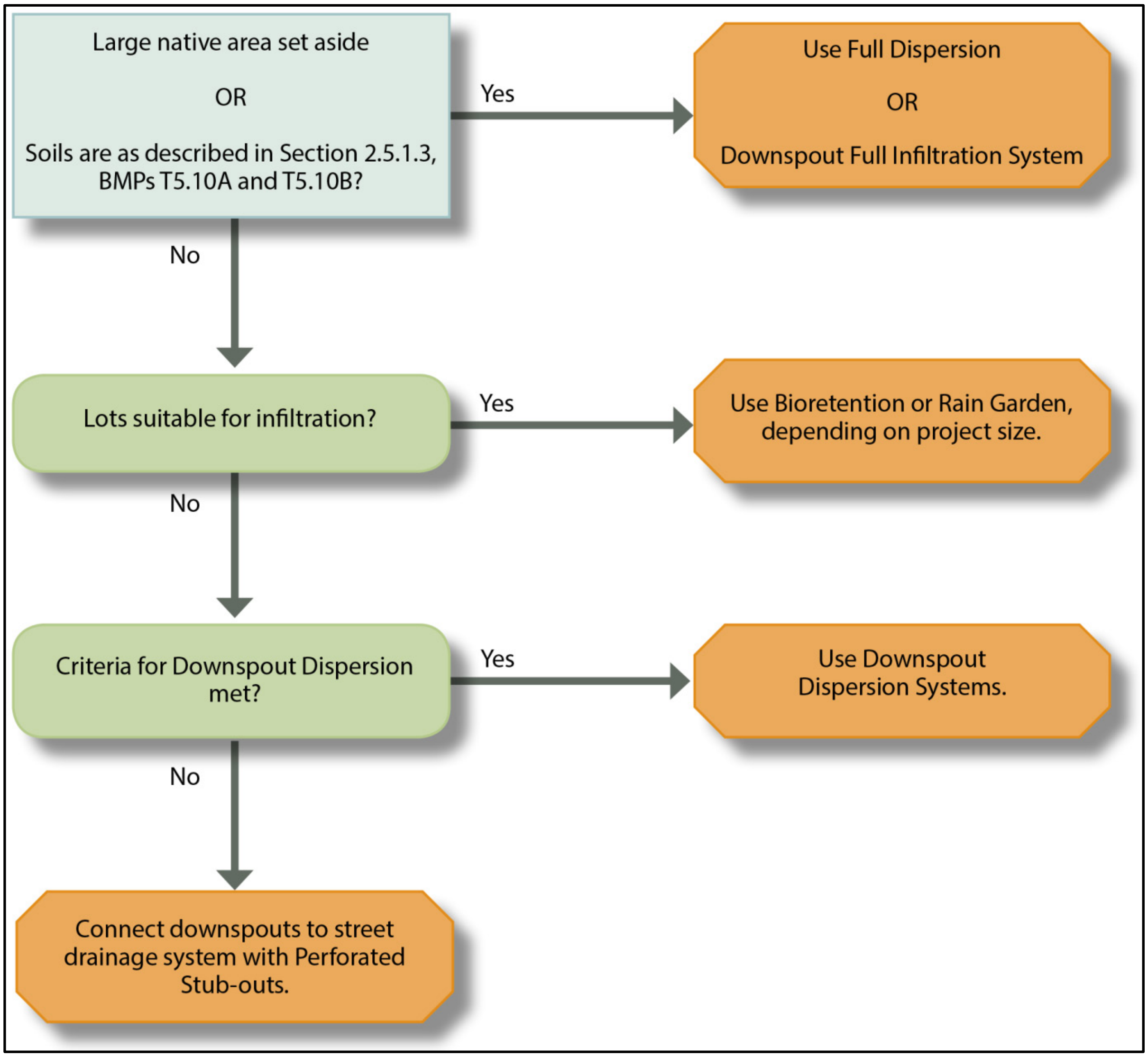

Figure 2.2: Roof Downspout Selection Process

2.5.1.3 Roof Downspout BMP Applications, Limitations and Infeasibility Criteria

BMP T5.30A: Full Dispersion and BMP T5.30B: Dispersion to Pasture and Cropland

See Section 2.5.3 for applications and limitations associated with these BMPs.

BMP T5.10A: Downspout Full Infiltration – Drywells and BMP T5.10B: Downspout Full Infiltration – Trenches

These systems are deemed feasible without infiltration testing when a qualified professional determines that USDA textural classes consisting of coarse sand to medium sand, loam, or cobbles and gravels are present in the infiltration zone. If other soils are present in the infiltration zone consider a rain garden or bioretention facility instead. Other infeasibility criteria include:

- Less than three feet of permeable soil exists from the proposed finished ground elevation at the drywell or trench location to the seasonal high groundwater table.
- Less than one foot exists between the bottom of the infiltration trench or drywell to the groundwater elevation.
- It cannot meet the setback requirements in Section 2.5.1.4.

BMP T5.10C: Downspout Dispersion

- Downspout dispersion where feasible, must be used on lots where downspout full infiltration, full dispersion, and bioretention/rain gardens are not feasible.
- Splash blocks may be used if a vegetated flow path at least 50 feet in length is available, as measured from the downspout to the downstream property line, structure, slope over 15%, stream, wetland, or other impervious surface. Sensitive area buffers may count toward flow path lengths.
- If the vegetated flow path (measured as defined above) is less than 25 feet, a perforated stub-out connection may be used in lieu of downspout dispersion. A perforated stub-out may also be used where implementation of downspout dispersion might cause erosion or flooding problems, either on site or on adjacent lots. For example, this provision might be appropriate for lots constructed on steep hills where downspout discharge could culminate and might pose a potential hazard for lower lying lots, or where dispersed flows could create problems for adjacent off-site lots. This provision does not apply to situations where lots are flat and on-site downspout dispersal would result in saturated yards. Perforated stub-outs are not appropriate when seasonal water table is <1 foot below trench bottom.
- For sites with septic systems, the discharge point of all dispersion systems must be downgradient of the drainfield. This requirement may be waived if site topography clearly prohibits flows from intersecting the drainfield.

Dispersion trench limitations include:

- A vegetated flow path of at least 25 feet in length must be maintained between the outlet of the trench and any property line, structure, stream, wetland, or impervious surface.
- A vegetated flow path of at least 50 feet in length must be maintained between the outlet of the trench and any slope steeper than 15%. Sensitive area buffers may count towards flow path lengths.
- A setback of at least 5 feet between any edge of the trench and any structure or property line must be able to be provided.

BMP T5.10D: Perforated Stub-out Connection

In projects subject to Minimum Requirement #5 perforated stub-out connections may be used only when all other higher priority on-site stormwater management BMPs are not feasible, per the criteria for each of those BMPs.

Perforated stub-outs cannot be used when the seasonal water table is less than one foot below trench bottom.

A perforated stub-out may also be used where implementation of downspout dispersion might cause erosion or flooding problems, either on site or on adjacent lots.

BMP T5.14A: Rain Gardens and BMP T5.14B: Bioretention

See Section 2.5.4 for applications and limitations associated with these BMPs.

2.5.1.4 Roof Downspout Setbacks

The following setbacks are required for Downspout Full Infiltration:

- 100 feet from closed or active landfills.
- 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems.
- 100 feet upgradient from any septic system unless site topography clearly indicates that subsurface flows will not intersect the drainfield.
- 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemical, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground.
- 10 feet from any structure, property line, or sensitive area. However, if the roof downspout infiltration system is a common system shared by two or more adjacent residential lots and contained within an easement for maintenance given to owners of all residential properties draining to the system, then the setback from the property line(s) shared by the adjacent lots may be waived.
- 200 feet from the top of any slope over 40%.
- Not on slopes steeper than 15% unless information from a geotechnical engineer is provided stating that slope stability will not be compromised.

The following setbacks are required for Downspout Dispersion:

- 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems.
- 100 feet upgradient from any septic system unless site topography clearly indicates that subsurface flows will not intersect the drainfield.
- At least 10 feet from any structure, property line, or sensitive area.

- 50 feet from the top of any slope over 15%. This setback may be reduced to 15 feet based on a geotechnical evaluation.

Setbacks for other BMPs that are not exclusively used for roof downspout controls (e.g. bioretention) are given in their respective sections.

2.5.2 Soil Amendment BMPs

2.5.2.1 Purpose and Description

Naturally occurring (undisturbed) soil and vegetation provide important stormwater functions including: water infiltration; nutrient, sediment, and pollutant adsorption; sediment and pollutant biofiltration; water interflow storage and transmission; and pollutant decomposition. These functions are largely lost when development strips away native soil and vegetation and replaces it with minimal topsoil and sod. Not only are these important stormwater functions lost, but such landscapes themselves become pollution generating pervious surfaces due to increased use of pesticides, fertilizers and other landscaping and household/industrial chemicals.

Establishing soil quality and depth regains greater stormwater functions in the post development landscape, provides increased treatment of pollutants and sediments that result from development and habitation, and minimizes the need for some landscaping chemicals, thus reducing pollution through prevention.

The following BMP is mandatory for all sites required to meet either Minimum Requirements #1 – #5 or Minimum Requirements #1 – #9:

- BMP T5.13 Post Construction Soil Quality and Depth

2.5.3 Dispersion BMPs

2.5.3.1 Purpose and Description

Dispersion BMPs spread runoff over the land and prevent runoff from concentrating over the length of the designated flow path. For flows that are initially concentrated, dispersion BMPs require a long flow path; for flows that are not concentrated, dispersion BMPs can be effective over a shorter flow path.

Dispersion helps attenuate peak flows by slowing entry of runoff into a conveyance system, allowing for some infiltration and providing some water quality benefits.

Dispersion BMPs include:

- BMP T5.11 Concentrated Flow Dispersion
- BMP T5.12 Sheet Flow Dispersion

- BMP T5.18 Reverse Slope Sidewalk
- BMP T5.30A Full Dispersion
- BMP T5.30B Dispersion to Pasture and Cropland

2.5.3.2 Applications and Limitations

- BMP T5.11 Concentrated Flow Dispersion can be used in any situation where concentrated flow can be dispersed through vegetation.
- BMP T5.12 Sheet Flow Dispersion is used on flat or moderately sloping (< 15% slope) surfaces such as driveways, sports courts, patios, roofs without gutters, lawns, pastures; or any situation where concentration of flows can be avoided.
- BMP T5.18 Reverse Slope Sidewalk requires 10 feet of vegetated surface downslope that is not directly connected into the storm drainage system.
- BMP T5.30A Full Dispersion is used in the following situations:
    - Rural single family residential developments should use these dispersion BMPs wherever possible to minimize effective impervious surface to less than 10% of the development site.
    - Other types of development that retain 65% of the site (or a threshold discharge area on the site) in a forested or native condition may also use these BMPs to avoid triggering the flow control facility requirement.
- On a single-family residential lot or an agriculture parcel or parcels under the same ownership and greater than 22,000 square feet, full dispersion onto pasture and croplands (BMP T5.30B) is allowed when in compliance with the following criteria:
    - Crop land shall consist of land used to grow grass, grain, or row crops also including berries, nursery stock and orchards.
    - The crop or pasture land shall be under the same ownership as the project site.
    - For soils with an infiltration rate greater than 4 inches per hour, pasture or cropland shall have been cleared prior to the adoption of this standard (November 2009).
    - The total site area shall consist of at least 75 percent cropland, and no more than 15 percent of the site draining to the dispersion area shall be impervious surfaces. Less stringent ratios of sending land and receiving land uses may be submitted, with supporting modeling results showing flow control requirements are satisfied for the site.
    - No more than 10 percent of the pasture or cropland used for dispersion shall be used for purposes other than plant growth (for example, but not limited to, unpaved roads, staging areas, equipment storage, animal pens, haystacks, wheel lines, campsites, trails, etc.).

- Runoff from a driveway through the dispersion area shall be dispersed per BMP T5.11 or BMP T5.12 and shall have a flow path exceeding 300 feet.
  - Land used for dispersion shall be downslope from building sites and shall not exceed 5% slope.
  - There shall be a minimum 3-foot depth to the average annual maximum groundwater elevation.
  - The length used for dispersion shall be 300 feet or greater.
  - The preserved area is not required to be placed in a separate tract or recorded easement.
  - The Applications, Limitations and Setbacks for BMP T5.30A shall also apply to this BMP. Where conflicts between the requirements in BMP T5.30 and the requirements in this BMP occur, the requirements for this BMP shall apply.

- The following surfaces will be considered "fully dispersed per BMP T5.30A or BMP T5.30B if the meet the feasibility criteria listed for those BMPs, and if they meet the following:

Roof Surfaces

Roof surfaces are considered to be "fully dispersed" if they meet BMP T5.30A or BMP T5.30B and if they either: 1) comply with the Downspout Dispersion requirements of BMP T5.10C, but with vegetated flow paths of 100 feet or more through the native vegetation preserved area; or 2) disperse the roof runoff along with the road runoff in accordance with the roadway dispersion BMP section below.

Roadways

Roadway surfaces are considered to be "fully dispersed" if they meet BMP T5.30A or BMP T5.30B and if they comply with the following dispersion requirements:

1. The road section shall be designed to minimize collection and concentration of roadway runoff. Sheet flow over roadway fill slopes (i.e., where roadway subgrade is above adjacent right-of-way) should be used wherever possible to avoid concentration.

2. When it is necessary to collect and concentrate runoff from the roadway and adjacent upstream areas (e.g., in a ditch on a cut slope), concentrated flows shall be incrementally discharged from the ditch via cross culverts or at the ends of cut sections. These incremental discharges of newly concentrated flows shall not exceed 0.5 cfs at any one discharge point from a ditch for the 100-year runoff event. Where flows at a particular ditch discharge point were already concentrated under existing site conditions (e.g., in a natural channel that crosses the roadway alignment), the 0.5-cfs limit would be in addition to the existing concentrated peak flows.

3. Ditch discharge points with up to 0.2 cfs discharge for the peak 100-year flow shall use rock pads or dispersion trenches to disperse flows. Ditch discharge points with between 0.2 and 0.5 cfs discharge for the 100-year peak flow shall use only dispersion trenches to disperse flows.

4. Dispersion trenches shall be designed to accept surface flows (free discharge) from a pipe, culvert, or ditch end, shall be aligned perpendicular to the flow path, and shall be minimum 2 feet by 2 feet in section, 50 feet in length, filled with ¾-inch to 1½-inch washed rock, and provided with a level notched grade board. Manifolds may be used to split flows up to 2 cfs discharge for the 100-year peak flow between up to 4 trenches. Dispersion trenches shall have a minimum spacing of 50 feet between centerlines.

5. Flow paths from adjacent discharge points must not intersect within the 100-foot flow path lengths, and dispersed flow from a discharge point must not be intercepted by another discharge point. To enhance the flow control and water quality effects of dispersion, the flow path shall not exceed 15% slope, and shall be located within designated open space. Runoff may be conveyed to an area meeting these flow path criteria.

6. Ditch discharge points shall be located a minimum of 100 feet up gradient of steep slopes (i.e., slopes steeper than 40%), wetlands, and streams.

Driveways

Driveway surfaces are considered to be "fully dispersed" if they meet BMP T5.30A or BMP T5.30B AND if they either: 1) comply with BMP 5.11 for concentrated flow and BMP T5.12 for sheet flow-and have flow paths of 100 feet or more through native vegetation; or, 2) disperse driveway runoff along with the road runoff in accordance with the roadway dispersion BMP section below.

Cleared Areas

The runoff from cleared areas that are comprised of bare soil, non-native landscaping, lawn, and/or pasture of up to 25 feet in flow path length can be considered to be "fully dispersed" if it is dispersed through at least 25 feet of native vegetation in accordance with the following criteria:

1. The topography of the non-native pervious surface must be such that runoff will not concentrate prior to discharge to the dispersal area.

2. Slopes within the dispersal area should be no steeper than 15%.

If the width of the non-native pervious surface is greater than 25 feet, the vegetated flow path segment must be extended 1 foot for every 3 feet of width beyond 25 feet up to a maximum width of 250 feet.

2.5.3.3 Infeasibility Criteria for Dispersion BMPs

The infeasibility criteria in this section apply to the following BMPs:

- BMP T5.11 Concentrated Flow Dispersion
- BMP T5.12 Sheet Flow Dispersion
- BMP T5.30A Full Dispersion
- BMP T5.30B Pasture and Cropland Dispersion

The following criteria describe conditions that make dispersion LID BMPs infeasible to meet Minimum Requirement #5 for the BMPs listed above. It is important to note that even though a LID BMP is infeasible to meet the LID requirement, it may still be designed and used to meet the runoff treatment and/or flow control requirement for the TDA, if applicable.

Dispersion BMPs listed above are considered infeasible under the following conditions:

- Where a professional geotechnical evaluation recommends dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding.
- Where the only location available for the discharge location is less than 100 feet up gradient of a septic system.
- Where the only area available for the required length of the BMP's flow path is above an erosion hazard, toward a landslide hazard area, or on a slope greater than 20% unless a professional geotechnical engineer recommends dispersion can be used in these areas.
- Where the only area available to place the dispersion device (not the flow path), if applicable to the BMP, is located in a critical area or critical area buffer.
- Where the only area available to place the dispersion device (not the flow path), if applicable to the BMP, is located on a slope greater than 20% (5% for BMP T5.30B) or within 50 feet of a geohazard (CCC 40.430) area.
- Where the setbacks in Section 2.5.3.4 cannot be met.

Meeting any one of the criteria renders dispersion BMPs infeasible to meet Minimum Requirement #5 on the site. Citation of any of the infeasibility criteria must be based on an evaluation of site-specific conditions and must be documented in the Preliminary and Final TIR (Sections 1.8.1.5 and 1.8.2.3) on the LID Feasibility Checklist, along with any applicable written recommendations from a qualified professional. See Appendix 1-E for the LID Fesasibility Checklist.

2.5.3.4 Setbacks for Dispersion BMPs

- 100 feet upgradient from any septic system unless site topography clearly indicates that subsurface flows will not intersect the drainfield.
- 10 feet from any structure, property line, or sensitive area.

- 50 feet from a geohazard area per CCC 40.430.

2.5.4 Bioretention and Rain Garden BMPs

2.5.4.1 Purpose and Description

Bioretention facilities and rain gardens are designed to soak runoff into the ground and treat pollutants by filtering runoff through soil.

Bioretention facilities are engineered facilities that include a designed soil mix to treat pollutants. Rain gardens are non-engineered facilities that use a blend of native soil and compost as treatment media.

Bioretention areas and rain gardens also include plants adapted to the local climate and soil moisture conditions. Bioretention and rain garden BMPs include:

- BMP T5.14A Rain Garden
- BMP T5.14B Bioretention

The term bioretention is used to describe various designs using soil and plant complexes to manage stormwater. The following terminology is used in this manual:

- **Bioretention cells**: Shallow depressions with a designed planting soil mix and a variety of plant material, including trees, shrubs, grasses, and/or other herbaceous plants. Bioretention cells may or may not have an under-drain and are not designed as a conveyance system.
- **Bioretention swales**: Incorporate the same design features as bioretention cells; however, bioretention swales are designed as part of a system that can convey stormwater when maximum ponding depth is exceeded. Bioretention swales have relatively gentle side slopes and ponding depths that are typically 6 to 12 inches.
- **Bioretention planters and planter boxes**: Designed soil mix and a variety of plant material including trees, shrubs, grasses, and/or other herbaceous plants within a vertical walled container usually constructed from formed concrete, but could include other materials. Planter boxes are completely impervious and include a bottom (must include an under-drain). Planters have an open bottom and allow infiltration to the subgrade. These designs are often used in ultra-urban settings.

Where the surrounding native soils have adequate infiltration rates, bioretention can help comply with flow control and treatment requirements. Where the native soils have low infiltration rates, under-drain systems can be installed and the facility used to filter pollutants and detain flows that exceed infiltration capacity of the surrounding soil. However, designs utilizing under-drains provide less flow control benefits.

Rain gardens are generally used on smaller projects such as individual home sites where soils are not sufficiently well drained for roof downspout infiltration wells or trenches.

2.5.4.2 Applications and Limitations

BMP T5.14A: Rain Gardens

Rain gardens are an on-site stormwater management BMP option for projects that have to comply with Minimum Requirements #1 – #5, but they may not be used on sites complying with Minimum Requirements #1 – #9. For projects required to use List #1 of Minimum Requirement #5, Rain Gardens are to be used to the extent feasible for runoff from roofs and other hard surfaces unless a higher priority BMP is feasible.

Other applications and limitations are the same as for bioretention.

BMP T5.14B: Bioretention Facilities

Bioretention facilities are an on-site BMP option for projects that only have to comply with Minimum Requirements #1 – #5 (List #1). For projects required to meet Minimum requirements #1 - #9 and use List #2, bioretention facilities are to be used to the extent feasible for runoff from roofs and other hard surfaces unless a higher priority BMP is feasible.

Because bioretention facilities use an imported soil mix that has a moderate design infiltration rate, they are best applied for small drainages, and near the source of the stormwater. Cells may be scattered throughout a subdivision; a swale may run alongside the access road; or a series of planter boxes may serve the road. In these situations, they can but are not required to fully meet the requirement to treat 91% of the stormwater runoff file from pollution-generating surfaces. But the amount of stormwater that is predicted to pass through the soil profile may be estimated and subtracted from the 91% volume that must be treated. Downstream treatment facilities may be significantly smaller as a result.

Bioretention facilities that infiltrate into the ground can also serve a significant flow reduction function. They can, but are not required to fully meet the flow control duration standard of Minimum Requirement #7. Because they typically do not have an orifice restricting overflow or underflow discharge rates, they typically don't fully meet Minimum Requirement #7. However, their performance contributes to meeting the standard, and that can result in much smaller flow control facilities at the bottom of the project site. When used in combination with other low impact development techniques, they can also help achieve compliance with the Performance Standard option of Minimum Requirement #5.

Bioretention facilities constructed with imported compost materials must not be used within one-quarter mile of phosphorus-sensitive waterbodies if the underlying native soil does not meet the criteria for treatment described in Section 3.2.2.1. Bioretention also must not be used with an underdrain when the underdrain water would be routed to a phosphorus-sensitive receiving water. In Clark County, the Lacamas watershed above the dam at the south end of Round Lake is a phosphorus-sensitive water body.

2.5.4.3 Infeasibility Criteria for Rain Garden and Bioretention BMPs

Meeting any one of the following criteria make the Bioretention and Rain Garden BMPs not required to meet Minimum Requirement #5 on the site. Citation of any of the below infeasibility criteria must be based on an evaluation of site-specific conditions and must be documented in the Preliminary and Final TIR (Section 1.8.1.5 and Section 1.8.2.3) on the LID Feasibility Checklist, along with any applicable written recommendations from a qualified professional. See Appendix 1-E for the LID Feasibility Checklist.

It is important to note that even though a LID BMP is infeasible to meet the LID requirement, it may still be designed and used to meet the runoff treatment and/or flow control requirement, if applicable.

Bioretention and Rain Gardens are considered infeasible under the following conditions:

- Where the Responsible Official has determined that the BMP is not compatible with surrounding drainage systems (e.g. projects draining to existing stormwater collection system whose elevation or locale precludes connection to a properly functioning bioretention system).
- Where the land for the BMP is within an area designated as an erosion hazard or landslide hazard by the geotechnical report or county critical areas mapping.
- Where the site cannot reasonably be designed to locate the BMP on slopes less than 8%.
- On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:
    - The proposed BMP is within 100 feet of an area known to have deep soil contamination. [Note: this criterion is also found in Setbacks.]
    - The site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater.
    - The proposed BMP is located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area.
    - The BMP would be within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW.
- For a bioretention system or a rain garden that would serve a drainage area that is 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface; and 3) less than ¾ acres of pervious surface, where the minimum vertical separation of one foot to seasonal high water table, bedrock or other impervious layer cannot be achieved below the facility.

- For a bioretention system that would 1) serve a drainage area that is a) 5,000 sq. ft. or more of pollution-generating impervious surface, or b) 10,000 sq. ft. or more of impervious surface; or c) ¾ acres or more of pervious surface; and 2) cannot reasonably be broken down into amounts smaller than indicated in (1), where the minimum vertical separation of three feet to seasonal high water table, bedrock or other impervious layer cannot be achieved below the facility.
- Where field testing indicates that soils have a measured (a.k.a. initial) native soil coefficient of permeability less than 0.3 inches per hour. [Note: an LID infiltration BMP may still be feasible with the use of an underdrain to help meet Minimum Requirements #6 or #7, depending on soil and filtration media characteristics.]
- Where the site cannot reasonably be designed to avoid placing bioretention or rain garden within setbacks given in Section 2.5.4.4.
- Where a professional evaluation demonstrates that any condition below is met:
    - Where a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding.
    - Where the site has groundwater that drains into an erosion hazard or landslide hazard area.
    - Where the only area available for siting the BMP threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces.
    - Where infiltrating water would threaten existing below grade basements.
    - Where infiltrating water would threaten shoreline structures such as bulkheads.
    - Where the only area available for siting the BMP is one that does not allow for a safe overflow pathway to the municipal separate storm sewer system or to a private storm sewer system.
    - Where there is a lack of usable space for rain garden/bioretention facilities at redevelopment sites, or where there is insufficient space within the existing public right-of-way on public road projects.

2.5.4.4 Setbacks

The following setbacks shall be used for bioretention systems and rain gardens:

- 50 feet from the top of slopes greater than 20% or with more than 10 feet of vertical relief.
- 100 feet from a landfill (active or closed).
- 100 feet from a drinking water well or a spring used for drinking water.
- 10 feet from any small on-site sewage disposal drain field, including reserve areas, and grey water reuse systems. For setbacks from a "large on-site sewage disposal system," see Chapter 246-272B WAC.

- From an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous waste in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground:
    - 10 feet when the system capacity is 1100 gallons or less.
    - 100 feet when the system capacity is greater than 1100 gallons.
- 100 feet from an area with known deep soil contamination.
- For a bioretention system or raingarden that would serve a drainage area that is less than 5,000 sq. ft. of pollution-generating impervious surface and less than 10,000 sq. ft. of impervious surface, 10 feet from any structure or property lines.
- For a bioretention system that would serve a drainage area that is 5,000 sq. feet or more of pollution-generating impervious surface or 10,000 sq. ft. or more of impervious surface or ¾ acres or more of pervious surfaces, 20 feet from the downslope side of any foundation, structure, or property line and 100 feet from the upslope side of any foundation. These setbacks may be increased or decreased based on engineering analysis that shows the performance of a building's foundation system will not be adversely affected by the presence of the bioretention facility.

2.5.5 Permeable Pavement

2.5.5.1 Purpose and Description

Permeable paving surfaces are an important integrated management practice within the LID approach and can be designed to accommodate pedestrian, bicycle and auto traffic while allowing infiltration, treatment and storage of stormwater. The general categories of permeable paving systems include:

- **Porous hot or warm-mix asphalt pavement** is a flexible pavement similar to standard asphalt that uses a bituminous binder to adhere aggregate together. However, the fine material (sand and finer) is reduced or eliminated and, as a result, voids form between the aggregate in the pavement surface and allow water to infiltrate.
- **Permeable Portland cement concrete** is a rigid pavement similar to conventional concrete that uses a cementitious material to bind aggregate together. However, the fine aggregate (sand) component is reduced or eliminated in the gradation and, as a result, voids form between the aggregate in the pavement surface and allow water to infiltrate.
- **Permeable interlocking concrete pavements (PICP) and aggregate pavers.** PICPs are solid, precast, manufactured modular units. The solid pavers are (impervious) high-strength Portland cement concrete manufactured with specialized production equipment. Pavements constructed with these units create joints that are filled with permeable aggregates and installed on an open-graded aggregate bedding course. Aggregate pavers (sometime called pervious pavers) are a different class of pavers from PICP. These include modular precast paving units made with similar sized aggregates bound together with Portland cement concrete with high-

strength epoxy or other adhesives. Like PICP, the joints or openings in the units are filled with open-graded aggregate and placed on an open-graded aggregate bedding course. Aggregate pavers are intended for pedestrian use only.

2.5.5.2 Applications and Limitations

Permeable pavements are appropriate in many applications where traditionally impermeable pavements have been used. Typical applications for permeable paving include parking lots, sidewalks, pedestrian and bike trails, driveways, residential access roads, and emergency and facility maintenance roads.

Limitations to the use of pervious pavement include:

- Run-on from pervious surfaces is not allowed, except from minor or incidental pervious areas that cannot be directed elsewhere. Those areas must be fully stabilized before discharging runoff to the pervious pavement.
- Unless the pavement, base course, and subgrade have been designed to accept runoff from adjacent impervious surfaces, slope impervious runoff away from the permeable pavement to the maximum extent practicable. Sheet flow from up-gradient impervious areas is not recommended, but permissible if the porous surface flow path is greater than the impervious surface flow path.

2.5.5.3 Infeasibility Criteria

Meeting any one of the following criteria make Permeable Pavement not required to meet Minimum Requirement #5 on the site. Citation of any of the below infeasibility criteria must be based on an evaluation of site-specific conditions and must be documented in the Preliminary and Final TIR (Section 1.8.1.5 and Section 1.8.2.3) on the LID Feasibility Checklist, along with any applicable written recommendations from a qualified professional. See Appendix 1-E for the LID Feasibility Checklist.

It is important to note that even though an LID BMP is infeasible to meet the LID requirement, it may still be designed and used to meet the runoff treatment and/or flow control requirement, if applicable.

Permeable pavements are considered infeasible under the following conditions:

- Roadways and parking areas where projected average daily traffic volumes are greater than 400 vehicles.
- Where the roadway will be subject to through truck traffic, not including such traffic as weekly garbage and recycling pick-up, daily school bus use, or frequent use by mail/parcel delivery trucks and maintenance vehicles.
- At multi-level parking garages, and over culverts and bridges.
- Where the site design cannot avoid putting pavement in areas likely to have long-term excessive

sediment deposition after construction (e.g., construction and landscaping material yards).

- Within an area designated as an erosion hazard or landslide hazard.
- On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:
  - The proposed BMP is within 100 feet of an area known to have deep soil contamination. [Note: this criterion is also a Setback.]
  - The site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater.
  - The proposed BMP is located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area.
  - The BMP would be within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW.
- Where the site cannot be designed to have a porous asphalt surface at less than 5% slope, or a permeable concrete surface at less than 10% slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12% slope. Grid systems upper slope limit can range from 6 to 12%; check with manufacturer and local supplier.
- Where the native soils below a pollution-generating permeable pavement (e.g., road or parking lot) do not meet the soil suitability criteria for providing treatment (See Book 2, Section 3.1.5.3).
- Where seasonal high groundwater or an underlying impermeable/low permeable layer would create saturated conditions within one foot of the bottom of the lowest gravel base course.
- Where underlying soils are unsuitable for supporting traffic loads when saturated. Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.
- Where measured coefficient of permeability is less than 0.3 inches per hour. In these instances, unless other infeasibility restrictions apply, roads and parking lots may be built with an underdrain, preferably elevated within the base course, if flow control benefits are desired.
- Where replacing existing impervious surfaces, unless the existing surface is a non-pollution generating surface over a soil with a coefficient of permeability of four inches per hour or greater.
- At sites defined as "high-use sites" as defined in Appendix 1-A.
- In areas with "industrial activity" as identified in 40 CFR 122.26(b)(14).
- Where the risk of concentrated pollutant spills is more likely such as gas stations, truck stops, and industrial chemical storage sites.
- Where routine, heavy applications of sand occur in frequent snow zones to maintain traction

during weeks of snow and ice accumulation. Most lowland western Washington areas do not fit this criterion.

- Where the surface(s) to be paved are within setbacks given in Section 2.5.5.4.
- Where a professional evaluation demonstrates any condition listed below is met:
    - Where professional geotechnical evaluation recommends infiltration not be used due to reasonable concerns about erosion, slope failure, or down gradient flooding.
    - Where the site has groundwater that drains into an erosion hazard or landslide hazard area.
    - Where infiltrating and ponded water below new permeable pavement area would compromise adjacent impervious pavements.
    - Where infiltrating water below a new permeable pavement area would threaten existing below grade basements.
    - Where infiltrating water would threaten shoreline structures such as bulkheads.
    - Downslope of steep, erosion prone areas that are likely to deliver sediment.
    - Where fill soils are used that can become unstable when saturated.
    - Where there are excessively steep slopes and water within the aggregate base layer or at the sub-grade surface cannot be controlled by detention structures and may cause erosion and structural failure, or where surface runoff velocities may preclude adequate infiltration at the pavement surface.
    - Where permeable pavements cannot provide sufficient strength to support heavy loads (such as at ports).
    - Where installation of permeable pavement would threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road sub-grades.

The following soil suitability criteria apply to permeable pavement used to meet Minimum Requirement #6. Sites not meeting these criteria are not feasible for permeable pavements for pollution-generating hard surfaces (e.g. roads, driveways, and parking lots):

- One foot depth of soil with any of the following characteristics:
    - Cation Exchange Capacity ≥ 5 milliequivalents CEC/100 g dry soil (USEPA Method 9091)
    - Organic Content > 1%
    - Measured coefficient of permeability < 9 in./hr.

2.5.5.4 Setbacks

The following setbacks are required for permeable pavements:

- 50 feet from the top of slopes greater than 20% with more than 10 feet of vertical relief.
- 100 feet from a landfill (active or closed).
- 100 feet from a drinking water well or a spring used for drinking water, if the pavement is a pollution-generating surface.
- 10 feet from on-site sewage drainage.
- 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous waste in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground.
- 100 feet from an area with known deep soil contamination.

2.5.6 Soil and Vegetation Protection and Enhancement BMPs

2.5.6.1 Purpose and Description

Mature native vegetation and soils are necessary to maintain watershed hydrology, stable stream channels, wetland hydro-periods, and healthy aquatic systems (Booth et al., 2002). They are also the most cost-effective and efficient tools for reducing quantity of stormwater produced and for stormwater quality.

Soil and Vegetation Protection and Enhancement BMPs include:

- BMP T5.16 Tree Retention and Tree Planting (Book 2, Chapter 2)
- BMP T5.19 Minimal Excavation Foundation (Book 2, Chapter 2)
- BMP T5.40 Preserving Native Vegetation (Book 2, Chapter 2)
- BMP T5.41 Better Site Design (Book 2, Chapter 2)

Design guidance for these BMPs may also be found in the *Low Impact Technical Guidance Manual for Puget Sound.*

2.5.7 LID Runoff Harvest and Use BMPs

LID Runoff Harvest and Use BMPs detain runoff for use in another application. BMPs include:

- BMP T5.17 Vegetated Roof (Book 2, Chapter 2)
- BMP T5.20 Rainwater Harvesting (Book 2, Chapter 2)

Design guidance for these BMPs may also be found in the *Low Impact Technical Guidance Manual for Puget Sound.*

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Chapter 3 Stormwater Runoff Treatment

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3.1 Introduction

3.1.1 Purpose

Urbanization and land development can cause an increase in the types and quantities of pollutants in surface and groundwaters. Runoff from roads and highways can be contaminated with pollutants from vehicles. Oil and grease, polynuclear aromatic hydrocarbons (PAH's), lead, zinc, copper, cadmium, as well as sediments (soil particles) and road salts are typical pollutants in road runoff. Runoff from industrial areas typically contains even more types of heavy metals, sediments, and a broad range of man-made organic pollutants, including phthalates, PAH's, and other petroleum hydrocarbons. Residential areas contribute the same road-based pollutants to runoff, as well as herbicides, pesticides, nutrients (from fertilizers), bacteria and viruses (from animal waste). All of these contaminants can seriously impair beneficial uses of receiving waters.

Minimum Requirement #6 requires the installation of runoff treatment BMPs for land disturbing activities passing thresholds. See Section 1.5.6 for the thresholds that trigger this Minimum Requirement.

3.1.2 How to Use this Chapter

Consult this chapter to select and design specific runoff treatment BMPs for permanent use development and redevelopment sites. Consult Book 2, Chapters 3 and 4 for the detailed design of each treatment BMP.

- Section 3.1 serves as an introduction and summarizes available options for treatment of stormwater.
- Section 3.2 outlines a step-by-step process for selecting treatment facilities for new development and redevelopment projects.
- Section 3.3 discusses selection criteria for pretreatment BMPs.
- Section 3.4 discusses selection criteria for runoff treatment BMPs.

3.2 Treatment BMP Selection Process

This section describes a step-by-step process for selecting the type of treatment facilities to be applied on an individual project and gives four menus of best management practices (BMPs) for different types of treatment: oil control treatment, phosphorus treatment, enhanced treatment, and basic treatment.

3.2.1 Step-by-Step Process for Selecting Treatment Facilities

Use this six-step process to determine the type of treatment facilities applicable to the project. Please refer to Figure 3.1.

Briefly, the steps are:

1. Identify the pollutants of concern based on the proposed land use and determine the receiving waters based on off-site analysis

2. Determine if an Oil Control Facility/Device is Required

3. Determine if Infiltration for Pollutant Removal is Practicable

4. Determine if Phosphorous Control is Required

5. Determine if Enhanced Treatment is Required

6. Select a Basic Treatment Facility

After selecting any BMP in the Step-by-Step Process, refer to the selection criteria in Book 2, Section 3.1, which may affect the design and placement of the facility.

Step 1: Pollutants of Concern/Land Use/Receiving Waters

To obtain a more complete determination of the potential impacts of a stormwater discharge, complete the Off-site Analysis described in Chapter 5. Clark County will verify the identification of the receiving water from the Off-site Analysis. If the discharge is to the local municipal storm drainage system, determine the receiving water for the drainage system.

List the proposed land use(s) of the project.

Proceed to Step 2.

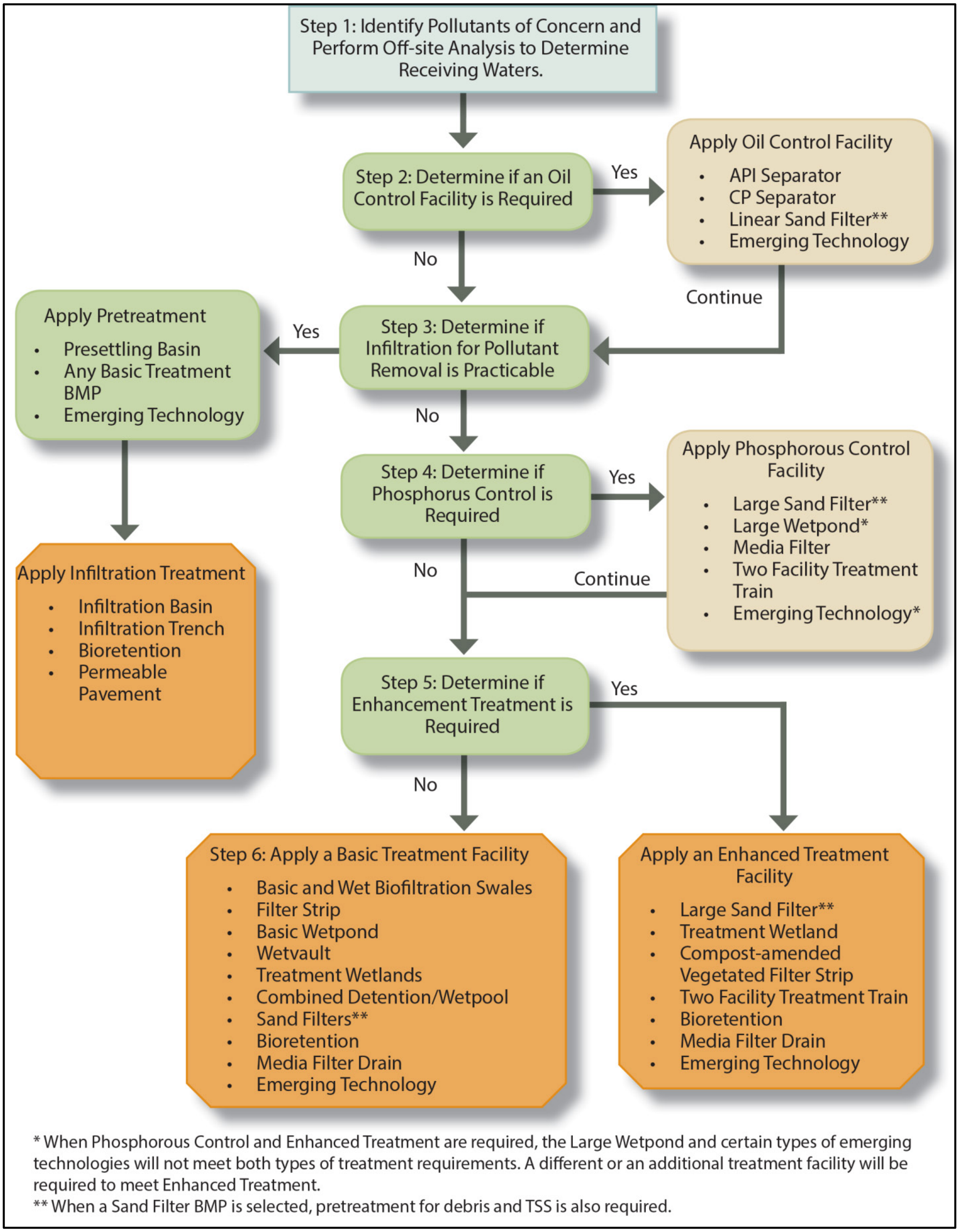

Figure 3.1: Treatment Facility Selection Flow Chart

Step 2: Determine if an Oil Control Facility/Device is Required

The use of oil control devices and facilities is dependent upon the specific land use proposed for development.

Where Applied

The Oil Control Menu applies to projects that have "high-use sites." High-use sites are those that typically generate high concentrations of oil due to high traffic turnover or the frequent transfer of oil. Select an oil control facility/device for sites meeting any the following conditions:

- An area of a commercial or industrial site subject to an expected average daily traffic (ADT) count equal to or greater than 100 vehicles per 1,000 square feet of gross building area.

Note: Gasoline stations, with or without small food stores, will likely exceed the high-use site threshold.

- An area of a commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including routinely delivered heating oil. Some examples are discussed below.

Note: The petroleum storage and transfer criterion is intended to address regular transfer operations such as gasoline service stations, not occasional filling of heating oil tanks.

- An area of a commercial or industrial site subject to parking, storage or maintenance of 25 or more vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.). Some examples are discussed below.

Note: In general, all-day parking areas are not intended to be defined as high-use sites, and should not require an oil control facility.

- A road intersection with a measured ADT count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements.

Note: The traffic count can be estimated from a traffic study prepared by a professional engineer or transportation specialist with experience in traffic estimation or using information from "Trip Generation," published by the Institute of Transportation Engineers (http://www.ite.org).

- The following land uses may have areas that fall within the definition of "high-use sites" and require oil control treatment. Further, these sites require special attention to the oil control treatment selected. Refer to Section 3.2.3.1 and 3.4.1 for more details.
    - Industrial machinery and equipment, and railroad equipment maintenance areas
    - Log storage and sorting yards
    - Aircraft maintenance areas

- Railroad yards
- Fueling stations
- Vehicle maintenance and repair sites
- Construction businesses (paving, heavy equipment storage and maintenance, storage of petroleum products)

Note: Some land use types require the use of a spill control (SC-type) oil/water separator. Those situations are described in Book 3, *Source Control*, and are separate from this treatment requirement.

Some of these sites will also be subject to the Washington Department of Ecology Industrial Stormwater Permit and should ensure that requirements of that permit are met.

For high-use sites located within a larger commercial center, only the impervious surface associated with the high-use portion of the site is subject to oil-control treatment requirements. If common parking for multiple businesses is provided, oil treatment shall be applied to the number of parking stalls required for the high-use business only. However, if the oil treatment collection area also receives runoff from other areas, the treatment facility must be sized to treat all water passing through it.

High-use roadway intersections shall treat lanes where vehicles accumulate during the signal cycle, including left and right turn lanes and through lanes, from the beginning of the left turn pocket. If no left turn pocket exists, the treatable area shall begin at a distance equal to three car lengths from the stop line. If runoff from the intersection drains to more than two collection areas that do not combine within the intersection, treatment may be limited to any two of the collection areas.

If an Oil Control Facility is required, select an appropriate Oil Control Facility from the Oil Control Menu in Section 3.2.3.1. After selecting an Oil Control Facility, proceed to Step 3.

If an Oil Control Facility is not required, proceed directly to Step 3.

Step 3: Determine if Infiltration for Pollutant Removal is Practicable

Infiltration can be effective at treating stormwater runoff, but soil properties must be appropriate to achieve effective treatment. This effectiveness is discussed in Section 3.2.2.1, Soil Type.

A proposed infiltration facility must also be checked to ensure that it does not adversely impact groundwater resources.

Unstable slopes can preclude the use of infiltration.

Infiltration treatment facilities must be preceded by a pretreatment facility, such as a presettling basin or vault, to reduce the occurrence of plugging. Any of the basic treatment facilities, and detention ponds designed to meet flow control requirements, can be used for pretreatment. If an oil/water separator is necessary for oil control, it can function as the presettling basin as long as the influent suspended solids concentrations are not high.

Infiltration through soils that do not meet the criteria for treatment in Section 3.2.2.1 is allowable as a flow control BMP following a treatment facility. Note that if infiltration for flow control occurs within ¼ mile of a phosphorus sensitive receiving water, phosphorus treatment is required. If infiltration for flow control occurs within ¼ mile of a fresh water body designated for aquatic life use or has an aquatic life use, then enhanced treatment is required for the land-use types described in Step 5 below.

If infiltration treatment is practicable, select a pretreatment facility from the Pretreatment Menu and an infiltration treatment facility from the Infiltration Menu. Then stop here.

If infiltration treatment is not practicable, proceed directly to Step 4.

Step 4: Determine if Control of Phosphorous is Required

In Clark County, phosphorus treatment shall be provided in the Lacamas watershed above the dam at the south end of Round Lake for all project sites meeting the thresholds triggering Minimum Requirement #6. This requirement applies to stormwater conveyed to the lake by surface flow as well as to stormwater infiltrated within one-quarter mile of the lake in soils that do not meet the suitability for treatment.

If phosphorus control is required, select and apply a phosphorus treatment facility from the Phosphorus Treatment Menu in Section 3.2.3.4. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria of each for compatibility with the site.

Note: Project sites subject to the Phosphorus Treatment requirement could also be subject to the Enhanced Treatment requirement (see Step 5). In that event, apply a facility or a treatment train that is listed in both the Enhanced Treatment Menu and the Phosphorus Treatment Menu.

If phosphorus treatment is required for the site, provisionally select a Phosphorous Treatment Facility, then proceed to Step 5.

If phosphorus treatment is not required for the site, proceed directly to Step 5.

Step 5: Determine if Enhanced Treatment is Required

Except where specified under Step 6, enhanced treatment to reduce dissolved metals is required for the following project sites that 1) discharge directly to fresh waters or conveyance systems tributary to fresh waters designated for aquatic life use or that have an existing aquatic life use; or 2) use infiltration strictly for flow control – not treatment – and the discharge is within ¼ mile of a fresh water designated for aquatic life use or that has an existing aquatic life use:

- Industrial project sites
- Commercial project sites
- Multi-family residential project sites
- High AADT roads as follows:
    - Within Urban Growth Management Areas:
        - Fully controlled and partially controlled limited access highways with Annual Average Daily Traffic (AADT) counts of 15,000 or more
        - All other roads with an AADT of 7,500 or greater
    - Outside of Urban Growth Management Areas:
        - Roads with an AADT of 15,000 or greater unless discharging to a 4^{th} Strahler order stream or larger;
        - Roads with an AADT of 30,000 or greater if discharging to a 4th Strahler order stream or larger (as determined using 1:24,000 scale maps to delineate stream order).

Areas of the above-listed project sites that are identified as subject to Basic Treatment requirements (see Step 6) are not also subject to Enhanced Treatment requirements. For developments with a mix of land use types, the Enhanced Treatment requirement shall apply when the runoff from the areas subject to the Enhanced Treatment requirement comprises 50% or more of the total runoff within a threshold discharge area.

If the project must apply Enhanced Treatment, select and apply an appropriate Enhanced Treatment facility. Please refer to the Enhanced Treatment Menu in Section 3.2.3.5. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria of each for compatibility with the site.

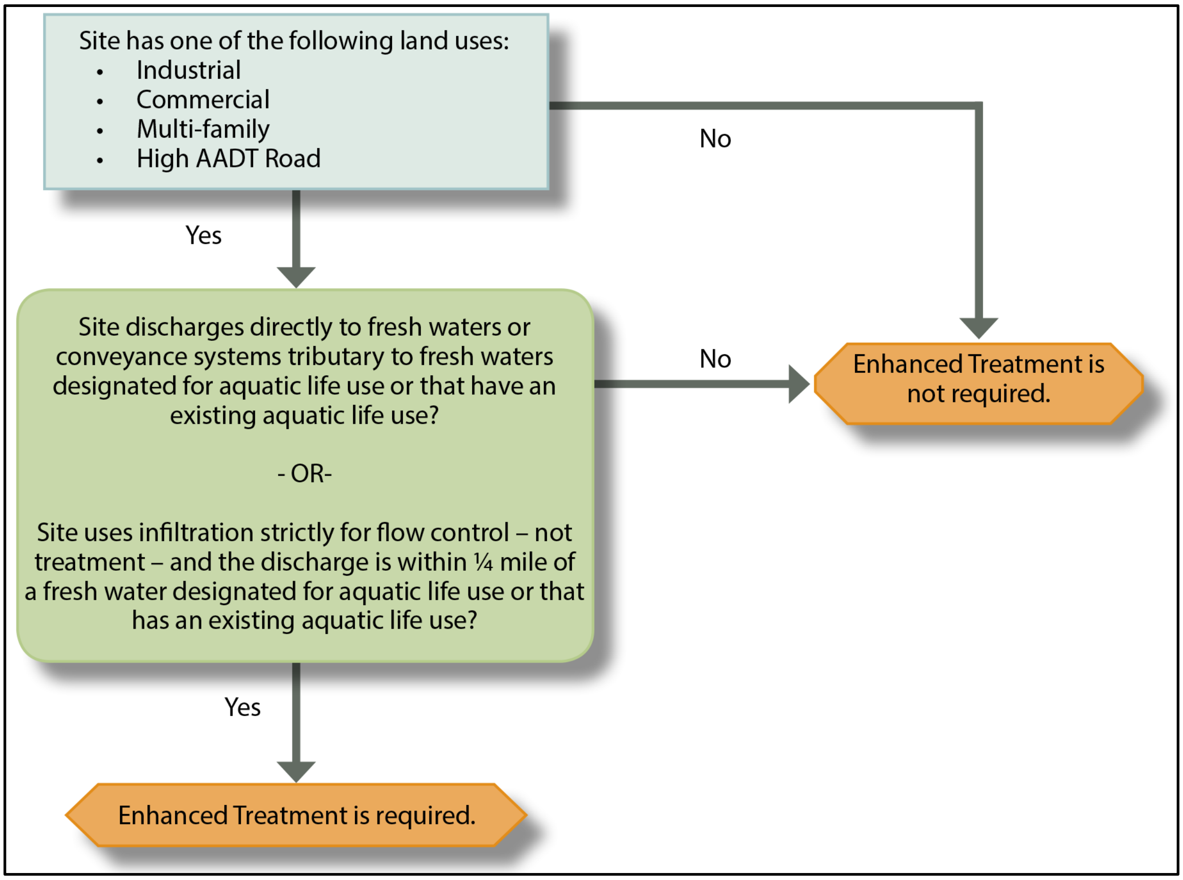

Figure 3.2: Enhanced Treatment Flow Chart

If Enhanced Treatment applies, and Phosphorous Treatment also applies (see Step 4), then select a facility or treatment train that is listed in both the Enhanced Menu and the Phosphorous Treatment menu, then stop here.

If Enhanced Treatment applies, select an appropriate Enhanced Treatment Facility, then stop here.

If Enhanced Treatment does not apply to the site, please proceed to Step 6.

Step 6: Select a Basic Treatment Facility

The Basic Treatment Menu is required in the following circumstances:

- Project sites that discharge to the ground, UNLESS:
    - The criteria for infiltration treatment are met and pretreatment is provided; OR
    - The project uses infiltration strictly for flow control – not treatment – and:
        - the discharge is within ¼-mile of a phosphorus sensitive lake (use the Phosphorus Treatment Menu), or

    - The land-use type is as is described in Step 5 and is within ¼ mile of a fresh water designated for aquatic life use or that has an existing aquatic life use (use the Enhanced Treatment Menu).

- Single Family Residential projects not otherwise needing phosphorus control in Step 4;
- Project sites discharging directly (or indirectly through a municipal separate storm sewer system) to identified Basic Treatment Receiving Waters. Basic Treatment Receiving Waters in Clark County are:
    - Columbia River
    - Lewis River
    - Washougal River
- Project sites that drain to fresh waters, or to waters tributary to fresh waters, that are not designated for aquatic life use or that do not have an existing aquatic life use;
- Landscaped areas of industrial, commercial, and multi-family project sites, and parking lots of industrial and commercial project sites, dedicated solely to parking of employees' private vehicles, which do not involve any other pollution-generating sources (e.g., industrial activities, customer parking, and storage of erodible or leachable material, wastes or chemicals).

For developments with a mix of land use types, the Basic Treatment requirement shall apply when the runoff from the areas subject to the Basic Treatment requirement comprises 50% or more of the total runoff within a threshold discharge area.

Please refer to the Basic Treatment Menu in Section 3.2.3.6. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria of each for compatibility with the site.

The treatment facility selection process is complete.

3.2.2 Other Treatment Facility Selection Factors

The selection of the most effective treatment facility should consider site physical factors and pollutants of concern. The types of site physical factors that influence facility selection are summarized below.

3.2.2.1 Soil Type

See Table 3.1 and the following for information on soil types suitable for use as treatment. The permeability of the soil underlying a treatment facility has a profound influence on its effectiveness. Facilities situated on soils with high infiltration rates will need a synthetic liner or the soils amended to reduce the infiltration rate and provide treatment. Maintaining a permanent pool in the first cell is necessary to avoid resuspension of settled solids. Biofiltration swales in coarse soils can also be amended to reduce the infiltration rate.

Consider the soil texture and design infiltration rates along with the physical and chemical characteristics specified below to determine if the soil is adequate for removing the target pollutants. The following criteria must be met to use the soil for treatment:

- Treatment soil must have a minimum 0.5 inches per hour design coefficient of permeability.
- Treatment soil must have a maximum measured infiltration rate of 9 inches per hour. Design (long-term) infiltration rates up to 3 inches per hour can also be considered, if in the judgement of the qualified professional, the treatment soil meets the characteristics of this section.
- Cation exchange capacity (CEC) of the treatment soil must be ≥5 milliequivalents CEC/100 g dry soil (USEPA Method 9081). *Consider empirical testing of soil sorption capacity, if practicable*. Ensure that soil CEC is sufficient for expected pollutant loadings, particularly heavy metals. CEC values of >5 meq/100g are expected in loamy sands, according to Rawls, et al.
- Depth of soil used for infiltration treatment must be a minimum of 18 inches. Depth of soil below permeable pavements serving as pollution-generating hard surfaces may be reduced to one foot if the permeable pavement does not accept run-on from other surfaces.
- Organic Content of the treatment soil (ASTM D 2974): Organic matter can increase the sorptive capacity of the soil for some pollutants. A minimum of 1.0 percent organic content is necessary.
- Waste fill materials shall not be used as infiltration soil media nor shall infiltration soil media be placed over uncontrolled or non-engineered fill soils.
- For engineered soils or for soils with very low permeability, the potential to bypass the treatment soil through the side-walls may be significant. In those cases, line the side-walls with at least 18 inches of treatment soil to prevent seepage of untreated flows through the side walls.
- For soils that do not meet the requirements of this section, treatment liners may be used. See Book 2, Section 3.1.6 for more information on treatment liners.

Note: Soil maps show topsoils and may not reflect material found several feet below ground surface. In Clark County it is common for sandy soils to be found under lower permeability topsoil.

Table 3.1 Preliminary Screening of Treatment Facilities Based on Soil Type

Soil Type	Infiltration/ Bioretention	Wet Pond*	Biofiltration* (Swale or Filter Strip)
Coarse Sand or Cobbles	✕	✕	✕
Sand	✔	✕	✕
Loamy Sand	✔	✕	✔
Sandy Loam	✔	✕	✔
Loam	✕	✕	✔
Silt Loam	✕	✕	✔
Sandy Clay Loam	✕	✔	✔
Silty Clay Loam	✕	✔	✔
Sandy Clay	✕	✔	✔
Silty Clay	✕	✔	✕
Clay	✕	✔	✕

Notes:

✔ Indicates that use of the technology is generally appropriate for this soil type.

✕ Indicates that use of the technology is generally not appropriate for this soil type

* Coarser soils may be used for these facilities if a liner is installed to prevent infiltration, or if the soils are amended to reduce the infiltration rate.

Note: Sand filtration is not listed because its feasibility is not dependent on soil type.

Bioretention using engineered media may also be used for treatment.

3.2.3 Treatment Facility Menus

This section identifies choices that comprise the treatment facility menus. The menus in this chapter are discussed in the order of the decision process shown in Figure 3.1 and are as follows:

- Oil Control Menu
- Pretreatment Menu
- Infiltration Menu
- Phosphorus Treatment Menu
- Enhanced Treatment Menu

- Basic Treatment Menu

Use the menus below as follows:

1. Follow the step-by-step selection process for treatment facilities in Section 3.2.1.
2. If the project requires oil control, choose one option in the Oil Control Menu.
3. If infiltration for treatment in practicable, choose one option from the Pretreatment Menu and one option from the Infiltration Menu.
4. Find the treatment menu that applies to the project – Phosphorous, Enhanced or Basic – and select one option from the appropriate menu.
    a. If no options appear to work well for the project site and pollutants of concern, consider selecting an emerging technology as discussed in Section 3.4.7.
5. Detailed facility designs for many possible options are given in Book 2, Chapter 4 of this manual.

3.2.3.1 Oil Control Menu

Note: Where this menu is applicable, it is in addition to facilities required by one of the other Treatment Menus.

Performance Goal

The facility choices in the Oil Control Menu are intended to achieve the goals of no ongoing or recurring visible sheen in the discharge or in the receiving water, and to have a 24-hour average Total Petroleum Hydrocarbon (TPH) concentration no greater than 10 mg/l, and a maximum of 15 mg/l for a discrete sample (grab sample).

Options

Oil control options include facilities that are small, treat runoff from a limited area, and require frequent maintenance. The options also include facilities that treat runoff from larger areas and generally have less frequent maintenance needs.

- API-Type Oil/Water Separator (BMP T11.10)
- Coalescing Plate Oil/Water Separator (BMP T11.11)
- Linear Sand Filter (BMP T8.30)
- Proprietary BMPs:
    - Filterra® System
    - Filterra® Boxless™

- Emerging Technology (see Section 3.4.7)

Note: The linear sand filter is used in the Basic, Enhanced, and Phosphorus Treatment menus also. If used to satisfy one of those treatment requirements, the same facility cannot also be used to satisfy the oil control requirement.

3.2.3.2 Pretreatment Menu

Options

Any one of the following options may be chosen to satisfy the pretreatment requirement.

- Presettling Basin (BMP T6.10)
- Any Basic Treatment BMP (see Basic Treatment Menu, below)
- Emerging Technology (see Section 3.4.7)

3.2.3.3 Infiltration Treatment Menu

Options

Any one of the following options may be chosen if infiltration for treatment can meet the applicable criteria of this manual and the site soils meet minimum soil criteria for treatment in accordance with Section 3.2.2.1, Soil Type.

- Infiltration Basin (also see Book 2, Chapter 5)
- Infiltration Trench (also see Book 2, Chapter 5)
- Bioretention (BMP T5.14B) (also see Book 2, Chapter 2)
- Permeable Pavement (BMP T5.15) (also see Book 2, Chapter 2)

3.2.3.4 Phosphorus Treatment Menu

Performance Goal

The Phosphorus Menu facility choices are intended to achieve a goal of 50% total phosphorus removal for a range of influent concentrations of 0.1 – 0.5 mg/l total phosphorus. In addition, the choices are intended to achieve the Basic Treatment performance goal. The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable.

Options

Any one of the following options may be chosen to satisfy the phosphorus treatment requirement.

- Large Sand Filter (BMP T8.11)
- Large Wetpond (BMP T10.10)

Note: If a Large Wetpond is used to satisfy the phosphorus treatment requirements, the same facility cannot be used to meet the enhanced treatment requirement too.

- Proprietary BMPs:
    - Filterra® System
    - Filterra® Boxless™
    - FloGard Perk Filter®
- Two-Facility Treatment Train (see Table 3.2)
- Infiltration (Chapter 4) with appropriate pretreatment

  If infiltration is through soils meeting treatment requirements, then a presettling basin or a basic treatment facility can serve for pretreatment.
- Infiltration preceded by Basic Treatment

  If infiltration is through soils that do not meet treatment requirements, treatment must be provided by a basic treatment facility unless the soil and site fit the description in the next option below.
- Infiltration preceded by Phosphorus Treatment

  If the soils do not meet treatment requirements and the infiltration site is within ¼ mile of a phosphorus-sensitive receiving water, or a tributary to that water, treatment must be provided by a treatment facility option listed here:
    - Large Sand Filter (BMP T8.11)
    - Large Wetpond (BMP T10.10)
    - Two-Facility Treatment Train
    - Proprietary BMPs:
        - Filterra® System
        - Filterra® Boxless™
        - FloGard Perk Filter®
- Emerging Technology (see Section 3.4.7)

Table 3.2 Treatment Trains for Phosphorous Removal

First Basic Treatment Facility	Second Treatment Facility
Biofiltration Swale	Basic Sand Filter or Sand Filter Vault
Filter Strip	Linear Sand Filter (no presettling needed)
Linear Sand Filter	Filter Strip
Basic Wetpond	Basic Sand Filter or Sand Filter Vault
Wetvault	Basic Sand Filter or Sand Filter Vault
Stormwater Treatment Wetland	Basic Sand Filter or Sand Filter Vault
Basic Combined Detention and Wetpool	Basic Sand Filter or Sand Filter Vault

3.2.3.5 Enhanced Treatment Menu

Performance Goal

The Enhanced Menu facility choices are intended to provide a higher rate of removal of dissolved metals than Basic Treatment facilities (greater than 30% dissolved copper removal, and greater than 60% dissolved zinc removal). In addition, the menu choices are intended to achieve the Basic Treatment performance goal. The performance goal assumes that the facility is treating stormwater with dissolved Copper typically ranging from 0.005 to 0.02 mg/l, and dissolved Zinc ranging from 0.02 to 0.3 mg/l.

The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable.

Options

Any one of the following options may be chosen to satisfy the enhanced treatment requirement:

- Large Sand Filter (BMP T8.11)
- Stormwater Treatment Wetland (BMP T10.30)
- Compost-amended Vegetated Filter Strip (CAVFS) (BMP T7.40)
- Two Facility Treatment Trains (See Table 3.3)
- Bioretention, when 91% of the influent runoff infiltrates through the imported soil mix (BMP T5.14B)
- Media Filter Drain (MFD) (BMP T8.40)
- Proprietary BMPs:

- Filterra® System
- Filterra® Boxless™

- Infiltration (Chapter 4) with appropriate pretreatment
  - Infiltration Treatment - If infiltration is through soils meeting treatment requirements (see Section 3.2.2.1), a presettling basin or a basic treatment facility can serve for pretreatment.
  - Infiltration preceded by Basic Treatment - If infiltration is through soils that do not meet treatment requirements per Section 3.2.2.1, treatment must be provided by a basic treatment facility unless the soil and site fit the description in the next option below.
  - Infiltration preceded by Enhanced Treatment - If the soils do not meet treatment requirements per Section 3.2.2.1 and the infiltration site is within ¼ mile of a fresh water designated for aquatic life use or that has an existing aquatic life use, treatment must be provided by one of the other treatment facility options listed above.
- Emerging Technology (see Section 3.4.7)

Table 3.3 Treatment Trains for Dissolved Metals Removal

First Basic Treatment Facility	Second Treatment Facility
Biofiltration Swale	Basic Sand Filter or Sand Filter Vault or Media Filter(1)
Filter Strip	Linear Sand Filter with no presettling cell needed
Linear Sand Filter	Filter Strip
Basic Wetpond	Basic Sand Filter or Sand Filter Vault or Media Filter(1)
Wetvault	Basic Sand Filter or Sand Filter Vault or Media Filter(1)
Basic Combined Detention/Wetpool	Basic Sand Filter or Sand Filter Vault or Media Filter(1)
Basic Sand Filter or Sand Filter Vault with a presettling cell if the filter isn't preceded by a detention facility	Media Filter(1)

(1) The media must be a type approved for basic or enhanced treatment use by Ecology. See "Emerging Technologies" on page 139 for approved media filters.

3.2.3.6 Basic Treatment Menu

Performance Goal

The Basic Treatment Menu facility choices are intended to achieve 80% removal of total suspended solids for influent concentrations that are greater than 100 mg/l, but less than 200 mg/l. For influent concentrations greater than 200 mg/l, a higher treatment goal may be appropriate. For influent concentrations less than 100 mg/l, the facilities are intended to achieve an effluent goal of 20 mg/l total suspended solids.

The performance goal applies to the water quality design storm volume or flow rate, whichever is applicable. The performance goal assumes that the facility is treating stormwater with a typical particle size distribution (see stormwater monitoring protocol on the Department of Ecology website).

Options

Any one of the following options may be chosen to satisfy the basic treatment requirement:

- Infiltration Treatment
- Sand Filters (BMP T8.10; BMP T8.11; BMP T8.20; BMP T 8.30)
- Basic and Wet Biofiltration Swales (BMP T9.10 and BMPT9.20)
- Basic Filter Strip (BMP T9.40)
- Compost-amended Vegetated Filter Strip (CAVFS) (BMP T7.40)
- Basic Wetpond (BMP T10.10)
- Wetvault (BMP T10.20)

  A wetvault may be used for commercial, industrial, or road projects if there are space limitations. Clark County discourages the use of wetvaults for residential projects. Combined detention/wetvaults are allowed.

- Stormwater Treatment Wetland (BMP T10.30)
- Combined Detention and Wetpool Facilities (BMP T10.40)
- Bioretention (BMP T5.14B)

  Where bioretention is intended to fully meet treatment requirements for its drainage area, it must be designed, using an approved continuous flow model, to pass at least 91% of the influent runoff file through the imported soil mix.

- Media Filter Drain (MFD) (BMP T8.40)
- Proprietary BMPs:
    - Filterra® System

    - Filterra® Boxless™
    - StormFilter® (using ZPG Media)
    - FloGard Perk Filter®
- Emerging Technology (see Section 3.4.7)

Where media filters are used as the second BMP in a treatment train, consider whether the flow rate to the filter vault is high enough to ensure activation of the filters. Consult with the manufacturer for requirements.

3.3 Pretreatment BMPs

3.3.1 Purpose and Description

This section presents the methods that may be used to provide pretreatment prior to basic or enhanced runoff treatment facilities.

Presettling basins are a typical pretreatment BMP used to remove suspended solids. All of the basic runoff treatment facilities may also be used for pretreatment to reduce suspended solids.

A detention pond sized to meet the flow control standard in Chapter 1, Minimum Requirement #7, may be used to provide pretreatment for suspended solids removal.

3.3.2 Applications and Limitations

Pretreatment must be provided in the following applications.

- For sand filters and infiltration BMPs to protect them from excessive siltation and debris.

3.3.3 Best Management Practices (BMPs) for Pretreatment

This section has only one non-proprietary BMP for pretreatment. Note that pretreatment may also be provided by any Basic Treatment BMP, including Proprietary BMPs approved for Basic Treatment.

3.3.3.1 Purpose and Description

A Presettling Basin provides pretreatment of runoff in order to remove suspended solids, which can impact other runoff treatment BMPs.

3.3.3.2 Application, Limitations and Setbacks

- Runoff treated by a Presettling Basin may not be discharged directly to a receiving water; it must be further treated by a basic or enhanced runoff treatment BMP.

- All facilities shall be a minimum of 20 feet from any structure, property line, and any critical area buffer.
- All facilities shall be 100 feet from any septic tank/drainfield (except wet vaults shall be a minimum of 20 feet).
- All facilities shall be a minimum of 50 feet from any steep (greater than 15 percent) slope. A geotechnical report must address the potential impact of a wet pond on a steep slope.
- Embankments that impound water must comply with the Washington State Dam Safety Regulations (Chapter 173-175 WAC). If the impoundment has a storage capacity (including both water and sediment storage volumes) greater than 10 acre-feet (435,600 cubic feet or 3.26 million gallons) above natural ground level, then dam safety design and review are required by Ecology.

3.3.3.3 Pretreatment BMPs List

The following BMPs may be used for Pretreatment. See Book 2, Chapter 4 for specific design criteria.

- BMP T6.10: Presettling Basin
- Any Basic Treatment BMP (see Basic Treatment Menu, above)

3.4 Runoff Treatment BMPs

3.4.1 Oil and Water Separators

This section provides a discussion of oil and water separators, including their application and design criteria. BMPs are described for baffle type and coalescing plate separators.

3.4.1.1 Purpose and Description

Oil and water separators remove oil and other water-insoluble hydrocarbons as well as settleable solids from stormwater runoff.

See Book 2, Chapters 3 and 4 for specific design criteria for the two typical configurations of oil and water separators:

- BMP T11.10: The American Petroleum Institute (API) (also called baffle type) (American Petroleum Institute, 1990).
- BMP T11.11: The coalescing plate (CP) type using a gravity mechanism for separation.

Oil removal separators typically consist of three bays: forebay, separator section, and the afterbay. The CP separators need considerably less space for separation of the floating oil due to the shorter travel distances between parallel plates. A spill control manhole is a simple catch basin with a T-inlet for temporarily trapping small volumes of oil. The spill control manhole may be used for source control (see Book 3) and is included here for comparison only; it is not designed for, or to be used for, treatment purposes.

3.4.1.2 Applications and Limitations

Pretreatment should be considered if the level of TSS in the inlet flow would cause clogging or otherwise impair the long-term efficiency of the separator.

For low concentrations of oil, other treatments may be more applicable. These include sand filters and emerging technologies.

There is concern that oil/water separators used for stormwater treatment have not performed to expectations.(Watershed Protection Techniques, 1994; Schueler, Thomas R., 1992) Therefore, emphasis should be given to proper application, design, maintenance (particularly sludge and oil removal), and prevention of fouling and plugging of the coalescing plate.(US Army of Engineers, 1994) Other treatment systems, such as sand filters and emerging technologies, should be considered for the removal of insoluble oil and TPH.

The following information should be considered when considering the use of API or CP oil/water separators:

- If practicable, determine oil/grease (or TPH) and TSS concentrations, lowest temperature, pH; and empirical oil rise rates in the runoff, and the viscosity, and specific gravity of the oil. Also determine whether the oil is emulsified or dissolved. (Washington State Department of Ecology, 1995). Do not use oil/water separators for the removal of dissolved or emulsified oils such as coolants, soluble lubricants, glycols, and alcohols.
- Locate the separator off-line and bypass the incremental portion of flows that exceed the off-line 15-minute, Water Quality design flow rate multiplied by the ratio indicated in Book 2, Figure 4.3. If it is necessary to locate the separator on-line, try to minimize the size of the area needing oil control, and use the on-line water quality design flow rate multiplied by the ratio indicated in Book 2, Figure 4.2.
- Use only impervious conveyances for oil contaminated stormwater.
- Specify appropriate performance tests after installation and shakedown, and/or certification by a professional engineer that the separator is functioning in accordance with design objectives. Expeditious corrective actions must be taken if it is determined the separator is not achieving acceptable performance levels.
- Add pretreatment for TSS that could cause clogging of the CP separator, or otherwise impair the long-term effectiveness of the separator.

3.4.1.3 Performance Objectives

Oil and water separators should be designed to achieve the goals of no ongoing or recurring visible sheen in the discharge or in the receiving water and to have a 24-hour average Total Petroleum

Hydrocarbon (TPH) concentration no greater than 10 mg/l, and a maximum of 15 mg/l for a discrete sample (grab sample).

3.4.1.4 Oil and Water Separator BMPs

The following BMPs may be used for Oil Control:

- BMP T11.10: API (Baffle type) Separator Bay
- BMP T11.11: Coalescing Plate Separator

3.4.2 Sand Filter Treatment BMPs

3.4.2.1 Purpose and Description

This section presents criteria for the design, construction and maintenance of runoff treatment sand filters including basin, vault, and linear filters.

Sand filtration treatment facilities collect and treat design runoff volumes to remove total suspended solids (TSS), phosphorus, and insoluble organics (including oils) from stormwater. A typical sand filtration system consists of a pretreatment system, flow spreader(s), sand bed, and underdrain piping. The sand filter bed includes a geotextile fabric between the sand bed and the bottom underdrain system.

The variations of a sand filter include a basic sand filter basin, large sand filter basin, sand filter vault, and linear sand filter. Various sand filter configurations are given in Book 2, Chapter 4.

3.4.2.2 Applications and Limitations

Sand filtration can be used in most residential, commercial, and industrial developments where debris, heavy sediment loads, and oils and greases will not clog or prematurely overload the sand, or where adequate pretreatment is provided for these pollutants.

Locate sand filters off-line before or after detention (Chang, 2000). Sand filters are also suited for locations with space constraints in retrofit, and new/redevelopment situations. Size off-line systems to treat 91% of the runoff volume predicted by an approved continuous flow model. If a project must comply with Minimum Requirement #7, Flow Control, design an overflow of bypass structure to route flows from larger storms to a retention/detention facility.

Pretreatment is necessary to reduce velocities to the sand filter and remove debris, floatables, large particulate matter, and oils. In high water table areas, adequate drainage of the sand filter may require additional engineering analysis and design considerations. Consider an underground filter in areas subject to freezing conditions (Urbonas, 1997).

3.4.2.3 Site Suitability

Consider the following site characteristics when considering a sand filtration system:

- Space availability, including room for a presettling basin
- Sufficient hydraulic head, at least 4 feet from inlet to outlet
- Adequate operation and maintenance capability including accessibility requirements for O & M
- Pretreatment requirements for oil, debris and solids in the tributary runoff

3.4.2.4 Performance Objectives

Basic and Large Sand Filter

Basic sand filters are intended to achieve the following average pollutant removals:

- Basic Performance Treatment Goal: 80% total suspended solids (TSS) at influent Event Mean Concentrations (EMCs) of 100-200 mg/L.
- Oil Performance Treatment Goal: Oil and grease to below 10 mg/L daily average and 15 mg/L at any time, with no ongoing or recurring visible sheen in the discharge.

Large Sand Filter

Large sand filters are intended to meet the Phosphorous Treatment Goal by removing at least 50% of the total phosphorus compounds (influent 0.1 to 0.5 mg/l, as total phosphorus) and by collecting and treating 95% of the runoff volume. (ASCE and WEF, 1998)

3.4.2.5 Best Management Practices (BMPs) for Sand Filtration

The following BMPs are Sand Filtration BMPs:

- BMP T8.10: Basic Sand Filter Basin
- BMP T8.11: Large Sand Filter Basin
- BMP T8.20: Sand Filter Vault
- BMP T8.30: Linear Sand Filter

3.4.3 Media Filter Drains

3.4.3.1 Purpose and Description

The media filter drain (MFD), previously referred to as the ecology embankment, is a linear flow-through stormwater runoff treatment device that can be sited along street or highway side slopes (conventional design) and medians (dual media filter drains), borrow ditches, or other linear depressions. Cut-slope applications may also be considered. The media filter drain can be used where available right of way is limited, sheet flow from the street surface is feasible, and lateral gradients are generally less than 25% (4H:1V).

The Media Filter Drain (MFD) has four basic components: a gravel no-vegetation zone, a grass strip, the MFD mix bed, and a conveyance system for flows leaving the MFD mix. The MFD mix is composed of gravel, perlite, dolomite, and gypsum.

3.4.3.2 Applications and Limitations

Applications

The media filter drain and the dual media filter drain designs are runoff treatment options that can be sited in most right of way confined situations. In many cases, a media filter drain or a dual media filter drain can be sited without the acquisition of additional right of way needed for conventional stormwater facilities or capital-intensive expenditures for underground wet vaults.

Since maintaining sheet flow across the media filter drain is required for its proper function, the ideal locations for media filter drains are along long, linear grades with lateral side slopes less than 4H:1V and longitudinal slopes no steeper than 5%. As side slopes approach 3H:1V, without design modifications, sloughing may become a problem due to friction limitations between the separation geotextile and underlying soils. The longest flow path from the contributing area delivering sheet flow to the media filter drain should not exceed 150 feet.

Limitations

- Steep slopes. Avoid construction on longitudinal slopes steeper than 5%. Avoid construction on 3H:1V lateral slopes, and preferably use less than 4H:1V slopes. In areas where lateral slopes exceed 4H:1V, it may be possible to construct terraces to create 4H:1V slopes or to otherwise stabilize up to 3H:1V slopes. (For details, see Geometry, Components and Sizing Criteria, Cross Section in the Structural Design Considerations section below).
- Wetlands. Do not construct in wetlands and wetland buffers. In many cases, a media filter drain (due to its small lateral footprint) can fit within the highway fill slopes adjacent to a wetland buffer. In those situations where the highway fill prism is located adjacent to wetlands, an interception trench/underdrain will need to be incorporated as a design element in the media filter drain.
- Shallow groundwater. Mean high water table levels at the project site need to be determined to ensure the media filter drain mix bed and the underdrain (if needed) will not become saturated by shallow groundwater.
- Unstable slopes. In areas where slope stability may be problematic, consult a geotechnical engineer.

For more information on Media Filter Drains consult WSDOT's *Highway Runoff Manual*.

3.4.3.3 Performance Objectives

Media filter drains are intended to achieve the:

- Basic Treatment Goal
- Phosphorous Treatment Goal
- Enhanced Treatment Goals: greater than 30% reduction of dissolved copper, and greater than 60% reduction of dissolved zinc.

3.4.4 Biofiltration Treatment BMPs

3.4.4.1 Purpose and Description

This section discusses biofiltration treatment facilities such as swales and filter strips. These include biofiltration swales, wet biofiltration swales, continuous inflow swales, and filter strips.

Wet biofiltration swales are used where a grassy biofiltration swale is desired but not allowed or advisable because one or more of the following conditions exist:

- The swale is on clay soils and is downstream of a detention pond providing flow control.
- Saturated soil conditions are likely because of seeps or base flows on the site.
- Longitudinal slopes are slight (generally less than 2 percent).
- The swale is part of a treatment train.

A continuous inflow biofiltration swale is to be used when inflows are not concentrated, such as locations along the shoulder of a road without curbs. This design may also be used where frequent, small point flows enter a swale, such as through curb inlet ports spaced at intervals along a road, or from a parking lot with frequent curb cuts. In general, no inlet port should carry more than about 10 percent of the flow.

A continuous inflow swale is not appropriate for a situation in which significant lateral flows enter a swale at some point downstream from the head of the swale. In this situation, the swale width and length must be recalculated from the point of confluence to the discharge point in order to provide adequate treatment for the increased flows.

3.4.4.2 Applications and Limitations

Biofiltration can be used as a basic treatment BMP for stormwater runoff from roadways, driveways, parking lots, and highly impervious ultra-urban areas or as the first stage of a treatment train. In cases where hydrocarbons, high TSS, or debris would be present in the runoff, such as high-use sites, a pretreatment system for those components is necessary. An off-line location is preferred to avoid flattening vegetation and the erosive effects of high flows. Consider biofilters in retrofit situations where appropriate.

Data suggest that the performance of biofiltration swales is highly variable from storm to storm. Clark County recommends considering other treatment methods that perform more consistently, such as sand filters, wet ponds, filter vaults and bioretention before choosing a biofiltration swale.

The basic filter strip is typically used on-line and adjacent and parallel to paved areas such as parking lots, driveways, and roadways.

3.4.4.3 Site Suitability

Consider the following factors for determining site suitability:

- Target pollutants that can be treated by biofiltration.
- Accessibility requirements for Operation and Maintenance.
- Suitable growth environment (soil, etc.) for the vegetation.
- Adequate siting for a pretreatment facility if high petroleum hydrocarbon levels (oil/grease) or high TSS loads could impair treatment capacity or efficiency.

3.4.4.4 Best Management Practices (BMPs) for Biofiltration

The following BMPs are Biofiltration BMPs:

- BMP T9.10: Basic Grassy Biofiltration Swale
- BMP T9.20: Wet Biofiltration Swale
- BMP T9.30: Continuous Inflow Biofiltration Swale
- BMP T9:40: Basic Filter Strip
- BMP T7.40: Compost-amended Vegetated Filter Strip (CAVFS)

3.4.5 Wetpool Facilities

3.4.5.1 Purpose and Description

This section presents the methods, criteria, and details for analysis and design of wetponds, wetvaults, and stormwater wetlands.

These facilities have as a common element a permanent pool of water - the wetpool. Each of the wetpool facilities can be joined with a detention or flow control pond in a combined facility.

3.4.5.2 Applications and Limitations

A wetpond can be integrated to the contours of a site fairly easily. In clayey soils and where groundwater is near the land surface, the wetpond holds a permanent pool of water. In more porous soils, wetponds may still be used, but water seepage from unlined cells could result in a dry pond, particularly in the summer months. Lining the first cell with a low permeability liner is one way to deal with this situation. As long as the first cell retains a permanent pool of water during the wet season, this situation will not reduce the pond's effectiveness but may be an aesthetic drawback.

Wetponds work best when the water already in the pond is moved out en masse by incoming flows, a phenomenon called "plug flow." Because treatment works on this displacement principle, the wetpool storage of wetponds may be provided below the groundwater level without interfering unduly with treatment effectiveness. However, if combined with a detention function, the live storage must be above the seasonal high groundwater level.

Wetponds may be single-purpose facilities, providing only runoff treatment, or they may be combined with a detention pond to also provide flow control. If combined, the wetpond can often be stacked under the detention pond with little further loss of development area. See BMP T10.40 for a description of combined detention and wetpool facilities.

A wetvault may be used for commercial, industrial, or roadway projects if there are space limitations precluding the use of other treatment BMPs. The use of wetvaults for residential development is highly discouraged. Combined detention and wetvaults are allowed; see BMP T10.40.

The stormwater wetland design occupies about the same surface area as wetponds, but has the potential for better aesthetic integration because of the abundance of emergent aquatic vegetation. The most critical factor for a successful design is the provision of an adequate supply of water for most of the year. Careful planning is needed to ensure sufficient water will be retained to sustain good wetland plant growth. Since water depths are shallower than in wetponds, water loss by evaporation is an important concern. Stormwater wetlands are a good stormwater treatment facility choice in areas with high winter groundwater levels

Note that BMP T10.40 includes a treatment wetland with detention.

The basis for pollutant removal in combined facilities is the same as in the stand-alone water quality facilities. However, in the combined facility, the detention function creates fluctuating water levels and adds turbulence. For simplicity, the positive effect of the extra live storage volume and the negative effect of increased turbulence are assumed to balance, and are thus ignored when sizing the wetpool volume. For the combined detention/stormwater wetland, criteria that limit the extent of water level fluctuation are specified to better ensure survival of the wetland plants.

Unlike the wetpool volume, the live storage component of the facility should be provided above the seasonal high water table.

3.4.5.3 Best Management Practices (BMPs) for Wetpool Facilities

The four BMPs listed are currently recognized as effective treatment techniques using wetpool facilities. Select the appropriate BMPs using the Step-by-Step process and the Treatment Facility Menus in Section 3.2.3.

- BMP T10.10: Wetpond – Basic and Large

- BMP T10.20: Wetvault
- BMP T10.30: Stormwater Treatment Wetland
- BMP T10.40: Combined Detention and Wetpool

3.4.6 Proprietary BMPs

As of the printing of this manual, the following proprietary BMPs are accepted by Clark County for applicable treatment uses:

- StormFilter® using ZPG Media is accepted for Basic Treatment.
- Filterra® System and Filterra® Boxless™ are accepted for Oil Treatment, Basic Treatment, Enhanced Treatment, and Phosphorous Treatment.
- Perk Filter® is accepted for Basic Treatment and Phosphorous Treatment.

Consult a BMPs manufacturer for design, specifications, and installation criteria.

Proprietary BMPs that have not been accepted by Clark County or that may emerge after the printing of this manual are known as Emerging Technologies. Section 3.4.7, below, discusses the use of Emerging Technologies in Clark County.

3.4.7 Emerging Technologies

3.4.7.1 Background

Traditional best management practices (BMPs) such as wetponds and filtration swales may not be appropriate in some situations due to size and space restraints or inability to remove target pollutants. Therefore the stormwater treatment industry emerged to develop new stormwater treatment devices.

Emerging technologies are stormwater treatment devices that are new to the stormwater treatment marketplace. These devices include both permanent and construction site treatment technologies. Many of these devices have not undergone complete performance testing so their performance claims cannot be verified. Emerging technologies often lack a documented maintenance history that supports understanding long-term operational costs.

Washington State Department of Ecology developed the Technology Assessment Protocol – Ecology (TAPE) and Chemical Technology Assessment Protocol Ecology (CTAPE) protocols to help local governments in selecting new stormwater treatment technologies. Ecology posts information on emerging technologies at the emerging technologies website: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Use Levels for Emerging Technologies

Ecology's use level designations describe how an emerging technology may be used in Washington. There are three use level designations: pilot use level designation, conditional use level designation, and general use level designation.

Ecology lists technologies that have obtained a use level designation through the TAPE process on its Emerging Technologies website:
http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html.

Pilot Use Level Designation (PULD)

For technologies that have limited performance data, the pilot use level designation allows limited use to conduct field-testing

Conditional Use Level Designation (CULD)

Ecology may give a conditional use level designation if a manufacturer collected field data through a protocol reasonably consistent with but not fully meeting the TAPE protocol. Conditional Use Level Designations have monitoring requirements and expiration dates. Therefore it is uncertain whether they will eventually receive approvable for general use.

General Use Level Designation (GULD)

The general use level designation (GULD) confers a general acceptance for the specified applications (land uses). General Use Level Designation BMPs may be used for new development, redevelopment, or retrofit situations anywhere in Washington, subject to conditions that Ecology places within the Use Designation document.

3.4.7.2 Using Emerging Technology BMPs in Clark County

Clark County accepts several Proprietary BMPs as listed in Section 3.4.6 of this manual.

For Emerging Technologies arising after the publication of this manual, the Responsible Official maintains a list of BMPs accepted by Clark County. Applicants may petition the Responsible Official to include an Emerging Technology on the approved list.

Information the Responsible Official may consider before including a new Emerging Technology on the approved list includes:

- Equivalence with the most current *Stormwater Management Manual for Western Washington* – Washington Department of Ecology approval level.
- Cost of maintenance – information describing the nature and frequency of maintenance actions and materials costs to predict maintenance costs, knowledge to maintain the BMP, and capital costs for maintenance equipment.

- Ease of access – degree of need for confined space entry. Equipment required to perform maintenance.
- Worker safety – the BMP's typical location (e.g. street, tract, etc.), weights of components or materials to be lifted and confined space concerns.
- Long-term serviceability – demonstrated track record of the manufacturer. Ramifications if the manufacturer goes out of business. The use of the BMP regionally or nationally.
- Sole source availability – replacement parts and media are available from more than one source.

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Chapter 4 Flow Control

Chapter Contents

Chapter Tables

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4.1 Introduction

4.1.1 Purpose

This chapter presents methods, criteria, and details for analysis and selection of flow control BMPs. Flow control facilities are detention or infiltration facilities engineered to meet the flow control standards specified in Minimum Requirement #7. This chapter can also be used to meet the LID Performance Standard for Minimum Requirement #5.

4.1.2 How to Use this Chapter

The standards of this chapter must be used to select flow control facilities that meet Minimum Requirement #7.

4.2 Flow Control BMP Selection

Minimum Requirement #7 (Flow Control) includes area thresholds that determine applicability. Those thresholds determine whether each threshold discharge area (TDA) of a project must use flow control facilities designed by a professional engineer. TDAs falling under the threshold may only need to meet Minimum Requirement #5 (On-Site Stormwater Management). The following outlines steps in selecting Flow Control Facilities.

1. Read the definitions in Appendix 1-A to become acquainted with the following terms: effective impervious surface, impervious surface, hard surface, pollution-generating impervious surface (PGIS), pollution-generating hard surface (PGHS), pollution-generating pervious surface (PGPS), converted vegetation areas, and threshold discharge area.

2. Outline the threshold discharge areas (TDA) for the project site.

3. Determine the area of pollution-generating hard surfaces (including pollution-generating permeable pavements) and pollution-generating pervious surfaces (not including permeable pavements) in each TDA. Compare those totals to the project thresholds in Section 1.5.7 to determine where flow control facilities are required. Note that On-site Stormwater Management BMPs (Minimum Requirement #5) are always applicable.

4. Compute the totals for effective impervious surface and converted vegetation areas in each TDA. Compare those totals to the project thresholds in Section 1.5.7.2 to determine if flow control facilities are required.

5. Select Flow Control BMPs and Facilities. On-site Stormwater Management BMPs must be applied to the maximum extent practicable in accordance with Minimum Requirement #5. In addition, flow control facilities must be provided for discharges from those threshold discharge areas that exceed the Minimum Requirement #7 thresholds. Use an approved

continuous flow model and Chapter 5 (infiltration) and Chapter 6 (Detention) in Book 2 to size and design flow control facilities.

6. Select either an infiltration facility and/or a detention facility to meet Minimum Requirement #7, using the following criteria:

A: Determine whether the site is suitable for infiltration.

Perform the site characterization study per Section 4.3.1.2 and infiltration testing per Section 4.3.1.3 to determine if infiltration is feasible to meet Minimum Requirement #7. If infiltration is feasible, use the design criteria for infiltration basins, drywells, or trenches in Book 2, Chapter 5 to design these facilities.

Note that if the soils are suitable, infiltration can be used to meet runoff treatment (Minimum Requirement #6) and flow control (Minimum Requirement #7) requirements. However, since such a facility would have to be located on-line it would be quite large in order to achieve the flow duration standard of Minimum Requirement #7. See Chapter 3 for more information about using infiltration to meet the runoff treatment standard.

B: If infiltration is not feasible, detention facilities must be used to meet Minimum Requirement #7. These facilities must be sized using an approved continuous flow model. Refer to Book 2, Chapter 6 for Detention Facility design.

Note that the more the site is left undisturbed, and the fewer impervious surfaces are created, the smaller the detention facility. In addition, the greater the use of On-site Stormwater Management BMPs, the smaller the detention facility.

4.3 Flow Control BMPs

4.3.1 Infiltration Facilities

Infiltration facilities for flow control are used to reduce the volume and rate of stormwater runoff by conveying flows from new development or redevelopment to the ground after appropriate treatment. Proper design of infiltration facilities requires careful determination of the infiltration rates on the project site.

The following steps must be followed in the selection of infiltration as a flow control BMP:

1. Select a site or sites for potential infiltration facilities and pretreatment facilities.

2. Perform a site characterization study as described in Section 4.3.1.2. The information from this study must be included in the Soils Report (See Section 1.8.3).

3. Perform field tests and determine the field measured coefficient of permeability (the infiltration rate) as described in Section 4.3.1.3 and Appendix 1-C.

4. Apply correction factors per Section 4.3.1.3 to determine the design infiltration rate.

5. Determine if infiltration is feasible (i.e. the infiltration rate is high enough that infiltration of stormwater meeting Minimum Requirement #7 is feasible) and if so select an infiltration BMP.

6. If infiltration is feasible, size the facilities using the design criteria in Book 2, Chapter 5.

Typical BMPs for infiltration include infiltration ponds, infiltration trenches, drywells, and perforated pipe.

4.3.1.1 Regulatory Requirements

Washington State Department of Ecology Underground Injection Control

Below-surface stormwater infiltration facilities, such as drywells and perforated pipes, are classified by Ecology as Underground Injection Control (UIC) wells (See Underground Injection Control Program, Chapter 173-218 WAC). The two major requirements of Ecology's UIC regulations are to register UIC wells with the Washington State Department of Ecology prior to their installation and to make sure that underground sources of groundwater are not endangered by pollutants in the discharge (Non-Endangerment Standard). These regulations have requirements on minimum depth to groundwater (5 feet), as well as siting and installation requirements. They also list development activities that are prohibited from using UICs.

Ecology's UIC guidelines, as found in *Guidance for UIC Wells that Manage Stormwater* (Ecology 2006), provides information on what is classified as a UIC, provides design information that must be followed for UIC installation, and provides information on requirements to meet the Non-endangerment Standard.

Clark County requires verification of UIC registration before approval of final plans. Where UIC regulations conflict with County code, the more stringent of the two regulations shall apply, as determined by the Responsible Official.

Clark County Code 40.410 CARA

The county's Critical Aquifer Recharge Area (CARA) regulation, CCC 40.410, prohibits placement of Class V injection wells in Category I CARAs and requires a permit for placement of Class V injection wells for certain non-residential developments in Category II CARAs. Consult CCC 40.410

for further information, and see Maps Online at Clark County's web site for the locations of CARAs (http://gis.clark.wa.gov/mapsonline/).

4.3.1.2 Site Characterization Study

One of the first steps in siting and designing infiltration facilities is to conduct a site characterization study. This study must include the following steps.

Step 1: Surface Features Characterization

1. Gather information on the following site features:
    - Topography within 500 feet of the proposed facility.
    - Location of water supply wells within 500 feet of proposed facility.
    - Location of CARAs regulated under Chapter 40.410 within 500 feet of the proposed facility.
    - A description of local site geology, including soil or rock units likely to be encountered, the groundwater regime, and geologic history of the site.
2. Review the following site suitability criteria. When a site investigation reveals that any of the criteria in this section cannot be met, consider appropriate measures such as relocation or resizing so that the infiltration facility will not pose a threat to safety, health, and the environment and meet the requirements in this section.
    a. Setback Criteria: Setback requirements are listed in Table 4.1.

Table 4.1: Stormwater Infiltration Facility Setbacks

Stormwater infiltration facility setback from:	Distance
Drinking water wells	100 feet minimum
Building foundations	20 feet minimum from the downslope side of foundations 100 feet minimum from the upslope side of foundations These setbacks may be increased or decreased based on engineering analysis that shows the performance of the building's foundation system will not be adversely affected by the presence of the stormwater facility
Slopes equal to or greater than 15%	50 feet minimum from the crests of slopes. This setback may be increased or decreased based on engineering analysis that shows the stability of the slope will not be adversely affected by the presence of the stormwater facility.
Property lines	20 feet from any property line. However, if an infiltration trench is a common system shared by the two or more adjacent lots and contained within an easement for maintenance given to owners of all lots draining to the system, then the setback from the property line(s) shared by the adjacent lots may be waived.

b. Critical Aquifer Recharge Areas (CARA): Review Section 4.3.1.1 and CCC 40.410 for regulation regarding installation of infiltration facilities within CARA sites.

c. High Vehicle Traffic Areas: An infiltration BMP can be used in areas of industrial activity and the high vehicle traffic areas described below. For such applications, provide sufficient pollutant removal (including oil removal) upstream of the infiltration facility to ensure that groundwater quality standards will not be violated and that the infiltration facility will not be adversely affected. High Vehicle Traffic Areas are:

- Commercial or industrial sites subject to an expected average daily traffic count (ADT) ≥100 vehicles/1,000 ft² gross building area (trip generation).
- Road intersections with an ADT of ≥ 25,000 on the main roadway and ≥ 15,000 on any intersecting roadway.

Step 2: Subsurface Characterization

1. Subsurface explorations (test holes, wells or test pits) for site characterization should include:

   a. For drywells, at least one exploration per drywell(s) location.

b. For infiltration basins, at least one exploration per 5,000 ft^2 of basin infiltrating surface (in no case less than two per basin).

c. For infiltration trenches, at least one exploration per 200 feet of trench length (in no case less than two per trench).

NOTE: The depth and number of exploration, and samples can be adjusted, if in the judgment of an engineer with geotechnical expertise (P.E.), a geologist, engineering geologist, or hydrogeologist licensed in the State of Washington that the conditions are such that the changes still provide enough data to accurately estimate the performance of the infiltration system. Written proof shall be provided in the Soils Report (Section 1.8.3).

2. Subsurface explorations to a depth below the base of the infiltration facility of at least 5 times the maximum design depth of ponded water proposed for the infiltration facility, but not less than 10 feet below the base of the facility. At sites with shallow groundwater (less than 15 feet from the estimated base of facility), and where a groundwater mounding analysis is necessary, determine the thickness of the saturated zone. In high water table sites, the subsurface exploration sampling need not be conducted lower than two (2) feet below the groundwater table.

3. Continuous sampling (representative samples from each soil type and/or unit within the infiltration receptor) to a depth below the base of the infiltration facility of 2.5 times the maximum design ponded water depth, but not less than 10 feet. For large infiltration facilities serving drainage areas of 10 acres or more, sampling up to 50 or more feet may be required.

4. If using the soil grain size analysis method for estimating infiltration rates: laboratory testing as necessary to establish the soil gradation characteristics and other properties as necessary, to complete the infiltration facility design. At a minimum, conduct one grain size analysis per soil stratum in each test hole within 2.5 times the maximum design water depth, but not less than 10 feet. When assessing the soil characteristics of the site, soil layers at greater depths must be considered if the licensed professional conducting the investigation determines that deeper layers will influence the rate of infiltration for the facility, requiring soil gradation/classification testing for layers deeper than indicated above.

5. Prepare detailed logs for each test pit or test hole and a map showing the location of the test pits or test holes. Logs must include at a minimum, depth of pit or hole, soil descriptions, depth to water, presence of stratification. NOTE: Logs must substantiate whether stratification does or does not exist. The licensed professional may consider additional methods of analysis to substantiate the presence of stratification that will significantly impact the design of the infiltration facility.

6. Soil characterization for each soil unit (soils of the same texture, color, density, compaction, consolidation and permeability) encountered should include:

- Grain size distribution (ASTM D422 or equivalent AASHTO specification), if using the soil grain size analysis method to estimate infiltration rates;
- Visual grain size classification;
- Percent clay content (include type of clay, if known);
- Color/mottling;
- Variations and nature of stratification.

7. Locate the groundwater table and establish its gradient, direction of flow, and seasonal variations, considering the water table aquifer (defined as the uppermost aquifer in open conditions). Groundwater monitoring wells shall be installed to monitor variations in groundwater level through at least one wet season (October 1 through April 30).

8. For facilities serving a drainage area of one acre or over, one groundwater monitoring well shall be installed in each proposed infiltration facility location, unless:
   - GIS groundwater data from Clark County or available field information describing water table elevations within 500 feet of the site indicates that the seasonal high groundwater elevation is at least 15 feet below the base of the proposed facility. Examples of field information that can be used include public well records and groundwater monitoring reports from other development sites.; OR
   - The seasonal high groundwater elevation has been found to be at least 15 feet below the facility base from monitoring wells installed at the site where monitoring was conducted during at least one wet season in the preceding three years.

9. For facilities serving a drainage area less than one acre, establish that the depth to groundwater or other hydraulic restriction layer will be at least 10 feet below the base of the facility. This can be determined through the use groundwater monitoring wells as described above, through subsurface explorations or through information from nearby wells (500 feet or closer).

Step 3: Soil Testing

1. Field measured infiltration test to determine the coefficient of permeability must be conducted using one of the methods listed in Section 4.3.1.3.

2. If the infiltration facility will provide treatment the soil characterization must also include:
   - Cation exchange capacity (CEC) and organic matter content for each soil type and strata where distinct changes in soil properties occur, to a depth below the base of the facility of at least 2.5 times the maximum design water depth, but not less than 6 feet.

4.3.1.3 Coefficient of Permeability

Field-measured coefficient of permeability rates (also termed infiltration rates) can be determined using one of the three in-situ field measurements, or, if the site has unconsolidated and uncemented sediments, by a correlation to grain size distribution from soil samples. The latter method uses the ASTM soil size distribution test procedure (ASTM D422), which considers the full range of soil particle sizes, to develop soil size distribution curves.

Once the coefficient of permeability has been measured in the field, the design rate needs to be determined. This section discusses the procedures for adjusting the field-determined rate for use in designing facilities.

Field Measurements

Select one of the four methods described below to measure the field coefficient of permeability rate at the site. Use the field-measured coefficient of permeability to determine the design (long-term) infiltration rate. Then use the design (long-term) rate for routing and sizing the infiltration facility, and for checking for compliance with the maximum drawdown time of 48 hours. A detailed description of these test methods can be found in Appendix 1-C.

1. Modified Single-Ring Falling Head Test

   This test was developed by local (Clark County) geotechnical engineers and was approved for use by Ecology in Clark County's 2009 *Stormwater Manual*. More information on this test method can be found in ASCE 2009 and the methodology associated with this test is described in Appendix 1-C.

2. Large-Scale Pilot Infiltration Test (PIT)

   The Pilot Infiltration Test (PIT) is a field procedure for estimating the measured coefficient of permeability of the soil profile beneath the proposed infiltration facility. More information on this method can be found in Appendix 1-C.

3. Small-Scale Pilot Infiltration Test

   A small-scale PIT can be substituted for the large-scale PIT in any of the following instances:

   - The drainage area to the infiltration site is less than one acre.
   - The testing is for the LID BMPs of bioretention or permeable pavement that either serve small drainage areas (less than an acre) and /or are widely dispersed throughout a project site.
   - The site has a high infiltration rate, making a full-scale PIT difficult, and the site geotechnical investigation suggests uniform subsurface characteristics.
   - Site accessibility or safety concerns impede the ability to conduct a large-scale PIT.

4. Soil Grain Size Analysis Method

   If the site has unconsolidated or uncemented sediments, then measured coefficient of permeability rates can be determined by a correlation to grain size distribution from soil samples. This method uses the ASTM soil size distribution test procedure (ASTM D422), which considers the full range of soil particle sizes, to develop soil size distribution curves.

Correction Factors / Design Infiltration Rate

The coefficient of permeability obtained from the field tests above is a measured rate. This rate must be reduced through correction factors that are appropriate for the design situation to produce a design rate.

Correction factors account for site variability, number of tests conducted, uncertainty of the test method, and the potential for long-term clogging due to siltation and bio-buildup. Table 4.2 summarizes the typical range of correction factors to account for these issues. The specific correction factors used shall be determined based on the professional judgment of the licensed engineer considering all issues that may affect the infiltration rate over the long term, subject to the approval of Clark County.

The correction factors in Table 4.2 shall be used to establish the allowable infiltration rate for both the PIT test and the single-ring falling head test. The safety factor for a sacrificial system can be reduced if the system is designed to infiltrate runoff for a design event with a 2-year return period.

Table 4.2: Infiltration Rate Correction Factors

Base Correction Factor	
The base correction factor is meant to account for soil variability and long-term system degradation due to siltation, crusting, or other factors.	2
Soils Correction Factor	
Additive correction factor recommended by geotechnical professional as a result of soil or groundwater conditions.	Minimum value of 2, or greater as recommended by the geotechnical engineer
System Design Correction Factors	
If the infiltration facility serves a basin with an impervious area greater than 2 acres.	Add ½
If the infiltration facility serves a basin with an impervious area greater than 5 acres.	Add 1
Infiltration facilities in closed depressions.	Add 2
If a sacrificial system is provided and left operational following permanent site stabilization.	Subtract ½

4.3.2 Detention

This section presents criteria for selecting a detention facility to meet Minimum Requirement #7, while detailed design criteria are presented in Book 2, Chapter 6. Detention facilities provide for the temporary storage of increased surface water runoff resulting from development pursuant to the performance standards set forth in Minimum Requirement #7 for flow control. Detention facilities can also provide for retention of stormwater through infiltration in the bottom of the pond.

4.3.2.1 Detention Standard

Please see Section 1.5.7 for the standard requirements for meeting Minimum Requirement 7 using detention.

4.3.2.2 Applications and Limitations

1. Stormwater detention facilities that can impound 10 acre-feet (435,600 cubic feet; 3.26 million gallons) or more with the water level measured at the embankment crest are subject to the state's dam safety requirements, even if water storage is intermittent and infrequent (WAC 173-175-020(1)). For stormwater detention facilities, this means sizing the emergency spillway to accommodate the runoff from the dam safety design storm. Other dam safety requirements include geotechnical issues, construction inspection and documentation, dam breach analysis, inundation mapping, emergency action planning, and periodic inspections by project owners and by Dam Safety engineers. Electronic versions of the guidance documents are available on the Department of Ecology Web site at http://www.ecy.wa.gov/programs/wr/dams/dss.html.

2. Ponds must be designed as flow-through systems (however, parking lot storage may be utilized through a back-up system). Stormwater must enter through a conveyance system separate from the control structure and outflow conveyance system. Maximizing distance between the inlet and outlet is encouraged to promote sedimentation.

3. Pond bottoms should be level and located a minimum of 0.5 foot (preferably 1 foot) below the inlet and outlet to provide sediment storage.

4. A geotechnical analysis and report must be prepared for facilities associated with slopes over 15%, or if located within 200 feet of the top of a slope steeper than 40%, or landslide hazard area. The scope of the geotechnical report should include the assessment of impoundment seepage on the stability of the natural slope where the facility will be located within the setback limits set forth in this section.

4.3.2.3 Detention Ponds in Infiltrative Soils

Detention ponds may be sited on soils that are sufficiently permeable for a properly functioning infiltration system. These detention ponds have a surface discharge and may also utilize infiltration as a second pond outflow. Detention ponds sized with infiltration as a second outflow must meet all the requirements of this chapter, and Book 2, Chapter 5 for infiltration basins, including a soils report, testing, groundwater protection, presettling, and construction techniques.

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Chapter 5 Off-site Analysis

Chapter Contents

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5.1 Introduction

5.1.1 Purpose

This chapter provides requirements for off-site analysis and mitigation. These requirements are in addition to the minimum requirements identified in Chapter 1.The off-site analysis is a field investigation of downstream impacts on water quality and surface water conditions resulting from a development, redevelopment, or other land-disturbing activity.

5.1.2 How to Use this Chapter

An off-site analysis is required when a project that must meet Minimum Requirements #1 – #9 meets any of the following criteria:

- Adds 35,000 square feet or more of new pervious surface.
- Constructs or modifies a drainage pipe or ditch that is 12 inches or more in size/depth or that receives runoff from a drainage pipe or ditch that is 12 inches or more in size/depth.
- Contains or lies adjacent to a landslide, steep slope, or erosion hazard area.
- Is not exempt from Minimum Requirement #8.
- The project changes the rate, volume, duration, or location of discharges to and from the project site.

If any of the above criteria are met, the applicant shall complete the Qualitative Analysis in Section 5.2.1.

Depending upon the presence of existing or predicted flooding, erosion or water quality problems, and on the proposed design of the on-site drainage facilities, the County may require a qualitative analysis further downstream, mitigation measures, or a quantitative analysis.

Existing off-site impacts that are not affected by the project site do not require mitigation. However, in cases where the project site is the cause of the existing impact, the applicant shall mitigate for those impacts.

5.2 Off-site Analysis

5.2.1 Qualitative Analysis

The qualitative downstream analysis shall extend downstream for the entire flow path, from the project site to the receiving water, or up to one-quarter mile, whichever is less. The qualitative analysis may be stopped shorter than the required ¼ mile downstream if the analysis reaches a

County identified trunk main. Trunk mains are defined as public stormwater drainage pipes equal to or greater than 36 inches and installed at a minimum slope of 0.5%.

The upstream qualitative analysis shall identify and describe points where water enters the site and the tributary area that contributes water to those run-on locations.

A basin map delineating the on-site and off-site basin upstream and downstream for the site shall be provided. The basin map shall be to a defined scale and must show the receiving water body. Maps printed from the County's GIS website may be used as a base for the basin map, and to obtain contours and existing stormwater facility information. Field verification of county information may be required as directed by the Responsible Official. The following describes components (or tasks) of the qualitative analysis.

Task 1: Inspection of Conveyance System and Outfall

The existing conditions and potential impacts to be evaluated shall include, at a minimum, but not be limited to:

1. Erosion at outfalls
2. Conveyance system capacity.
3. Localized flooding.

The design engineer shall physically inspect the existing on-site and off-site drainage systems of the study area for each discharge location for existing or potential problems and drainage features. An inspection and investigation shall include the following:

1. Collect information on pipe sizes, channel characteristics, and drainage structures.
2. Identify existing/potential constrictions or capacity deficiencies in the drainage system.
3. Identify existing/potential flooding problems.
4. Identify existing/potential erosion, scouring, or bank sloughing at outfalls.
5. Note date and weather at time of inspection.

Task 2: Description of the Drainage System and Its Existing and Predicted Problems

For each drainage system component (e.g., pipe, culvert, bridge, outfall, pond, vault), the analysis shall include the location, physical description, problems, and field observations.

All existing or potential problems (e.g., flooding, erosion) identified in Task 1 shall be described. The descriptions shall be used to determine whether adequate mitigation can be identified or whether more detailed quantitative analysis is necessary. The following information shall be provided for each existing or potential problem:

1. Magnitude of or damage caused by the problem.
2. General frequency and duration.
3. Return frequency of storm or flow when the problem occurs (may require quantitative analysis).
4. Water elevation when the problem occurs.
5. Names and concerns of the parties involved.
6. Current mitigation of the problem.
7. Possible cause of the problem.
8. Whether the project is likely to aggravate the problem or create a new one.

5.2.2 Quantitative Analysis

Upon review of the qualitative analysis, Clark County may require a quantitative analysis, depending on the presence of existing or predicted flooding, erosion, or water quality problems and on the proposed design of the on-site drainage facilities.

The quantitative analysis shall extend downstream for the entire flow path, from the project site to the receiving water, or up to one-quarter mile, whichever is less. The quantitative analysis may be stopped shorter than the required ¼ mile downstream if the analysis reaches a trunk main. Trunk mains are defined as public stormwater drainage pipes equal to or greater than 36 inches and installed at a minimum slope of 0.5%. All existing and proposed off-site stormwater conveyance shall meet the design criteria described in the methods of analyses.

If a capacity problem or streambank erosion problem is found during the quantitative downstream analysis, mitigation measures may be required.

Include the following as part of the quantitative downstream analysis:

- Capacity and percent full in each reach.
- Description of design flows used in analysis.
- Velocity in each reach.
- Upstream and downstream basin maps showing the flow route for both on-site and offsite stormwater.

- Include all model assumptions, outputs, and equations used in the analysis. If model parameters are used that are different than typical standards of practice, justification of the parameters is required.
- Clearly describe headwater and tailwater assumptions.
- The 25-year and 100-year hydraulic gradelines must be shown.
- Include model outputs for both under capacity conditions and if the applicant is proposing to upsize the downstream system, outputs showing the upsized conditions.

The quantitative analysis shall provide information on the severity and frequency of an existing problem or the likelihood of creating a new problem. It shall evaluate proposed mitigation intended to avoid aggravation of the existing problem and creation of a new problem.

As-built drawings may be utilized to obtain structure information to be used in the downstream analysis. If as-built drawings are used, the engineer is responsible for verifying that all elevations are in the same datum. The County may require a field survey of the existing storm drainage system downstream from the project for a minimum of ¼ mile from the point of connection to the existing public drainage system, or may require portions of the system to be field surveyed.

5.2.3 Mitigation Measures

Clark County may require mitigation measures, depending on the results of the off-site analysis. Possible mitigation measures could include upsizing of off-site conveyance or additional flow control measures. Where required, the mitigation will be of a type to be determined by the Responsible Official.

Chapter 6 Construction Stormwater Pollution Prevention

Chapter Contents

Chapter Tables

6.1 Introduction

6.1.1 Purpose

This chapter presents guidance on the selection of BMPs to manage construction site stormwater in accordance with Minimum Requirement #2, Construction Stormwater Pollution Prevention. The chapter also guides the applicant in developing a Stormwater Pollution Prevention Plan (SWPPP) for projects that require it. All new development and redevelopment projects are responsible for preventing erosion and discharge of sediment or other pollutants into receiving waters and to meet Minimum Requirement #2.

Construction stormwater pollution prevention is a set of activities and best management practices (BMPs) focused on managing stormwater impacts associated with construction activities. BMPs that, when properly planned, installed, and maintained, can minimize stormwater impacts, such as heavy stormwater flows, soil erosion, water-borne sediment, and degradation of water quality. Proper implementation of BMPs selected in accordance with this chapter can help minimize construction delays and save money otherwise spent on repairing erosion. These BMPs are usually temporary, lasting as long as construction activity on the site.

All projects that include land disturbing activities such as development projects, grading projects and building construction are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters. Thresholds and requirements are defined in Chapter 1.

For more information on the impacts of erosion and sediment on the environment and how erosion occurs, see Volume II, Sections 1.4 through 1.6 of the Stormwater Management Manual for Western Washington (Ecology, 2014).

6.1.2 How to Use this Chapter

Chapter 6 addresses preparing for and implementing a Construction Stormwater Pollution Prevention Plans (SWPPP). Use this chapter to develop a SWPPP and select BMPs to control erosion, sediment and other pollutants during construction. Submit the Construction SWPPP according to the submittal requirements in Section 1.8. Projects disturbing less than 1 acre of land may use the Abbreviated Construction SWPPP in Appendix 1-J in lieu of using the instructions in this Chapter.

- Section 6.2 gives guidance to project proponents that must develop a SWPPP for the County and also must obtain a NPDES Construction Stormwater General Permit from Department of Ecology.
- Section 6.3 describes the SWPPP and presents a step-by-step method for developing a Construction SWPPP. It includes lists of suggested BMPs to meet each of the 13 elements of construction stormwater pollution prevention.

- Section 6.4 lists and describes the required 13 elements of a Construction SWPPP. All elements must be included in the SWPPP.
- Section 6.5 lists BMPs for construction stormwater control and site management, including BMPs for source control and BMPs that address runoff, conveyance, and treatment.

Optional: Applicants with large and engineered projects that will disturb less than one acre of land may prepare the Abbreviated Construction SWPPP in Appendix 1-J in lieu of using the instructions in this Chapter.

Applicants with projects that qualify for a Small Project submittal in accordance with Section 1.7 should use the Stormwater Site Plan Short Form in Appendix 1-I to develop and submit the SWPPP.

6.2 Relationship to Construction Stormwater General Permit

Many projects permitted in Clark County will also require a NPDES Construction Stormwater General Permit from Washington Department of Ecology. Generally, projects that disturb an acre or more of land and discharge stormwater to surface waters of the state require the state construction permit in addition to the land use, engineering and building permits required by the county. Some exceptions are noted in the Construction Stormwater General Permit itself.

Clark County erosion and sediment control requirements are equivalent to the 2014 *Stormwater Management Manual for Western Washington*. The state construction permit has its own set of requirements that are very similar. The state permit includes requirements such as site discharge monitoring and water quality reporting requirements that are not included in county code.

If a development site permitted under Clark County code 40.386 and the Department of Ecology also requires a NPDES Construction Stormwater General Permit (CSWGP), then the site operator is obligated to follow both sets of construction stormwater prevention rules. Use Table 6.1 as a general guideline for how to meet both with the least duplication of effort. Clark County makes no guarantee that the guidance provided in Table 6.1 will result in timely processing or issuance of the Construction Stormwater General Permit by Department of Ecology.

Note: the guidance in Table 6.1 does not apply to sites that do not require a CSWGP.

Table 6.1 Coordinating Construction Stormwater General Permit with Minimum Requirement #2

Construction permit Document / Action	Clark County Requirement	Ecology Construction Permit	Do This
Notice of Intent (NOI)	Not Required	Submit NOI to Ecology and Clark County 60 days prior to discharging stormwater from the site.[6]	Submit NOI to Ecology and Clark County at least 60 days prior to discharging stormwater from the site.[6]
Public Notice	Not Required (specific to stormwater discharges from the site)	1 x each week for 2 consecutive weeks, at least 7 days apart. Specific language is in the CSWGP.	Advertise a public notice 1 x each week for 2 consecutive weeks, at least 7 days apart. Follow guidelines for specific language in the CSWGP.
Erosivity Waiver	Not Applicable	Optional	If the site qualifies for an erosivity waiver from the CSWGP, submit the waiver to Ecology. Continue to use the CCSM to meet Minimum Requirement #2 for Clark County.
Stormwater Pollution Prevention Plan (SWPPP)	Prepare a SWPPP according to the CCSM, including 13 Elements. Clark County allows fewer BMPs to select from than CSWGP. Submit to Clark County with Erosion Control Inspection fee.	Prepare a SWPPP according to CSWGP, including 12 elements[7].	Prepare a SWPPP according instructions in the CCSM and add a contingency plan per Section S9B(1)(e) of the CSWGP to the narrative. Submit to Clark County with the Erosion Control inspection fee and before discharging stormwater from the site.
Monitoring	Not Required	Required, depending on site size. Use Section S4 beginning on page 12 of the CSWGP to determine requirements.	Monitor the construction site per Section of the CSWGP.
Table continues on following page.			

[6] Submission of the NOI 60 days prior to discharging stormwater is a minimum established by Washington Department of Ecology. However, Ecology may take significantly longer than 60 days to review a NOI in some circumstances. The applicant is responsible for communicating with Ecology directly to determine Ecology's review timelines in different circumstances and for submitting the NOI accordingly.

[7] At time of publication, Ecology has issued a draft CSWGP that contains the 13 elements of a SWPPP currently required by Clark County. Clark County assumes that the updated CSWGP permit will go into effect around the time this manual becomes effective in Clark County.

Construction permit Document / Action	Clark County Requirement	Ecology Construction Permit	Do This
Site Log Book	Required	Required as part of Monitoring, Section S4.	Maintain a site log book that contains a record of the implementation of the SWPPP. Ensure the log is available for county and state inspectors.
Inspections	Operator is required to inspect, maintain and repair using qualified personnel all BMPs as needed to assure continued performance of their intended function.	Required as Part of Monitoring in Section S4 of the CSWGP.	Follow inspection requirements in Section S4 of the CSWGP.
CESCL	Required for sites that disturb 1 acre or more or that use a licensed contractor for land-disturbing activity	Required for sites that disturb 1 acre or more	Identify a CESCL in the SWPPP.
Sampling for water quality criteria for discharges to specific water bodies listed by Ecology	Not Required	Required depending on size of disturbed area. Specialized sampling is required depending on receiving water body.	Follow sampling requirements in Section S4 of the CSWGP and in Special Condition S8.
Notice of Termination (NOT)	Not Required	Required after final site stabilization or temporary stabilization and homeowners have taken possession of residences	Follow NOT requirements in S10 of the CSWGP.

6.3 Stormwater Pollution Prevention Plan Development

The Construction SWPPP must include each of the 13 elements listed in Section 6.4 unless site conditions render any of the elements unnecessary and the exemption from that element is clearly justified in writing.

A complete description of each element and associated BMPs is given Section 6.4.

The Construction SWPPP must describe best management practices (BMPs) to prevent erosion and sedimentation, and to identify, reduce, eliminate or prevent stormwater contamination and water pollution from construction activity. The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.

6.3.1 What is a Construction SWPPP?

A Construction Stormwater Pollution Prevention Plan (SWPPP) is a written plan to implement measures to identify, prevent, and control the contamination of point source discharge of stormwater. The Construction SWPPP explains and illustrates the measures, usually in the form of best management practices (BMPs), to take on a construction site to control potential pollution problems. The primary pollutant of concern on construction sites is sediment from erosion.

As site work progresses, the plan must be modified routinely in prescribed time periods to reflect changing site conditions. The Construction SWPPP must be located on the construction site or within reasonable access to the site for construction and inspection personnel, although a copy of the drawings must be kept on the construction site at all times.

6.3.2 BMP Selection, Standards, and Specifications

Section 6.5 contains list of approved BMPs for each of the 13 elements of a SWPPP. BMPs must be selected from the lists, or from other approved BMPs in this manual, and designed and installed in accordance with the standards and specifications given in Book 2, Chapter 8. BMPs may be used singularly or in combination. The Responsible Official may allow BMPs from other guidance documents or manuals which Washington Department of Ecology has approved as equivalent under the NPDES Phase I Municipal Stormwater Permit.

6.3.3 Construction SWPPP Process

The Construction SWPPP consists of two parts: a narrative and drawings. Both parts shall contain information specific to the construction site.

6.3.3.1 Narrative

The Construction SWPPP narrative must address the following subject areas:

- Site and Project Description
    - Project description: Describe the nature and purpose of the construction project. Include the total size of the area, any increase in existing impervious area; the total area expected to be disturbed by clearing, grading, excavation or other construction activities, including off-site borrow and fill areas; and the volumes of grading cut and fill that are proposed.
    - Existing site conditions: Describe the existing topography, vegetation, and drainage. Include a description of any structures or development on the parcel including the area of existing impervious surfaces.
    - Adjacent areas: Describe adjacent areas, including streams, lakes, wetlands, residential areas, and roads that might be affected by the construction project. Describe how areas draining to the project may affect the site. Provide a

description of the upstream drainage leading to the site and the downstream drainage leading from the site to the receiving body of water.

  - Critical areas: Describe areas on or adjacent to the site that are classified as critical areas. Critical areas that receive runoff from the site shall be described up to ¼ mile away. Describe special requirements for working near or within these areas.
  - Soil: Describe the soil on the site, giving such information as soil names, mapping unit, erodibility, settleability, permeability, depth, depth to groundwater, texture, and soil structure.
  - Potential erosion problem areas: Describe areas on the site that have potential erosion problems.

- The Thirteen Elements: Describe how the Construction SWPPP addresses each of the 13 required elements. Include the type and location of BMPs used to satisfy the required element. If an element is not applicable to a project, provide a written justification for why it is not necessary.
- Construction Schedule and Phasing: Describe the construction schedule. If the schedule extends into the wet season, describe what activities will continue during the wet season and how the transport of sediment from the construction site to receiving waters will be prevented. Describe the intended sequence and timing of construction activities and any proposed construction phasing.
- Financial/ownership Responsibilities: Describe ownership and obligations for the project. Include bond forms and other evidence of financial responsibility for environmental liabilities associated with construction.
- Engineering calculations: Attach any calculations made for the design of such items as sediment ponds, diversions, and waterways, as well as calculations for runoff and stormwater detention design (if applicable). Engineering calculations must bear the signature and stamp of an engineer licensed in the state of Washington.
- Certified Erosion and Sediment Control Lead (CESCL): Identify a CESCL along with their contact information and expiration of their CESCL certification.

6.3.3.2 Drawings

1. Vicinity map - Provide a map with enough detail to identify the location of the construction site, adjacent roads, and receiving waters.
2. Site map - Provide a site map(s) showing the following features:
3. A legal description of the property boundaries or an illustration of property lines (including distances) in the drawings.
4. The direction of north in relation to the site.

5. Existing structures and roads, if present.

6. Boundaries and labeling of different soil types.

7. Areas of potential erosion problems.

8. Any on-site and adjacent surface waters, critical areas, their buffers, FEMA base flood boundaries, and shoreline management boundaries.

9. Existing contours and drainage basins and the direction of flow for the different drainage areas.

10. Final and interim grade contours as appropriate, drainage basins, and the direction of stormwater flow during and upon completion of construction.

11. Areas of proposed soil disturbance, including all areas affected by clearing, grading and excavation.

12. Locations where stormwater discharges to surface waters during and upon completion of construction.

13. Existing unique or valuable vegetation and the vegetation that is to be preserved.

14. Cut and fill slopes indicating top and bottom of slope catch lines.

15. Stockpile, waste storage, and vehicle storage/maintenance areas.

16. Total cut and fill quantities and the method of disposal for excess material.

17. Conveyance systems - Provide a map that shows the following temporary and permanent conveyance features:

    a. Locations for temporary and permanent swales, interceptor trenches, or ditches.

    b. Drainage pipes, ditches, or cut-off trenches associated with erosion and sediment control and stormwater management.

    c. Temporary and permanent pipe inverts and minimum slopes and cover.

    d. Grades, dimensions, and direction of flow in all ditches and swales, culverts, and pipes.

    e. Details for bypassing off-site runoff around disturbed areas.

    f. Locations and outlets of any dewatering systems.

18. Location of detention BMPs – Provide a map that shows the locations of stormwater detention BMPs.

19. Erosion and Sediment Control (ESC) BMPs – provide a map that shows all major structural and nonstructural ESC BMPs including:

    a. The location of sediment pond(s), pipes and structures.

    b. Dimension pond berm widths and inside and outside pond slopes.

    c. The trap/pond storage required and the depth, length, and width dimensions.

    d. Typical section views through pond and outlet structure.

    e. Typical details of gravel cone and standpipe, and/or other filtering devices.

    f. Stabilization technique details for inlets and outlets.

    g. Control/restrictor device location and details.

    h. Stabilization practices for berms, slopes, and disturbed areas.

    i. Rock specifications and detail for rock check dam, if used.

    j. Spacing for rock check dams as required.

    k. Front and side sections of typical rock check dams.

    l. The location, detail, and specification for silt fence.

20. The construction entrance location and a detail.

21. Other Maps – Provide a map that indicates:

    a. Pollutant BMPs – the location of BMPs to be used for the control of pollutants other than sediment, such as high or low pH and hydrocarbons.

    b. Monitoring locations – water quality sampling locations, if sampling is required by Clark County.

22. Detailed drawings – Any structural source control practices used that are not referenced in this manual or other manuals approved as equivalent by Ecology must be explained and illustrated with detailed drawings.

23. Notes addressing construction phasing and scheduling must be included on the drawings.

6.3.4 Step-By-Step Procedure

There are three basic steps in producing a Construction SWPPP:

Step 1 – Data Collection

Step 2 – Data Analysis

Step 3 – Construction SWPPP Development and Implementation

Guidance for developing a Construction SWPPP is included as the Construction SWPPP Checklist in Appendix 1-F.

6.3.4.1 Step 1 - Data Collection

Evaluate existing site conditions and gather information that will help develop the most effective Construction SWPPP. The Construction SWPPP author may use the information collected during the development of the Stormwater Site Plan to provide the information listed below.

Topography

Prepare a topographic drawing of the site to show the existing contour elevations at intervals of 1 to 5 feet depending upon the slope of the terrain.

Drainage

Locate and clearly mark existing drainage swales and patterns on the drawing, including existing storm drain pipe systems.

Soils

Identify and label soil type(s) and erodibility (low, medium, high or an index value) on the drawing or in the narrative.

Characterize soils for permeability, percent organic matter, and effective depth. This information is available in generalized descriptions for the county in a federal Natural Resource Conservation Service report. Typical general descriptions include:

- A sieve analysis of the soils
- Permeability (in/hr)
- Available water-holding capacity (in/in)
- The percent of organic matter

Soils information can be obtained from a Natural Resource Conservation Service (NRCS) manual or the NRCS' Web Soil Survey website at http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

Washington state soil survey information is available at:
http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=WA

Additionally, site-specific soil data can be obtained through site soil analysis as a part of preparation of a Technical Information Report and a Soils Report (see Section 1.8.1.5 and Section 1.8.3).

Ground Cover and Native Vegetation

Label existing vegetation on the drawing. Show features such as tree clusters, grassy areas, and unique or sensitive vegetation. Unique vegetation may include existing trees above a given diameter. Indicate existing denuded or exposed soil areas. Show other special features such as individual trees and areas of native vegetation required to be protected during construction. Projects may protect areas of native vegetation to meet LID requirements.

Critical Areas

Delineate critical areas adjacent to or within the site on the drawing. Show features such as steep slopes, erosion hazard areas, riparian habitat buffers, streams, floodplains, lakes, wetlands and wetland buffers, and geologic hazard areas. Delineate setbacks and buffer limits for these features on the drawings. On the drawings, show other related jurisdictional boundaries such as Shorelines Management and the Federal Emergency Management Agency (FEMA) base floodplain.

Adjacent Areas

Identify existing buildings, roads, and facilities adjacent to or within the project site on the drawings. Identify existing and proposed utility locations, construction clearing limits and erosion and sediment control BMPs on the drawings.

Existing Encumbrances

Identify wells, existing and abandoned septic drainfield, utilities, easements, setbacks, and site constraints.

Precipitation Records

Determine the average monthly rainfall and rainfall intensity for the required design storm events. These records may be available from the local permitting agency. Volume III also has resources for determining rainfall values.

6.3.4.2 Step 2 - Data Analysis

Consider the data collected in Step 1 to identify potential problems and limitations of the site. The following are some important factors to consider in data analysis:

Topography

The primary topographic considerations are slope steepness and length. Steeper and longer slopes have greater erosion potential than do flat and short slopes. A qualified engineer, licensed geologist, soil professional, or certified erosion and sediment control lead should determine erosion potential.

Drainage

Convey runoff through the use of natural drainage patterns that consist of overland flow, swales and depressions to avoid constructing an artificial drainage system. Properly stabilize man-made ditches and waterways so they do not create erosion problems. Take care to ensure that increased runoff from the site will not erode or flood the existing natural drainage system. Consider possible sites for temporary stormwater retention and detention.

Direct construction away from areas of saturated soil where groundwater may be encountered and away from critical areas where drainage will concentrate. Preserve natural drainage patterns on the site.

Soils

Evaluate soil properties such as surface and subsurface runoff characteristics, depth to impermeable layer, depth to seasonal groundwater table, permeability, shrink-swell potential, texture, settleability, and erodibility. Develop the Construction SWPPP based on known soil characteristics and topography.

Protect infiltration sites from clay and silt, which will reduce infiltration capacities.

Ground Cover

Ground cover is the most important factor in terms of preventing erosion. Preserving existing vegetation will prevent erosion better than constructing BMPs to treat polluted runoff. Trees and other vegetation protect the soil structure. If the existing vegetation cannot be saved, consider such practices as phasing construction, temporary seeding, and mulching. Phasing construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once.

Critical Areas

Any critical areas within or adjacent to the development should exert a strong influence on land development decisions. Delineate critical areas and their buffers on the drawings and clearly flag critical areas in the field. For example, chain link fencing may be more useful than flagging to assure that equipment operators stay out of critical areas. Only unavoidable work should take place within critical areas and their buffers. Such unavoidable work will require special BMPs, county critical area permitting, restrictions, and mitigation plans.

Adjacent Areas

An analysis of adjacent properties should focus on areas upslope and downslope from the project. Water bodies that will receive direct runoff from the site are a major concern. Evaluate the types, values, and sensitivities of and risks to downstream resources, such as property, stormwater facilities, infrastructure or aquatic systems. Select erosion and sediment controls accordingly.

Precipitation Records

Refer to Book 2, Chapter 1 to determine the required rainfall records and the method of analysis for design of BMPs such as ponds and Book 2, Chapter 7 for design of conveyances.

Timing of the Project

Consider the timing and duration of the project when selecting BMPs. Projects that will proceed during the wet season and projects that will last through several seasons must take all necessary precautions to remain in compliance with the water quality standards.

6.3.4.3 Step 3 – Develop and Implement the Construction SWPPP

After collecting and analyzing the data to determine the site limitations, develop a Construction SWPPP. The project proponent shall include each of the 13 elements in the Construction SWPPP, unless site conditions render the element unnecessary and the exemption from that element is clearly justified in the narrative of the SWPPP. All items in each element are required, as long as the project is not exempt from the element.

6.4 The Thirteen Elements Described

6.4.1 Element #1: Preserve Vegetation/Mark Clearing Limits

- Before beginning land disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area.
- Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practical. If not practical to retain it in place, then stockpile it on-site, cover it to prevent erosion, and replace it immediately when the site is ready for stabilization.

Suggested BMPs

- BMP C101: Preserving Natural Vegetation
- BMP C102: Buffer Zones
- BMP C103: High Visibility Plastic or Metal Fence
- BMP C233: Silt Fence

6.4.2 Element #2: Establish Construction Access

- Limit construction vehicle access and exit to one route, if possible.
- Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking sediment onto roads.
- Locate wheel wash or tire baths on site, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads.
- If sediment is tracked off site, clean the affected roadway thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Remove sediment from roads by shoveling, sweeping, or pick up and transport the sediment to a controlled sediment disposal area.
- Conduct street washing only after sediment is removed in accordance with the above bullet.
- Control street wash wastewater by pumping back on site or otherwise preventing it from discharging into systems tributary to waters of the State.

Suggested BMPs

- BMP C105: Stabilized Construction Entrance/Exit
- BMP C106: Wheel Wash
- BMP C107: Construction Road/Parking Area Stabilization

6.4.3 Element #3: Control Flow Rates

- Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site.
- Where necessary to comply with the bullet above, construct permanent stormwater retention or detention facilities as one of the first steps in grading. Such facilities must function properly before constructing site improvements (e.g. impervious surfaces).
- If permanent infiltration basins are used for flow control during construction, protect these facilities from siltation during the construction phase. The Responsible Official may require installation of a temporary sedimentation pond.

Sites that must implement flow control for the developed site condition must also control stormwater release rates during construction. Construction site stormwater discharges shall not exceed the discharge durations of the pre-developed condition for the range of pre-developed discharge rates from ½ of the 2-year flow through the 10-year flow as predicted by an approved continuous flow model. The pre-developed condition to be matched shall be the land cover condition immediately prior to the development project. This restriction on release rates can affect the size of the storage pond and treatment cells.

Suggested BMPs

- BMP C203: Water Bars
- BMP C207: Check Dams
- BMP C209: Outlet Protection
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond
- Refer to Chapter 4 for selection of ponds, and Book 2, Chapter 6 for design of ponds; also see Book 2, Chapter 7 for design of conveyance

6.4.4 Element #4: Install Sediment Controls

- Design, install and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.
- Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.
- Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.
- Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard in Element #3, bullet #1.
- Locate BMPs intended to trap sediment on site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.
- Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.

Suggested BMPs

- BMP C231: Brush Barrier
- BMP C232: Gravel Filter Berm
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip
- BMP C235: Wattles
- BMP C240: Sediment Trap
- BMP C241: Temporary Sediment Pond
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration

6.4.5 Element #5: Stabilize Soils

- Stabilize exposed and unworked soils by application of effective BMPs that prevent erosion. Control stormwater volume and velocity within the site to minimize soil erosion.
- Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.
- Soils must not remain exposed and unworked for more than the time periods set forth below:
    - During the dry season (May 1 - Sept. 30): 7 days
    - During the wet season (October 1 - April 30): 2 days
- Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.
- Stabilize soil stockpiles from erosion, protect with sediment trapping measures, and where possible, locate away from storm drain inlets, waterways, and drainage channels.
- Minimize the amount of soil exposed during construction activity.
- Minimize the disturbance of steep slopes.
- Minimize soil compaction and, unless infeasible, preserve topsoil.

Suggested BMPs

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C123: Plastic Covering
- BMP C124: Sodding

- BMP C125: Topsoiling/Composting
- BMP C126: Polyacrylamide for Soil Erosion Protection
- BMP C130: Surface Roughening
- BMP C131: Gradient Terraces
- BMP C140: Dust Control

6.4.6 Element #6: Protect Slopes

- Design and construct cut-and-fill slopes in a manner to minimize erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).
- Divert off-site stormwater (run-on) or groundwater away from slopes and disturbed areas. Manage off-site stormwater separately from stormwater generated on the site.
- At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion.
    - Temporary pipe slope drains must handle the peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate predicted by an approved continuous flow model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using an approved continuous flow model to predict flows, bare soil areas should be modeled as "landscaped" area.
- Place excavated material on the uphill side of trenches, consistent with safety and space considerations.
- Place check dams at regular intervals within constructed channels that are cut down a slope.

Additional Guidance

- BMP combinations are the most effective method of protecting slopes with disturbed soils. For example use both mulching and straw erosion control blankets in combination.

Suggested BMPs

- BMP C120: Temporary and Permanent Seeding
- BMP C121: Mulching
- BMP C122: Nets and Blankets
- BMP C130: Surface Roughening

- BMP C131: Gradient Terraces
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C203: Water Bars
- BMP C204: Pipe Slope Drains
- BMP C205: Subsurface Drains
- BMP C206: Level Spreader
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam)

6.4.7 Element #7: Protect Drain Inlets

- Protect storm drain inlets made operable during construction and existing storm drain inlets that receive runoff from the site so that stormwater runoff does not enter the conveyance system without first being filtered or treated to remove sediment.
- Clean or remove and replace inlet protection devices when sediment has filled one-third of the available storage or when the standard specified by the product manufacturer is exceeded.
- Inspect inlets weekly, at a minimum, and daily during storm events.

Suggested BMPs

- BMP C220: Storm Drain Inlet Protection

6.4.8 Element #8: Stabilize Channels and Outlets

- Design, construct, and stabilize all on-site conveyance channels to prevent erosion from the following expected peak flows:
    - Channels must handle the peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate indicated by an approved continuous flow model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using an approved continuous flow model to predict flows, bare soil areas should be modeled as "landscaped area".
- Provide stabilization and armoring, adequate to prevent erosion of outlets, adjacent streambanks, slopes, and downstream reaches at the outlets of all conveyance systems.

Suggested BMPs

- BMP C202: Channel Lining
- BMP C122: Nets and Blankets
- BMP C201: Grass-Lined Channels
- BMP C206: Level Spreader
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (Geotextile-Encased Check Dam)
- BMP C209: Outlet Protection

6.4.9 Element #9: Control Pollutants

- Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.
- Handle and dispose of all pollutants, including waste materials and demolition debris that occur on-site in a manner that does not cause contamination of stormwater.
- Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure. Double-walled tanks do not require additional secondary containment.
- Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.
- Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland land application, or to the sanitary sewer, with local sewer district approval.
- Apply fertilizers and pesticides in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Follow manufacturers' label requirements for application rates and procedures.
- Use BMPs to prevent contamination of stormwater runoff by pH-modifying sources. The sources for this contamination include, but are not limited to, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, dewatering concrete vaults, concrete pumping and mixer washout waters.
- Adjust the pH of stormwater if necessary to prevent violations of the water quality standards.

- Assure that washout of concrete trucks is performed off-site or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on site, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the State is prohibited.
- Obtain written approval from the Department of Ecology before using chemical treatment other than CO_2 or dry ice to adjust pH.

Suggested BMPs

- BMP C151: Concrete Handling
- BMP C152: Sawcutting and Surfacing Pollution Prevention
- BMP C153: Material Delivery, Storage and Containment
- BMP C154: Concrete Washout Area
- BMP C250: Construction Stormwater Chemical Treatment
- BMP C251: Construction Stormwater Filtration
- BMP C252: High pH Neutralization Using CO_2
- BMP C253: pH Control for High pH Water
- See Book 4 – Source Control

6.4.10 Element #10: Control De-Watering

- Discharge foundation, vault, and trench dewatering water, which have characteristics similar to stormwater runoff at the site, into a controlled conveyance system before discharge to a sediment trap or sediment pond.
- Discharge clean, non-turbid de-watering water, such as well-point groundwater, to systems tributary to, or directly into surface waters of the state, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters or interfere with the operation of the system. Do not route clean dewatering water through stormwater sediment ponds. Note that "surface waters of the State" may exist on a construction site as well as off site; for example, a creek running through a site.
- Handle highly turbid or contaminated dewatering water separately from stormwater.
- Other treatment or disposal options may include:
    - Infiltration.
    - Transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.
    - Ecology-approved on-site chemical treatment or other suitable treatment technologies.

- Sanitary sewer discharge with local sewer district approval, if there is no other option.
- Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.

Suggested BMPs

- BMP C203: Water Bars
- BMP C236: Vegetative Filtration

6.4.11 Element #11: Maintain BMPs

- Maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.
- Remove all temporary erosion and sediment control BMPs within 30 days after achieving final site stabilization or after the temporary BMPs are no longer needed, unless the BMP is biodegradable and designed to remain in place after construction (e.g. compost socks).
- Protect all BMPs installed for the permanent control of stormwater from sediment and compaction. All BMPs that are to remain in place following completion of construction shall be examined and placed in full operating conditions. If sediment enters the BMPs during construction, it shall be removed and the facility shall be returned to the conditions specified in the construction documents.
- Remove or stabilize trapped sediment on site. Permanently stabilize disturbed soil resulting from removal of BMPs or vegetation.

Suggested BMPs

- BMP C150: Materials On Hand
- BMP C160: Certified Erosion and Sediment Control Lead

6.4.12 Element #12: Manage the Project

- Phase development projects to the maximum degree practicable and take into account seasonal work limits.
- Inspect, maintain, and repair all BMPs as needed to assure continued performance of their intended function.
    - All land disturbing activities performed by licensed contractors must have site inspections conducted by an individual who possesses a valid CESCL certification.
    - All projects disturbing one acre or more must have site inspections conducted by an individual who possesses a valid CESCL certification.

  - Prior to initiating land-disturbing activities, all sites must identify an inspector, which will be the CESCL on sites meeting criteria above, in the SWPPP.
    - The inspector/CESCL must attend the Preconstruction Conference and the Preconstruction Site Inspection.
  - The inspector/CESCL shall be present on-site or be on-call at all times.
- Construction site operators shall maintain, update, and implement the Construction SWPPP.

Site Inspection Requirements

- The CESCL or inspector must assess the:
  - Site conditions and construction activities that could impact the quality of stormwater.
  - Effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- The CESCL or inspector must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen. They must evaluate the effectiveness of BMPs and determine if it is necessary to install, maintain, or repair BMPs to improve the quality of stormwater discharges.

Based on the results of the inspection, construction site operators must correct problems identified by:

  - Reviewing the SWPPP for compliance with the 13 construction SWPPP elements and making appropriate revisions within 7 days of the inspection.
  - Immediately beginning the process of fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible, addressing the problems no later than within 10 days of the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, the construction site operator may request an extension from the Responsible Official within the initial 10-day response period.
  - Documenting BMP implementation and maintenance in the site log book (sites larger than 1 acre).
- The CESCL or inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition, individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week.) The CESCL or inspector may reduce the inspection frequency for temporarily stabilized, inactive sites to once every calendar month

Wet Season Requirements

- From October 1 through April 30, clearing, grading, and other soil disturbing activities is permitted only if shown to the satisfaction of Clark County that the site operator will prevent silt-laden runoff from leaving the site through a combination of the following:
    - Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters.
    - Limit activities and the extent of disturbed areas.
    - Proposed erosion and sediment control measures.
    - Based on the information provided and/or local weather conditions, the Responsible Official may expand or restrict the seasonal limitation on site disturbance. The Responsible Official may take enforcement action – such as a notice of violation, administrative order, penalty, or stop-work order under any of the following circumstances:
        - If, during the course of any construction activity or soil disturbance during the seasonal limitation period, sediment leaves the construction site causing a violation of the surface water quality standard.
        - If clearing and grading limits or erosion and sediment control measures shown in the approved plan are not maintained.

The following activities are exempt from the seasonal clearing and grading limitations:

- Routine maintenance and necessary repair of erosion and sediment control BMPs.
- Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil.
- Activities where there is one hundred percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Suggested BMPs

- BMP C150: Materials On Hand
- BMP C160: Certified Erosion and Sediment Control Lead
- BMP C162: Scheduling

6.4.13 Element #13: Protect Low Impact Development BMPs

- Protect all bioretention and rain garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into them. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden bioretention/rain garden soils, and replacing the removed soils with soils meeting the design specification.

- Prevent compacting bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction by construction equipment.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements or base materials.
- Pavements fouled with sediments or no longer passing an initial infiltration text must be cleaned using procedures from Book 4 or the manufacturer's procedures.
- Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

See Chapter 5: Precision Site Preparation and Construction in the LID Technical Guidance Manual for Puget Sound for more detail on protecting LID integrated management practices.

Suggested BMPs

- BMP C102: Buffer Zone
- BMP C103: High Visibility Fence
- BMP C200: Interceptor Dike and Swale
- BMP C201: Grass-Lined Channels
- BMP C207: Check Dams
- BMP C208: Triangular Silt Dike (TSD) (Geotextile-Encased Check Dam)
- BMP C231: Brush Barrier
- BMP C233: Silt Fence
- BMP C234: Vegetated Strip

6.5 BMP Selection

Table 6.2 summarizes the Source Control BMPs that are applicable to the 13 Elements. Use this table to help select source control BMPs for the project site. Elements not shown are not satisfied through installation of Source Controls. BMP Information Sheets for design and installation of the BMPs are found in Book 2, Chapter 8.

Table 6.3 summarizes the Conveyance and Treatment BMPs that are applicable to the 13 Elements. Use this table to help select conveyance and treatment BMPs for the project site. Elements not shown are not satisfied through installation of runoff conveyance and treatment BMPs. BMP Information Sheets for design and installation of the BMPs are found in Book 2, Chapter 8.

Table 6.2 Source Control BMPs by SWPPP Element

Element Name	Preserve Vegetation / Mark Clearing Limits	Establish Construction Access	Stabilize Soils	Protect Slopes	Stabilize Channels and Outlets	Control Pollutants	Maintain BMPs	Manage the Project	Protect Low Impact Development BMPs
▼ BMP Element No. ▶	**1**	**2**	**5**	**6**	**8**	**9**	**11**	**12**	**13**
BMP C101: Preserving Natural Vegetation	✔								
BMP C102: Buffer Zones	✔								✔
BMP C103: High Visibility Plastic or Metal Fence	✔								✔
BMP C105: Stabilized Construction Entrance/Exit		✔							
BMP C106: Wheel Wash		✔							
BMP C107: Construction Road/ Parking Stabilization		✔							
BMP C120: Temporary & Permanent Seeding			✔	✔					
BMP C121: Mulching			✔	✔					
BMP C122: Nets & Blankets			✔	✔	✔				
BMP C123: Plastic Covering			✔						
BMP C124: Sodding			✔						
BMP C125: Topsoiling/ Composting			✔						
BMP C126: Polyacrylamide for Soil Erosion Protection			✔						
BMP C130: Surface Roughening			✔	✔					
BMP C131: Gradient Terraces			✔	✔					
BMP C140: Dust Control			✔						
BMP C150: Materials on Hand							✔	✔	
BMP C151: Concrete Handling						✔			
BMP C152: Sawcutting and Surfacing Pollution Prevention						✔			
BMP C153: Material Delivery, Storage & Containment						✔			
BMP C154: Concrete Washout Area						✔			
BMP C160: Certified Erosion & Sediment Control Lead							✔	✔	
BMP C162: Scheduling								✔	

Table 6.3 Runoff Conveyance and Treatment BMPs by SWPPP Element

Element Name	Control Flow Rates	Install Sediment Controls	Protect Slopes	Protect Drain Inlets	Stabilize Channels and Outlets	Control Pollutants	Control Dewatering	Protect Low Impact Development BMPs
▼ BMP Element No. ▶	**3**	**4**	**6**	**7**	**8**	**9**	**10**	**13**
BMP C200: Interceptor Dike and Swale			✔					✔
BMP C201: Grass-lined Channels			✔					✔
BMP C202: Channel Lining					✔			
BMP C203: Water Bars	✔		✔				✔	
BMP C204: Pipe Slope Drains			✔					
BMP C205: Surface Drains			✔					
BMP C206: Level Spreader			✔				✔	✔
BMP C207: Check Dams	✔		✔		✔			✔
BMP C208: Triangular Silt Dike (Geotextile Encased Check Dam)			✔					
BMP C209: Outlet Protection	✔				✔			
BMP C220: Storm Drain Inlet Protection				✔				
BMP C231: Brush Barrier		✔						✔
BMP C232: Gravel Filter Berm		✔						
BMP C233: Silt Fence		✔						✔
BMP C234: Vegetated Strip		✔						✔
BMP C235: Wattles	✔	✔						
BMP C236: Vegetated Filtration							✔	
BMP C240: Sediment Trap	✔	✔						
BMP C241: Temporary Sediment Pond	✔	✔						
BMP C250: Construction Stormwater Chemical Treatment		✔				✔		
BMP C251: Construction Stormwater Filtration		✔				✔		
BMP C252: High pH Neutralization Using CO_2						✔		
BMP C253: pH Control for High pH Water						✔		

6.5.1 Products Approved as Equivalent

Ecology has approved products as equivalent to some BMPs in this chapter. The products did not pass through the Technology Assessment Protocol – Ecology (TAPE) process. Clark County may choose not to accept a product approved as equivalent. The products are available for review on Ecology's website at http://www.ecy.wa.gov/programs/wq/stormwater/newtech/equivalent.html

BMPs that have approved equivalents will contain a notation in the Conditions of Use. Obtain approval in the Construction SWPPP from the Responsible Official prior to using an approved equivalent.

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Book 1 Appendices

Appendix 1-A

Glossary

Glossary

The following terms are provided for reference and use with this manual. They shall be superseded by any other definitions for these terms adopted by ordinance, unless they are defined in a Washington State WAC or RCW, or are used and defined as part of the Minimum Requirements for all new development and redevelopment.

AASHTO classification	The official classification of soil materials and soil aggregate mixtures for highway construction, used by the American Association of State Highway and Transportation Officials**.**
Absorption	The penetration of a substance into or through another, such as the dissolving of a soluble gas in a liquid.
Adjacent steep slope	A slope with a gradient of 15 percent or steeper within five hundred feet of the site.
Adjustment	A variation in the application of a Minimum Requirement to a particular project. Adjustments provide substantially equivalent environmental protection.
Adsorption	The adhesion of a substance to the surface of a solid or liquid; often used to extract pollutants by causing them to be attached to such adsorbents as activated carbon or silica gel. Hydrophobic, or water-repulsing adsorbents, are used to extract oil from waterways when oil spills occur. Heavy metals such as zinc and lead often adsorb onto sediment particles.
Aeration	The process of being supplied or impregnated with air. In waste treatment, the process used to foster biological and chemical purification. In soils, the process by which air in the soil is replenished by air from the atmosphere. In a well aerated soil, the soil air is similar in composition to the atmosphere above the soil. Poorly aerated soils usually contain a much higher percentage of carbon dioxide and a correspondingly lower percentage of oxygen.
Aerobic	Living or active only in the presence of free (dissolved or molecular) oxygen.
Aerobic bacteria	Bacteria that require the presence of free oxygen for their metabolic processes.
Aggressive plant species	Opportunistic species of inferior biological value that tend to out-compete more desirable forms and become dominant; applied to native species in this manual.

Algae	Primitive plants, many microscopic, containing chlorophyll and forming the base of the food chain in aquatic environments. Some species may create a nuisance when environmental conditions are suitable for prolific growth.
Algal bloom	Proliferation of living algae on the surface of lakes, streams or ponds; often stimulated by phosphate over-enrichment. Algal blooms reduce the oxygen available to other aquatic organisms.
American Public Works Association (APWA)	The Washington State Chapter of the American Public Works Association.
Anadromous	Fish that grow to maturity in the ocean and return to rivers for spawning.
Anaerobic	Living or active in the absence of oxygen.
Anaerobic bacteria	Bacteria that do not require the presence of free or dissolved oxygen for metabolism.
Annual flood	The highest peak discharge on average which can be expected in any given year.
Antecedent moisture conditions	The degree of wetness of a watershed or within the soil at the beginning of a storm.
Anti-seep collar	A device constructed around a pipe or other conduit and placed through a dam, levee, or dike for the purpose of reducing seepage losses and piping failures.
Anti-vortex device	A facility placed at the entrance to a pipe conduit structure such as a drop inlet spillway or hood inlet spillway to prevent air from entering the structure when the pipe is flowing full.
Applicable BMPs	As used in SMMWW Volume IV, applicable BMPs are those source control BMPs that are expected to be required by local governments at new development and redevelopment sites. This manual substitutes the term "Required BMPs" in Book 3.
Applicant	The person who has applied for a development permit or approval.
Appurtenances	Machinery, appliances, or auxiliary structures attached to a main structure, but not considered an integral part thereof, for the purpose of enabling it to function.
Aquifer	A geologic stratum containing ground water that can be withdrawn and used for human purposes.
Arterial	A road or street primarily for through traffic. The term generally includes roads or streets considered collectors. It does not include local access roads which are generally limited to providing access to abutting property. See also RCW 35.78.010, RCW 36.86.070, and RCW 47.05.021.

As-built drawings — Engineering plans which have been revised to reflect all changes to the plans which occurred during construction.

As-graded — The extent of surface conditions on completion of grading.

BSBL — See Building set back line.

Background — A description of pollutant levels arising from natural sources, and not because of man's immediate activities.

Backwater — Water upstream from an obstruction which is deeper than it would normally be without the obstruction.

Baffle — A device to check, deflect, or regulate flow.

Bankfull discharge — A flow condition where streamflow completely fills the stream channel up to the top of the bank. In undisturbed watersheds, the discharge conditions occur on average every 1.5 to 2 years and controls the shape and form of natural channels.

Base flood — A flood having a one percent chance of being equaled or exceeded in any given year. This is also referred to as the 100-year flood.

Base flood elevation — The water surface elevation of the base flood. It shall be referenced to the National Geodetic Vertical Datum of 1929 (NGVD).

Baseline sample — A sample collected during dry-weather flow (i.e., it does not consist of runoff from a specific precipitation event).

Basin plan — A plan that assesses, evaluates, and proposes solutions to existing and potential future impacts to the beneficial uses of, and the physical, chemical, and biological properties of waters of the state within a basin. Basins typically range in size from 1 to 50 square miles. A plan should include but not be limited to recommendations for:

- Stormwater requirements for new development and redevelopment;
- Capital improvement projects;
- Land Use management through identification and protection of critical areas, comprehensive land use and transportation plans, zoning regulations, site development standards, and conservation areas;
- Source control activities including public education and involvement, and business programs;
- Other targeted stormwater programs and activities, such as maintenance, inspections and enforcement;
- Monitoring; and
- An implementation schedule and funding strategy.

A plan that is "adopted and implemented" must have the following characteristics:

- It must be adopted by legislative or regulatory action of jurisdictions with responsibilities under the plan;
- Ordinances, regulations, programs, and procedures recommended by the plan should be in effect or on schedule to be in effect; and,
- An implementation schedule and funding strategy that is in progress.

Bearing capacity The maximum load that a material can support before failing.

Bedrock The more or less solid rock in place either on or beneath the surface of the earth. It may be soft, medium, or hard and have a smooth or irregular surface.

Bench A relatively level step excavated into earth material on which fill is to be placed.

Berm A constructed barrier of compacted earth, rock, or gravel. In a stormwater facility, a berm may serve as a vertical divider typically built up from the bottom.

Best management practice (BMP) The schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington State.

Biochemical oxygen demand (BOD) An indirect measure of the concentration of biologically degradable materials present in organic wastes. The amount of free oxygen utilized by aerobic organisms when allowed to attack the organic material in an aerobically maintained environment at a specified temperature (20°C) for a specific time period (5 days), and thus stated as BOD5. It is expressed in milligrams of oxygen utilized per liter of liquid waste volume (mg/l) or in milligrams of oxygen per kilogram of waste solution (mg/kg = ppm = parts per million parts). Also called biological oxygen demand.

Biodegradable Capable of being readily broken down by biological means, especially by microbial action. Microbial action includes the combined effect of bacteria, fungus, flagellates, amoebae, ciliates, and nematodes. Degradation can be rapid or may take many years depending upon such factors as available oxygen and moisture.

Bioengineering The combination of biological, mechanical, and ecological concepts (and methods) to control erosion and stabilize soil through the use of vegetation or in combination with construction materials.

Biofilter A designed treatment facility using a combined soil and vegetation system for filtration, infiltration, adsorption, and biological uptake of pollutants in stormwater when runoff flows over and through.

	Vegetation growing in these facilities acts as both a physical filter which causes gravity settling of particulates by regulating velocity of flow, and also as a biological sink when direct uptake of dissolved pollutants occurs. The former mechanism is probably the most important in western Washington where the period of major runoff coincides with the period of lowest biological activity.
Biofiltration	The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials.
Biological control	A method of controlling pest organisms by means of introduced or naturally occurring predatory organisms, sterilization, the use of inhibiting hormones, or other means, rather than by mechanical or chemical means.
Biological magnification	The increasing concentration of a substance along succeeding steps in a food chain. Also called biomagnification.
Bioretention BMP	Engineered vegetated facilities that store and treat stormwater by passing it through a specified soil profile, and either retain or detain the treated stormwater for flow attenuation. Refer to Book 1, Chapter 3; and Book 2, Chapter 1 for Bioretention BMP types and design specifications.
Bollard	A post (may or may not be removable) used to prevent vehicular access.
Bond	A surety bond, cash deposit or escrow account, assignment of savings, irrevocable letter of credit or other means acceptable to or required by the manager to guarantee that work is completed in compliance with the project's drainage plan and in compliance with all local government requirements.
Borrow area	A source of earth fill material used in the construction of embankments or other earth fill structures.
Buffer	The zone contiguous with a sensitive area that is required for the continued maintenance, function, and structural stability of the sensitive area. The critical functions of a riparian buffer (those associated with an aquatic system) include shading, input of organic debris and coarse sediments, uptake of nutrients, stabilization of banks, interception of fine sediments, overflow during high water events, protection from disturbance by humans and domestic animals, maintenance of wildlife habitat, and room for variation of aquatic system boundaries over time due to hydrologic or climatic effects. The critical functions of terrestrial buffers include protection of slope stability, attenuation of surface water flows from stormwater runoff and precipitation, and erosion control.

Building setback line (BSBL)	A line measured parallel to a property, easement, drainage facility, or buffer boundary, that delineates the area (defined by the distance of separation) where buildings or other obstructions are prohibited (including decks, patios, outbuildings, or overhangs beyond 18 inches). Wooden or chain link fences and landscaping are allowable within a building setback line. In this manual the minimum building setback line shall be 5 feet.
CIP	See Capital Improvement Project.
Capital Improvement Project or Program (CIP)	A project prioritized and scheduled as a part of an overall construction program or, the actual construction program.
Catch basin	A chamber or well, usually built at the curb line of a street, for the admission of surface water to a sewer or subdrain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.
Catchline	The point where a severe slope intercepts a different, more gentle slope.
Catchment	Surface drainage area.
Cation Exchange Capacity (CEC)	The amount of exchangeable cations that a soil can adsorb. Units are milli-equivalents per 100 g of soil, typically abbreviated simply as meq. Soil found to have a CEC of 5 meq at pH 7 will have CEC < 5 meq when pH < 7..
CESCL	See Certified Erosion and Sediment Control Lead
Certified Erosion and Sediment Control Lead (CESCL)	An individual who has current certification through an approved erosion and sediment control training program that meets the minimum training standards established by Ecology (see BMP C160 of Book 2). A CESCL is knowledgeable in the principles and practices of erosion and sediment control. The CESCL must have the skills to assess site conditions and construction activities that could impact the quality of stormwater and, the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges. Certification is obtained through an Ecology approved erosion and sediment control course. Course listings are provided online at Ecology's website.
Channel	A feature that conveys surface water and is open to the air.
Channel, constructed	Channels or ditches constructed (or reconstructed natural channels) to convey surface water.
Channel, natural	Streams, creeks, or swales that convey surface/ground water and have existed long enough to establish a stable route and/or biological community.

Channel stabilization	Erosion prevention and stabilization of velocity distribution in a channel using vegetation, jetties, drops, revetments, and/or other measures.
Channel storage	Water temporarily stored in channels while enroute to an outlet.
Channelization	Alteration of a stream channel by widening, deepening, straightening, cleaning, or paving certain areas to change flow characteristics.
Check dam	Small dam constructed in a gully or other small watercourse to decrease the streamflow velocity, minimize channel scour, and promote deposition of sediment.
Chemical oxygen demand (COD)	A measure of the amount of oxygen required to oxidize organic and oxidizable inorganic compounds in water. The COD test, like the BOD test, is used to determine the degree of pollution in water.
Civil engineer	A professional engineer licensed in the State of Washington in Civil Engineering.
Civil engineering	The application of the knowledge of the forces of nature, principles of mechanics and the properties of materials to the evaluation, design and construction of civil works for the beneficial uses of mankind.
Clay lens	A naturally occurring, localized area of clay which acts as an impermeable layer to runoff infiltration.
Clearing	The destruction and removal of vegetation by manual, mechanical, or chemical methods.
Closed depression	An area greater than 5, 000 square feet at overflow elevation that is low-lying and that has no or such a limited surface water outlet that the area acts as a stormwater retention facility. The primary loss of water volume from a closed depression is through evapotranspiration and discharge into the ground rather than through surface flow.
Coefficient of permeability	The quality of saturated soil that enables water or air to move through it. Also known as hydraulic conductivity.
Cohesion	The capacity of a soil to resist shearing stress, exclusive of functional resistance.
Coliform bacteria	Microorganisms common in the intestinal tracts of man and other warm-blooded animals; all the aerobic and facultative anaerobic, gram-negative, nonspore-forming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°C. Used as an indicator of bacterial pollution.
Commercial agriculture	Those activities conducted on lands defined in RCW 84.34.020(2), and activities involved in the production of crops or livestock for wholesale trade. An activity ceases to be considered commercial agriculture when the area on which it is conducted is proposed for conversion to a nonagricultural use or has lain idle for more than five

(5) years, unless the idle land is registered in a federal or state soils conservation program, or unless the activity is maintenance of irrigation ditches, laterals, canals, or drainage ditches related to an existing and ongoing agricultural activity.

Common Plan of Development or Sale
A site where multiple separate and distinct construction activities may be taking place at different times on different schedules and/or by different contractors, but still under a single plan. Examples include: 1) phase projects and projects with multiple filings or lots, even if the separate phases or filings/lots will be constructed under separate contract or by separate owners (e.g., a development where lots are sold to separate builders); 2) a development plan that may be phased over multiple years, but is still under a consistent plan for long-term development; 3) projects in a contiguous area that may be unrelated but still under the same contract, such as construction of a building extension and a new parking lot at the same facility; and 4) linear projects such as roads, pipelines, or utilities. If the project is part of a common plan of development or sale, the disturbed area of the entire plan must be used in determine permit requirements.

Compaction
The densification, settlement, or packing of soil in such a way that permeability of the soil is reduced. Compaction effectively shifts the performance of a hydrologic group to a lower permeability hydrologic group. For example, a group B hydrologic soil can be compacted and be effectively converted to a group C hydrologic soil in the way it performs in regard to runoff.

Compaction may also refer to the densification of a fill by mechanical means.

Compensatory storage
New excavated storage volume equivalent to the flood storage capacity eliminated by filling or grading within the flood fringe. Equivalent shall mean that the storage removed shall be replaced by equal volume between corresponding one-foot contour intervals that are hydraulically connected to the floodway through their entire depth.

Compost
Organic solid waste that has undergone biological degradation and transformation under controlled conditions designed to promote aerobic decomposition at a solid waste facility in compliance with the requirements of Chapter 173-350 WAC, or biosolids composted in compliance with Chapter 173-308 WAC. Composting is a form of organic material recycling. Natural decay of organic solid waste under uncontrolled conditions does not result in composted material. (Note: various BMPs have restrictions on the percentage of biosolids in compost, or do not allow biosolids in compost.)

Comprehensive planning
Planning that takes into account all aspects of water, air, and land resources and their uses and limits.

Conservation district	A public organization created under state enabling law as a special-purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries, usually a subdivision of state government with a local governing body and always with limited authority. Often called a soil conservation district or a soil and water conservation district.
Constructed wetland	Those wetlands intentionally created on sites that are not wetlands for the primary purpose of wastewater or stormwater treatment and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system.
Construction Stormwater Pollution Prevention Plan	A document that describes the potential for pollution problems on a construction project and explains and illustrates the measures to be taken on the construction site to control those problems.
Contour	An imaginary line on the surface of the earth connecting points of the same elevation.
Converted Vegetation (Areas)	The surfaces on a project site where native vegetation, pasture, scrub/shrub, or unmaintained non-native vegetation (e.g., Himalayan blackberry, scotch broom) are converted to lawn or landscaped areas, or where native vegetation is converted to pasture.
Conveyance	A mechanism for transporting water from one point to another, including pipes, ditches, and channels.
Conveyance system	The drainage facilities, both natural and man-made, which collect, contain, and provide for the flow of surface and stormwater from the highest points on the land down to a receiving water. The natural elements of the conveyance system include swales and small drainage courses, streams, rivers, lakes, and wetlands. The human-made elements of the conveyance system include gutters, ditches, pipes, channels, and most retention/detention facilities.
Cover crop	A close-growing crop grown primarily for the purpose of protecting and improving soil between periods of permanent vegetation.
Created wetland	Means those wetlands intentionally created from nonwetland sites to produce or replace natural wetland habitat (e.g., compensatory mitigation projects).
Critical Areas	At a minimum, areas which include wetlands, areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas, frequently flooded areas, geologically hazardous areas, including unstable slopes, and associated areas and ecosystems.

Critical Drainage Area An area with such severe flooding, drainage and/or erosion/sedimentation conditions that the area has been formally adopted as a Critical Drainage Area by rule under the procedures specified in an ordinance.

Critical reach The point in a receiving stream below a discharge point at which the lowest dissolved oxygen level is reached and stream recovery begins.

Culvert Pipe or concrete box structure that drains open channels, swales or ditches under a roadway or embankment. Typically with no catchbasins or manholes along its length.

Cut Portion of land surface or area from which earth has been removed or will be removed by excavating; the depth below original ground surface to excavated surface.

Cut-and-fill Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Cut slope A slope formed by excavating overlying material to connect the original ground surface with a lower ground surface created by the excavation. A cut slope is distinguished from a bermed slope, which is constructed by importing soil to create the slope.

DNS See Determination of Nonsignificance.

Dead storage The volume available in a depression in the ground below any conveyance system, or surface drainage pathway, or outlet invert elevation that could allow the discharge of surface and stormwater runoff.

Dedication of land Refers to setting aside a portion of a property for a specific use or function.

Degradation (Biological or chemical) The breakdown of complex organic or other chemical compounds into simpler substances, usually less harmful than the original compound, as with the degradation of a persistent pesticide. (Geological) Wearing down by erosion. (Water) The lowering of the water quality of a watercourse by an increase in the pollutant loading.

Degraded (disturbed) wetland (community) A wetland (community) in which the vegetation, soils, and/or hydrology have been adversely altered, resulting in lost or reduced functions and values; generally, implies topographic isolation; hydrologic alterations such as hydroperiod alteration (increased or decreased quantity of water), diking, channelization, and/or outlet modification; soils alterations such as presence of fill, soil removal, and/or compaction; accumulation of toxicants in the biotic or abiotic components of the wetland; and/or low plant species richness with dominance by invasive weedy species.

Denitrification	The biochemical reduction of nitrates or nitrites in the soil or organic deposits to ammonia or free nitrogen.
Depression storage	The amount of precipitation that is trapped in depressions on the surface of the ground.
Design engineer	The professional civil engineer licensed in the State of Washington who prepares the analysis, design, and engineering plans for an applicant's permit or approval submittal.
Design storm	A prescribed hyetograph and total precipitation amount (for a specific duration recurrence frequency) used to estimate runoff for a hypothetical storm of interest or concern for the purposes of analyzing existing drainage, designing new drainage facilities or assessing other impacts of a proposed project on the flow of surface water. (A hyetograph is a graph of percentages of total precipitation for a series of time steps representing the total time during which the precipitation occurs.)
Detention	The release of stormwater runoff from the site at a slower rate than it is collected by the stormwater facility system, the difference being held in temporary storage.
Detention facility	An above or below ground facility, such as a pond or tank, that temporarily stores stormwater runoff and subsequently releases it at a slower rate than it is collected by the drainage facility system. There is little or no infiltration of stored stormwater.
Detention time	The theoretical time required to displace the contents of a stormwater treatment facility at a given rate of discharge (volume divided by rate of discharge).
Determination of Nonsignificance (DNS)	The written decision by the responsible official of the lead agency that a proposal is not likely to have a significant adverse environmental impact, and therefore an EIS is not required.
Development	Means new development, redevelopment, or both. See definitions for each.
Discharge	Runoff leaving a new development or redevelopment via overland flow, built conveyance systems, or infiltration facilities. A hydraulic rate of flow, specifically fluid flow; a volume of fluid passing a point per unit of time, commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, gallons per day, or millions of gallons per day.
Dispersion	Release of surface and stormwater runoff such that the flow spreads over a wide area and is located so as not to allow flow to concentrate anywhere upstream of a drainage channel with erodible underlying granular soils.

Ditch	A long narrow excavation dug in the earth for drainage with its top width less than 10 feet at design flow.
Divide, Drainage	The boundary between one drainage basin and another.
Drain	A buried pipe or other conduit (closed drain). A ditch (open drain) for carrying off surplus surface water or ground water.
(To) Drain	To provide channels, such as open ditches or closed drains, so that excess water can be removed by surface flow or by internal flow. To lose water (from the soil) by percolation.
Drainage	Refers to the collection, conveyance, containment, and/or discharge of surface and stormwater runoff.
Drainage basin	A geographic and hydrologic subunit of a watershed.
Drainage channel	A drainage pathway with a well-defined bed and banks indicating frequent conveyance of surface and stormwater runoff.
Drainage course	A pathway for watershed drainage characterized by wet soil vegetation; often intermittent in flow.
Drainage easement	A legal encumbrance that is placed against a property's title to reserve specified privileges for the users and beneficiaries of the drainage facilities contained within the boundaries of the easement.
Drainage pathway	The route that surface and stormwater runoff follows downslope as it leaves any part of the site.
Drainage project	Excavation or construction of pipes, culverts, channels, embankments, or other flow-altering structures in any stream, stormwater facility, or wetland in Clark County.
Drainage review	An evaluation by Plan Approving Authority staff of a proposed project's compliance with the drainage requirements in this manual or its technical equivalent.
Drainage, Soil	As a natural condition of the soil, soil drainage refers to the frequency and duration of periods when the soil is free of saturation; for example, in well-drained soils the water is removed readily but not rapidly; in poorly drained soils the root zone is waterlogged for long periods unless artificially drained, and the roots of ordinary crop plants cannot get enough oxygen; in excessively drained soils the water is removed so completely that most crop plants suffer from lack of water. Strictly speaking, excessively drained soils are a result of excessive runoff due to steep slopes or low available water-holding capacity due to small amounts of silt and clay in the soil material. The following classes are used to express soil drainage: Well drained - Excess water drains away rapidly and no mottling occurs within 36 inches of the surface.

- Moderately well drained - Water is removed from the soil somewhat slowly, resulting in small but significant periods of wetness. Mottling occurs between 18 and 36 inches.
- Somewhat poorly drained - Water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time. Mottling occurs between 8 and 18 inches.
- Poorly drained - Water is removed so slowly that the soil is wet for a large part of the time. Mottling occurs between 0 and 8 inches.
- Very poorly drained - Water is removed so slowly that the water table remains at or near the surface for the greater part of the time. There may also be periods of surface ponding. The soil has a black to gray surface layer with mottles up to the surface.

Drawdown Lowering of the water surface (in open channel flow), water table or piezometric surface (in ground water flow) resulting from a withdrawal of water.

Drop-inlet spillway Overall structure in which the water drops through a vertical riser connected to a discharge conduit.

Drop spillway Overall structure in which the water drops over a vertical wall onto an apron at a lower elevation.

Drop structure A structure for dropping water to a lower level and dissipating its surplus energy; a fall. A drop may be vertical or inclined.

Dry weather flow The combination of ground water seepage and allowed non-stormwater flows found in storm sewers during dry weather. Also that flow in streams during the dry season.

EIS See Environmental Impact Statement.

ESC Erosion and Sediment Control (Plan).

Earth material Any rock, natural soil or fill and/or any combination thereof. Earth material shall not be considered topsoil used for landscape purposes. Topsoil used for landscaped purposes shall comply with ASTM D 5268 specifications. Engineered soil/landscape systems are also defined independently.

Easement The legal right to use a parcel of land for a particular purpose. It does not include fee ownership, but may restrict the owner's use of the land.

Effective Impervious Surface Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. Impervious surfaces are considered ineffective if: 1) the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 – "Full Dispersion"; 2) residential roof runoff is infiltrated in accordance with Downspout Full Infiltration Systems in BMP 5.10A; or 3) approved continuous runoff modeling methods indicate that the entire runoff file is infiltrated.

Embankment A structure of earth, gravel, or similar material raised to form a pond bank or foundation for a road.

Emergent plants Aquatic plants that are rooted in the sediment but whose leaves are at or above the water surface. These wetland plants often have high habitat value for wildlife and waterfowl, and can aid in pollutant uptake.

Emergency spillway A vegetated earth channel used to safely convey flood discharges in excess of the capacity of the principal spillway.

Emerging technology Treatment technologies that have not been evaluated with approved protocols, but for which preliminary data indicate that they may provide a necessary function(s) in a stormwater treatment system. Emerging technologies need additional evaluation to define design criteria to achieve, or to contribute to achieving, state performance goals, and to define the limits of their use.

Energy dissipater Any means by which the total energy of flowing water is reduced. In stormwater design, they are usually mechanisms that reduce velocity prior to, or at, discharge from an outfall in order to prevent erosion. They include rock splash pads, drop manholes, concrete stilling basins or baffles, and check dams.

Energy gradient The slope of the specific energy line (i.e., the sum of the potential and velocity heads).

Engineered soil/ landscape system This is a self-sustaining soil and plant system that simultaneously supports plant growth, soil microbes, water infiltration, nutrient and pollutant adsorption, sediment and pollutant biofiltration, water interflow, and pollution decomposition. The system shall be protected from compaction and erosion. The system shall be planted and/or mulched as part of the installation.

The engineered soil/plant system shall have the following characteristics:

a. Be protected from compaction and erosion.

b. Have a plant system to support a sustained soil quality.

c. Possess permeability characteristics of not less than 6.0, 2.0, and 0.6 inches/hour for hydrologic soil groups A, B, and C, respectively (per ASTM D 3385). D is less than 0.6 inches/hour.

d. Possess minimum percent organic matter of 12, 14, 16, and 18 percent (dry-weight basis) for hydrologic soil groups A, B, C, and D, respectively (per ASTM D 2974).

Engineering geology The application of geologic knowledge and principles in the investigation and evaluation of naturally occurring rock and soil for use in the design of civil works.

Engineering plan A plan prepared and stamped by a professional civil engineer.

Enhancement To raise value, desirability, or attractiveness of an environment associated with surface water.

Environmental Impact Statement (EIS) A document that discusses the likely significant adverse impacts of a proposal, ways to lessen the impacts, and alternatives to the proposal. They are required by the national and state environmental policy acts when projects are determined to have significant environmental impact.

Erodible granular soils Soil materials that are easily eroded and transported by running water, typically fine or medium grained sand with minor gravel, silt, or clay content. Such soils are commonly described as Everett or Indianola series soil types in the SCS classification. Also included are any soils showing examples of existing severe stream channel incision as indicated by unvegetated streambanks standing over two feet high above the base of the channel.

Erodible or leachable materials Wastes, chemicals, or other substances that measurably alter the physical or chemical characteristics of runoff when exposed to rainfall. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage.

Erosion The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. Also, detachment and movement of soil or rock fragments by water, wind, ice, or gravity. The following terms are used to describe different types of water erosion:

Accelerated erosion - Erosion much more rapid than normal or geologic erosion, primarily as a result of the influence of the activities of man or, in some cases, of the animals or natural catastrophes that expose bare surfaces (e.g., fires).

- Geological erosion - The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of floodplains, coastal plains, etc. Synonymous with natural erosion.
- Gully erosion - The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet.
- Natural erosion - Wearing away of the earth's surface by water, ice, or other natural agents under natural environmental conditions of

climate, vegetation, etc., undisturbed by man. Synonymous with geological erosion.

- Normal erosion - The gradual erosion of land used by man which does not greatly exceed natural erosion.
- Rill erosion - An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils. See Rill.
- Sheet erosion - The removal of a fairly uniform layer of soil from the land surface by runoff.
- Splash erosion - The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface runoff.

Erosion classes (soil survey) A grouping of erosion conditions based on the degree of erosion or on characteristic patterns. Applied to accelerated erosion, not to normal, natural, or geological erosion. Four erosion classes are recognized for water erosion and three for wind erosion.

Erosion and sedimentation control Any temporary or permanent measures taken to reduce erosion; control siltation and sedimentation; and ensure that sediment-laden water does not leave the site.

Erosion and sediment control facility A type of drainage facility designed to hold water for a period of time to allow sediment contained in the surface and stormwater runoff directed to the facility to settle out so as to improve the quality of the runoff.

Erosion impacts See "Flooding and erosion impacts"

Escarpment A steep face or a ridge of high land.

Estuarine wetland Generally, an eelgrass bed; salt marsh; or rocky, sandflat, or mudflat intertidal area where fresh and salt water mix. (Specifically, a tidal wetland with salinity greater than 0.5 parts per thousand, usually semi-enclosed by land but with partially obstructed or sporadic access to the open ocean).

Estuary An area where fresh water meets salt water, or where the tide meets the river current (e.g., bays, mouths of rivers, salt marshes and lagoons). Estuaries serve as nurseries and spawning and feeding grounds for large groups of marine life and provide shelter and food for birds and wildlife.

Eutrophication Refers to the process where nutrient over-enrichment of water leads to excessive growth of aquatic plants, especially algae.

Evapotranspiration The collective term for the processes of evaporation and plant transpiration by which water is returned to the atmosphere.

Excavation	The mechanical removal of earth material.
Exception	Relief from the application of a Minimum Requirement to a project.
Exfiltration	The downward movement of runoff through the bottom of an infiltration BMP into the soil layer or the downward movement of water through soil.
FIRM	See Flood Insurance Rate Map.
Fertilizer	Any material or mixture used to supply one or more of the essential plant nutrient elements.
Fill	A deposit of earth material placed by artificial means.
Filter fabric	A woven or nonwoven, water-permeable material generally made of synthetic products such as polypropylene and used in stormwater management and erosion and sediment control applications to trap sediment or prevent the clogging of aggregates by fine soil particles.
Filter fabric fence	A temporary sediment barrier consisting of a filter fabric stretched across and attached to supporting posts and entrenched. The filter fence is constructed of stakes and synthetic filter fabric with a rigid wire fence backing where necessary for support. Also commonly referred to in the Washington Department of Transportation standard specifications as “construction geotextile for temporary silt fences.”
Filter strip	A grassy area with gentle slopes that treats stormwater runoff from adjacent paved areas before it concentrates into a discrete channel.
Flocculation	The process by which suspended colloidal or very fine particles are assembled into larger masses or floccules which eventually settle out of suspension. This process occurs naturally but can also be caused through the use of such chemicals as alum.
Flood	An overflow or inundation that comes from a river or any other source, including (but not limited to) streams, tides, wave action, storm drains, or excess rainfall. Any relatively high stream flow overtopping the natural or artificial banks in any reach of a stream.
Flood control	Methods or facilities for reducing flood flows and the extent of flooding.
Flood control project	A structural system installed to protect land and improvements from floods by the construction of dikes, river embankments, channels, or dams.
Flood frequency	The frequency with which the flood of interest may be expected to occur at a site in any average interval of years. Frequency analysis defines the "n-year flood" as being the flood that will, over a long period of time, be equaled or exceeded on the average once every "n" years.

Flood fringe	That portion of the floodplain outside of the floodway which is covered by floodwaters during the base flood; it is generally associated with slower moving or standing water rather than rapidly flowing water.
Flood hazard areas	Those areas subject to inundation by the base flood. Includes, but is not limited to streams, lakes, wetlands, and closed depressions.
Flood Insurance Rate Map (FIRM)	The official map on which the Federal Emergency Management Agency has delineated many areas of flood hazard, floodway, and the risk premium zones.
Flood Insurance Study	The official report provided by the Federal Emergency Management Agency that includes flood profiles and the FIRM.
Flood peak	The highest value of the stage or discharge attained by a flood; thus, peak stage or peak discharge.
Floodplain	The total area subject to inundation by a flood including the flood fringe and floodway.
Flood-proofing	Adaptations that ensure a structure is substantially impermeable to the passage of water below the flood protection elevation that resists hydrostatic and hydrodynamic loads and effects of buoyancy.
Flood protection elevation	The base flood elevation or higher as defined by the local government.
Flood protection facility	Any levee, berm, wall, enclosure, raise bank, revetment, constructed bank stabilization, or armoring, that is commonly recognized by the community as providing significant protection to a property from inundation by flood waters.
Flood routing	An analytical technique used to compute the effects of system storage dynamics on the shape and movement of flow represented by a hydrograph.
Flood stage	The stage at which overflow of the natural banks of a stream begins.
Flooding or erosion impacts	Flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks/roadways; earth movement or settlement; erosion and other potential damage.
Floodway	The channel of the river or stream and those portions of the adjoining floodplains that is reasonably required to carry and discharge the base flood flow. The portions of the adjoining floodplains which are considered to be "reasonably required" are defined by flood hazard regulations.
Flow control BMP (or facility)	A drainage facility designed to mitigate the impacts of increased surface and stormwater runoff flow rates generated by development. Flow control facilities are designed either to hold water for a considerable length of time and then release it by

evaporation, plant transpiration, and/or infiltration into the ground, or to hold runoff for a short period of time, releasing it to the conveyance system at a controlled rate.

Flow duration The aggregate time that peak flows are at or above a particular flow rate of interest. For example, the amount of time that peak flows are at or above 50% of the 2-year peak flow rate for a period of record.

Flow frequency The inverse of the probability that the flow will be equaled or exceeded in any given year (the exceedance probability). For example, if the exceedance probability is 0.01 or 1 in 100, that flow is referred to as the 100-year flow.

Flow path The route that stormwater runoff follows between two points of interest.

Forebay An easily maintained, extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a pond or wetland BMP.

Forest practice Any activity conducted on or directly pertaining to forest land and relating to growing, harvesting, or processing timber, including but not limited to:

a. Road and trail construction.
b. Harvesting, final and intermediate.
c. Precommercial thinning.
d. Reforestation.
e. Fertilization.
f. Prevention and suppression of diseases and insects.
g. Salvage of trees.
h. Brush control.

Forested communities (wetlands) In general terms, communities (wetlands) characterized by woody vegetation that is greater than or equal to 6 meters in height; in this manual the term applies to such communities (wetlands) that represent a significant amount of tree cover consisting of species that offer wildlife habitat and other values and advance the performance of wetland functions overall.

Freeboard The vertical distance between the highest designed water surface elevation and the elevation of the crest of the facility. For example, in pond design, freeboard is the vertical distance between the emergency overflow water surface and the top of the pond embankment.

Frequently flooded areas The 100-year floodplain designations of the Federal Emergency Management Agency and the National Flood Insurance Program or as defined by the local government.

Frost-heave — The upward movement of soil surface due to the expansion of water stored between particles in the first few feet of the soil profile as it freezes. May cause surface fracturing of asphalt or concrete.

Frequency of storm (design storm frequency) — The anticipated period in years that will elapse, based on average probability of storms in the design region, before a storm of a given intensity and/or total volume will recur; thus a 10-year storm can be expected to occur on the average once every 10 years. Sewers designed to handle flows that occur under such storm conditions would be expected to be surcharged by any storms of greater amount or intensity.

Full Stabilization — Characterization of a site that has been disturbed when all erodible soils on the site are fully covered in paving, quarry spalls, rolled erosion control products, bonded fiber matrix products, vegetative cover or other permanent erosion prevention measures that fully prevent soil erosion on the site.

Fully controlled limited access highway — A highway where the right of owner or occupants of abutting land or other persons to access, light, air, or view in connection with the highway is controlled to give preference to through traffic by providing access connections with selected public roads only, and by prohibiting crossings or direct private driveway connections at grade. (See WAC 468-58-010)

Function(s) — The ecological (physical, chemical, and biological) processes or attributes of a wetland without regard for their importance to society (see also values). Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, floodflow alteration, ground water recharge and discharge, water quality improvement, and soil stabilization.

Gabion — A rectangular or cylindrical wire mesh cage (a chicken wire basket) filled with rock and used as a protecting agent, revetment, etc., against erosion. Soft gabions, often used in streambank stabilization, are made of geotextiles filled with dirt, in between which cuttings are placed.

Gage or gauge — Device for registering precipitation, water level, discharge, velocity, pressure, temperature, etc. Also, a measure of the thickness of metal; e.g., diameter of wire, wall thickness of steel pipe.

Gaging station — A selected section of a stream channel equipped with a gage, recorder, or other facilities for determining stream discharge.

Geologist — A person who has earned a degree in geology from an accredited college or university or who has equivalent educational training and has at least five years of experience as a practicing geologist or four years of experience and at least two years post-graduate study, research or teaching. The practical experience shall include at least three years work in applied geology and landslide evaluation, in close association with qualified practicing geologists or geotechnical professional/civil engineers.

Geologically hazardous areas Areas that because of their susceptibility to erosion, sliding, earthquake, or other geological events, are not suited to the siting of commercial, residential, or industrial development consistent with public health or safety concerns.

Geometrics The mathematical relationships between points, lines, angles, and surfaces used to measure and identify areas of land.

Geotechnical professional civil engineer A practicing, geotechnical/civil engineer licensed as a professional Civil Engineer with the State of Washington who has at least four years of professional employment as a geotechnical engineer in responsible charge, including experience with landslide evaluation.

Grade The slope of a road, channel, or natural ground. The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared for the support of construction such as paving or the laying of a conduit.

(To) Grade To finish the surface of a canal bed, roadbed, top of embankment or bottom of excavation.

Gradient terrace An earth embankment or a ridge-and-channel constructed with suitable spacing and an acceptable grade to reduce erosion damage by intercepting surface runoff and conducting it to a stable outlet at a stable nonerosive velocity.

Grassed waterway A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses, used to conduct surface water from an area at a reduced flow rate. See also biofilter.

Gross building area The total floor area of the building measuring from the outer surface of exterior walls and windows and including all vertical penetrations (e.g. elevator shafts, etc.) and basement space.

Ground water Water in a saturated zone or stratum beneath the land surface or a surface waterbody.

Ground water recharge Inflow to a ground water reservoir.

Ground water table The free surface of the ground water, that surface subject to atmospheric pressure under the ground, generally rising and falling with the season, the rate of withdrawal, the rate of restoration, and other conditions. It is seldom static.

Gully A channel caused by the concentrated flow of surface and stormwater runoff over unprotected erodible land.

Habitat The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all of the basic requirements for life and should be protected from harmful biological, chemical, and physical alterations.

Hardpan A cemented or compacted and often clay-like layer of soil that is impenetrable by roots. Also known as glacial till.

Hard Surface An impervious surface, a permeable pavement, or a vegetated roof.

Harmful pollutant A substance that has adverse effects to an organism including immediate death, chronic poisoning, impaired reproduction, cancer or other effects.

Head (hydraulics) The height of water above any plane of reference. The energy, either kinetic or potential, possessed by each unit weight of a liquid, expressed as the vertical height through which a unit weight would have to fall to release the average energy possessed. Used in various compound terms such as pressure head, velocity head, and head loss.

Head loss Energy loss due to friction, eddies, changes in velocity, or direction of flow.

Heavy metals Metals of high specific gravity, present in municipal and industrial wastes, that pose long-term environmental hazards. Such metals include cadmium, chromium, cobalt, copper, lead, mercury, nickel, and zinc.

High-use site High-use sites are those that typically generate high concentrations of oil due to high traffic turnover or the frequent transfer of oil. High-use sites include:

- An area of a commercial or industrial site subject to an expected average daily traffic (ADT) count equal to or greater than 100 vehicles per 1,000 square feet of gross building area;
- An area of a commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, not including routinely delivered heating oil;
- An area of a commercial or industrial site subject to parking, storage or maintenance of 25 or more vehicles that are over 10 tons gross weight (trucks, buses, trains, heavy equipment, etc.);
- A road intersection with a measured ADT count of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway, excluding projects proposing primarily pedestrian or bicycle use improvements.

Highway A main public road connecting towns and cities.

Hog fuel Wood-based mulch.

Horton overland flow A runoff process whereby the rainfall rate exceeds the infiltration rate, so that the precipitation that does not infiltrate flows downhill over the soil surface.

HSPF	**Hydrological Simulation Program-Fortran.** A continuous simulation hydrologic model that transforms an uninterrupted rainfall record into a concurrent series of runoff or flow data by means of a set of mathematical algorithms which represent the rainfall-runoff process at some conceptual level.
Humus	Organic matter in or on a soil, composed of partly or fully decomposed bits of plant tissue or from animal manure.
Hydraulic Conductivity	The quality of saturated soil that enables water or air to move through it. Also known as coefficient of permeability.
Hydraulic gradient	Slope of the potential head relative to a fixed datum.
Hydrodynamics	Means the dynamic energy, force, or motion of fluids as affected by the physical forces acting upon those fluids.
Hydrograph	A graph of runoff rate, inflow rate or discharge rate, past a specific point over time.
Hydrologic cycle	The circuit of water movement from the atmosphere to the earth and return to the atmosphere through various stages or processes as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.
Hydrologic Soil Groups	A soil characteristic classification system defined by the U.S. Soil Conservation Service in which a soil may be categorized into one of four soil groups (A, B, C, or D) based upon infiltration rate and other properties. <u>Type A:</u> Low runoff potential. Soils having high infiltration rates, even when thoroughly wetted, and consisting chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission. <u>Type B:</u> Moderately low runoff potential. Soils having moderate infiltration rates when thoroughly wetted, and consisting chiefly of moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. <u>Type C:</u> Moderately high runoff potential. Soils having slow infiltration rates when thoroughly wetted, and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine textures. These soils have a slow rate of water transmission. <u>Type D:</u> High runoff potential. Soils having very slow infiltration rates when thoroughly wetted, and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a hardpan, till, or clay layer at or near the surface, soils with a compacted subgrade at or near the surface, and shallow soils or nearly

	impervious material. These soils have a very slow rate of water transmission.[1] [1] Vladimir Novotny and Harvey Olem. *Water Quality Prevention, Identification, and Management of Diffuse Pollution,* Van Nostrand Reinhold: New York, 1994, p. 109.
Hydrology	The science of the behavior of water in the atmosphere, on the surface of the earth, and underground.
Hydroperiod	A seasonal occurrence of flooding and/or soil saturation; it encompasses depth, frequency, duration, and seasonal pattern of inundation.
Hyetograph	A graph of percentages of total precipitation for a series of time steps representing the total time in which precipitation occurs.
Illicit discharge	All non-stormwater discharges to stormwater drainage systems that cause or contribute to a violation of state water quality, sediment quality or ground water quality standards, including but not limited to sanitary sewer connections, industrial process water, interior floor drains, car washing, and greywater systems.
Illustration	A drawing, diagram, plan, profile or image that illustrates an engineering design or concept and provides suggested dimensions or specifications, which may not be used directly in a design without further engineering design and certification by a licensed professional engineer in the state of Washington.
Impact basin	A device used to dissipate the energy of flowing water. Generally constructed of concrete in the form of a partially depressed or partially submerged vessel, it may utilize baffles to dissipate velocities.
Impervious	A surface which cannot be easily penetrated. For instance, rain does not readily penetrate paved surfaces.
Impervious surface	A non-vegetated surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A non-vegetated surface area which causes water to run off the surface in greater quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, packed earthen materials, and oiled, macadam or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces for the purposes of determining whether the thresholds for application of minimum requirements are exceeded. Open, uncovered retention/detention facilities shall be considered impervious surfaces for purposes of runoff modeling.

Impoundment	A natural or man-made containment for surface water.
Improvement	Streets (with or without curbs or gutters), sidewalks, crosswalks, parking lots, water mains, sanitary and storm sewers, drainage facilities, street trees and other appropriate items.
Industrial activities	Material handling, transportation, or storage; manufacturing; maintenance; treatment; or disposal. Areas with industrial activities include plant yards, access roads and rail lines used by carriers of raw materials, manufactured products, waste material, or by-products; material handling sites; refuse sites; sites used for the application or disposal of process waste waters; sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to stormwater.
Infill	Infill projects (as defined in CCC section 40.260.110) are a type of new development or redevelopment for the purposes of this manual.
Infiltration	Means the downward movement of water from the surface to the subsoil.
Infiltration facility (or system)	A drainage facility designed to use the hydrologic process of surface and stormwater runoff soaking into the ground, commonly referred to as a percolation, to dispose of surface and stormwater runoff.
Infiltration rate	The rate, usually expressed in inches/hour, at which water moves downward (percolates) through the soil profile. Short-term infiltration rates may be inferred from soil analysis or derived from field measurements. Long-term infiltration rates are affected by variability in soils and subsurface conditions at the site, the effectiveness of pretreatment or influent control, and the degree of long-term maintenance of the infiltration facility.
Ingress/egress	The points of access to and from a property.
Inlet	A form of connection between surface of the ground and a drain or sewer for the admission of surface and stormwater runoff.
Insecticide	A substance, usually chemical, that is used to kill insects.
Interception (Hydraulics)	The process by which precipitation is caught and held by foliage, twigs, and branches of trees, shrubs, and other vegetation. Often used for "interception loss" or the amount of water evaporated from the precipitation intercepted.
Interflow	That portion of rainfall that infiltrates into the soil and moves laterally through the upper soil horizons until intercepted by a stream channel or until it returns to the surface for example, in a roadside ditch,

wetland, spring or seep. Interflow is a function of the soil system depth, permeability, and water-holding capacity.

Intermittent stream A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long-continued supply from melting snow or other sources. It is dry for a large part of the year, ordinarily more than three months.

Invasive weedy plant species Opportunistic species of inferior biological value that tend to out-compete more desirable forms and become dominant; applied to non-native species in this manual.

Invert The lowest point on the inside of a sewer or other conduit.

Invert elevation The vertical elevation of a pipe or orifice in a pond that defines the water level.

Isopluvial map A map with lines representing constant depth of total precipitation for a given return frequency.

Lag time The interval between the center of mass of the storm precipitation and the peak flow of the resultant runoff.

Lake An area permanently inundated by water in excess of two meters deep and greater than 20 acres in size as measured at the ordinary high water marks.

Land disturbing activity Any activity that results in a change in the existing soil cover (both vegetative and nonvegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to clearing, grading, filling, and excavation. Vegetation maintenance practices, including landscape maintenance and gardening, are not considered land-disturbing activity. Stormwater facility maintenance is not considered land disturbing activity if conducted according to established standards and procedures.

Landslide Episodic downslope movement of a mass of soil or rock that includes but is not limited to rockfalls, slumps, mudflows, and earthflows. For the purpose of these rules, snow avalanches are considered to be a special case of landsliding.

Landslide hazard areas Those areas subject to a severe risk of landslide.

Leachable materials Those substances that, when exposed to rainfall, measurably alter the physical or chemical characteristics of the rainfall runoff. Examples include erodible soils, uncovered process wastes, manure, fertilizers, oil substances, ashes, kiln dust, and garbage dumpster leakage.

Leachate Liquid that has percolated through soil and contains substances in solution or suspension.

Leaching	Removal of the more soluble materials from the soil by percolating waters.
Legume	A member of the legume or pulse family, Leguminosae, one of the most important and widely distributed plant families. The fruit is a "legume" or pod. Includes many valuable food and forage species, such as peas, beans, clovers, alfalfas, sweet clovers, and vetches. Practically all legumes are nitrogen-fixing plants.
Level pool routing	The basic technique of storage routing used for sizing and analyzing detention storage and determining water levels for ponding water bodies. The level pool routing technique is based on the continuity equation: Inflow – Outflow = Change in storage.
Level spreader	A temporary ESC device used to spread out stormwater runoff uniformly over the ground surface as sheet flow (i.e., not through channels). The purpose of level spreaders is to prevent concentrated, erosive flows from occurring, and to enhance infiltration.
LID	See Low Impact Development
Low flow channel	An incised or paved channel from inlet to outlet in a dry basin which is designed to carry low runoff flows and/or baseflow, directly to the outlet without detention.
Low Impact Development (LID)	A stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project design.
Low Impact Development (LID) Best Management Practices	Distributed stormwater management practices, integrated into a project design, that emphasize pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation and transpiration. LID BMPs include, but are not limited to, bioretention/rain gardens, permeable pavements, roof downspout controls, dispersion, soil quality and depth, minimal excavation foundations, vegetated roofs, and water re-use.
Low Impact Development (LID) Principles	Land use management strategies that emphasize conservation, use of on-site natural features, and site planning to minimize impervious surfaces, native vegetation loss, and stormwater runoff.
Low permeable liner	A layer of compacted till or clay, or a geomembrane.
Lowest floor	The lowest enclosed area (including basement) of a structure. An area used solely for parking of vehicles, building access, or storage, in an area other than a basement area, is not considered a building's lowest floor, provided that the enclosed area meets all of the structural requirements of the flood hazard standards.

MDNS A Mitigated Determination of Nonsignificance (See DNS and Mitigation).

Maintenance Repair and maintenance includes activities conducted on currently serviceable structures, facilities, and equipment that involves no expansion or use beyond that previously existing and results in no significant adverse hydrologic impact. It includes those usual activities taken to prevent a decline, lapse, or cessation in the use of structures and systems. Those usual activities may include replacement of dysfunctioning facilities, including cases where environmental permits require replacing an existing structure with a different type structure, as long as the functioning characteristics of the original structure are not changed. One example is the replacement of a collapsed, fish blocking, round culvert with a new box culvert under the same span, or width, of roadway. In regard to stormwater facilities, maintenance includes assessment to ensure ongoing proper operation, removal of built-up pollutants (i.e., sediments), replacement of failed or failing treatment media, and other actions taken to correct defects as identified in the maintenance standards of Book 4. See also Pavement Maintenance exemptions in Book 1, Chapter 1.

Manning's equation An equation used to predict the velocity of water flow in an open channel or pipelines:

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

where:

V is the mean velocity of flow in feet per second

R is the hydraulic radius in feet

S is the slope of the energy gradient or, for assumed uniform flow, the slope of the channel in feet per foot; and

n is Manning's roughness coefficient or retardance factor of the channel lining.

Mass wasting The movement of large volumes of earth material downslope.

Master drainage plan A comprehensive drainage control plan intended to prevent significant adverse impacts to the natural and manmade drainage system, both on and off-site.

Mean annual water level fluctuation Derived as follows:

(1) Measure the maximum water level (e.g., with a crest stage gage, Reinelt and Horner 1990) and the existing water level at the time of the site visit (e.g., with a staff gage) on at least eight occasions spread through a year.

(2) Take the difference of the maximum and existing water level

on each occasion and divide by the number of occasions.

Mean depth Average depth; cross-sectional area of a stream or channel divided by its surface or top width.

Mean velocity The average velocity of a stream flowing in a channel or conduit at a given cross-section or in a given reach. It is equal to the discharge divided by the cross-sectional area of the reach.

Measuring weir A shaped notch through which water flows is measured. Common shapes are rectangular, trapezoidal, and triangular.

Mechanical analysis The analytical procedure by which soil particles are separated to determine the particle size distribution.

Mechanical practices Soil and water conservation practices that primarily change the surface of the land or that store, convey, regulate, or dispose of runoff water without excessive erosion.

Metals Elements, such as mercury, lead, nickel, zinc and cadmium, which are of environmental concern because they do not degrade over time. Although many are necessary nutrients, they are sometimes magnified in the food chain, and they can be toxic to life in high enough concentrations. They are also referred to as heavy metals.

Microbes The lower trophic levels of the soil food web. They are normally considered to include bacteria, fungi, flagellates, amoebae, ciliates, and nematodes. These in turn support the higher trophic levels, such as mites and earthworms. Together they are the basic life forms that are necessary for plant growth. Soil microbes also function to bioremediate pollutants such as petroleum, nutrients, and pathogens.

Mitigation Means, in the following order of preference:

a. Avoiding the impact altogether by not taking a certain action or part of an action;

b. Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts;

c. Rectifying the impact by repairing, rehabilitating or restoring the affected environment;

d. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and

e. Compensating for the impact by replacing, enhancing, or providing substitute resources or environments.

Modification, modified (wetland) A wetland whose physical, hydrological, or water quality characteristics have been purposefully altered for a management purpose, such as by dredging, filling, forebay construction, and inlet

	or outlet control.
Monitor	To systematically and repeatedly measure something in order to track changes.
Monitoring	The collection of data by various methods for the purposes of understanding natural systems and features, evaluating the impacts of development proposals on such systems, and assessing the performance of mitigation measures imposed as conditions of development.
NGPE	See Native Growth Protection Easement.
NGVD	National Geodetic Vertical Datum.
NPDES	The National Pollutant Discharge Elimination System as established by the Federal Clean Water Act.
National Pollutant Discharge Elimination System (NPDES)	The part of the federal Clean Water Act, which requires point source dischargers to obtain permits. These permits are referred to as NPDES permits and, in Washington State, are administered by the Washington State Department of Ecology.
Native Growth Protection Easement (NGPE)	An easement granted for the protection of native vegetation within a sensitive area or its associated buffer. The NGPE shall be recorded on the appropriate documents of title and filed with the County Records Division.
Native vegetation	Vegetation comprised of plant species, other than noxious weeds, that are indigenous to the coastal region of the Pacific Northwest and which reasonably could have been expected to naturally occur on the site. Examples include trees such as Douglas fir, Western Hemlock, Western Red Cedar, Alder, Big-leaf Maple, and Vine Maple; shrubs such as willow, elderberry, salmonberry and salal; and herbaceous plants such as sword fern, foam flower, and fireweed.
Natural location	Means the location of those channels, swales, and other non-manmade conveyance systems as defined by the first documented topographic contours existing for the subject property, either from maps or photographs, or such other means as appropriate. In the case of outwash soils with relatively flat terrain, no natural location of surface discharge may exist.
New development	Land disturbing activities, including Class IV -general forest practices that are conversions from timber land to other uses; structural development, including construction or installation of a building or other structure; creation of hard surfaces; and subdivision, short subdivision and binding site plans, as defined and applied in Chapter 58.17 RCW. Projects meeting the definition of redevelopment shall not be considered new development.

Nitrate (NO_3)	A form of nitrogen which is an essential nutrient to plants. It can cause algal blooms in water if all other nutrients are present in sufficient quantities. It is a product of bacterial oxidation of other forms of nitrogen, from the atmosphere during electrical storms and from fertilizer manufacturing.
Nitrification	The biochemical oxidation process by which ammonia is changed first to nitrites and then to nitrates by bacterial action, consuming oxygen in the water.
Nitrogen, Available	Usually ammonium, nitrite, and nitrate ions, and certain simple amines available for plant growth. A small fraction of organic or total nitrogen in the soil is available at any time.
Nonpoint source pollution	Pollution that enters a waterbody from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances.
Normal depth	The depth of uniform flow. This is a unique depth of flow for any combination of channel characteristics and flow conditions. Normal depth is calculated using Manning's Equation.
Noxious Weed	The legal term for any invasive, non-native plant that threatens agricultural crops, local ecosystems or fish and wildlife habitat. Washington State law establishes several classes of noxious weed. Class A weeds are non-native plant species whose distribution in Washington is still limited. Preventing new infestations is the highest priority. Eradication of all Class A plants is required by law. Class B weeds are non-native species presently limited to portions of the state. Where Class B weeds are not yet widespread, preventing new infestations is the highest priority. Where Class B weeds are already abundant, a control strategy is decided at the local level with containment as the primary goal.
NRCS Method	A single-event hydrologic analysis technique for estimating runoff based on the Curve Number method. The Curve Numbers are published by NRCS in *Technical Release No. 55: Urban Hydrology for Small Watersheds, 1986*. With the change in name to the Natural Resource Conservation Service, the method may be referred to as the NRCS Method.
Nutrients	Essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and algal blooms. Some nutrients can be toxic at high concentrations.
Off-line facilities	Water quality treatment facilities to which stormwater runoff is restricted to some maximum flow rate or volume by a flow-splitter.
Off-site	Any area lying upstream of the site that drains onto the site and any area lying downstream of the site to which the site drains.

Off-system storage Facilities for holding or retaining excess flows over and above the carrying capacity of the stormwater conveyance system, in chambers, tanks, lagoons, ponds, or other basins that are not a part of the subsurface sewer system.

Oil/water separator A vault, usually underground, designed to provide a quiescent environment to separate oil from water.

On-line facilities Water quality treatment facilities which receive all of the stormwater runoff from a drainage area. Flows above the water quality design flow rate or volume are passed through at a lower percent removal efficiency.

On-site The entire property that includes the proposed development.

On-site Stormwater Management BMPs As used in this manual, a synonym for Low Impact Development BMPs.

Operational BMPs Operational BMPs are a type of Source Control BMP. They are schedules of activities, prohibition of practices, and other managerial practices to prevent or reduce pollutants from entering stormwater. Operational BMPs include formation of a pollution prevention team, good housekeeping, preventive maintenance procedures, spill prevention and clean-up, employee training, inspections of pollutant sources and BMPs, and record keeping. They can also include process changes, raw material/product changes, and recycling wastes.

Ordinary high water mark The term ordinary high water mark means the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank; shelving; changes in the character of soil destruction on terrestrial vegetation, or the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding area.

The ordinary high water mark will be found by examining the bed and banks of a stream and ascertaining where the presence and action of waters are so common and usual, and so long maintained in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation. In any area where the ordinary high water mark cannot be found, the line of mean high water shall substitute. In any area where neither can be found, the channel bank shall be substituted. In braided channels and alluvial fans, the ordinary high water mark or substitute shall be measured so as to include the entire stream feature.

Organic matter Organic matter as decomposed animal or vegetable matter. It is measured by ASTM D 2974. Organic matter is an important reservoir of carbon and a dynamic component of soil and the carbon cycle. It improves soil and plant efficiency by improving soil physical properties including drainage, aeration, and other structural characteristics. It contains the nutrients, microbes, and higher-form

	soil food web organisms necessary for plant growth. The maturity of organic matter is a measure of its beneficial properties. Raw organic matter can release water-soluble nutrients (similar to chemical fertilizer). Beneficial organic matter has undergone a humification process either naturally in the environment or through a composting process.
Orifice	An opening with closed perimeter, usually sharp-edged, and of regular form in a plate, wall, or partition through which water may flow, generally used for the purpose of measurement or control of water.
Outlet	Point of water disposal from a stream, river, lake, tidewater, or artificial drain.
Outlet channel	A waterway constructed or altered primarily to carry water from man-made structures, such as terraces, tile lines, and diversions.
Outwash soils	Soils formed from highly permeable sands and gravels.
Overflow	A pipeline or conduit device, together with an outlet pipe, that provides for the discharge of portions of combined sewer flows into receiving waters or other points of disposal, after a regular device has allowed the portion of the flow which can be handled by interceptor sewer lines and pumping and treatment facilities to be carried by and to such water pollution control structures.
Overflow rate	Detention basin release rate divided by the surface area of the basin. It can be thought of as an average flow rate through the basin.
Overtopping	To flow over the limits of a containment or conveyance element.
Partially controlled limited access highway	A highway where the right of owner or occupants of abutting land or other persons to access, light, air, or view in connection with the highway is controlled to give preference to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings and some private driveway connections at grade. (See WAC 468-58-010)
Particle Size	The effective diameter of a particle as measured by sedimentation, sieving, or micrometric methods.
Peak discharge	The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.
Peak-shaving	Controlling post-development peak discharge rates to pre-development levels by providing temporary detention in a BMP.
Percolation	The movement of water through soil.
Percolation rate	The rate, often expressed in minutes/inch, at which clear water, maintained at a relatively constant depth, will seep out of a standardized test hole that has been previously saturated. The term

percolation rate is often used synonymously with infiltration rate (short-term infiltration rate).

Permanent Stormwater Control (PSC) Plan	A plan which includes permanent BMPs for the control of pollution from stormwater runoff after construction and/or land disturbing activity has been completed
Permeable pavement	Pervious concrete, porous asphalt, permeable pavers or other forms of pervious or porous paving material intended to allow passage of water through the pavement section. It often includes an aggregate base that provides structural support and acts as a stormwater reservoir.
Permeable soils	Soil materials with a sufficiently rapid infiltration rate so as to greatly reduce or eliminate surface and stormwater runoff. These soils are generally classified as SCS hydrologic soil types A and B.
Person	Any individual, partnership, corporation, association, organization, cooperative, public or municipal corporation, agency of the state, or local government unit, however designated.
Perviousness	Related to the size and continuity of void spaces in soils; related to a soil's infiltration rate.
Pervious Surface	A surface material that allows stormwater to infiltrate into the ground. Examples include lawn, landscape, pasture, native vegetation areas, and permeable pavements.
Pesticide	A general term used to describe any substance - usually chemical - used to destroy or control organisms; includes herbicides, insecticides, algicides, fungicides, and others. Many of these substances are manufactured and are not naturally found in the environment. Others, such as pyrethrum, are natural toxins that are extracted from plants and animals.
pH	A measure of the alkalinity or acidity of a substance which is conducted by measuring the concentration of hydrogen ions in the substance. A pH of 7.0 indicates neutral water. A 6.5 reading is slightly acid.
Physiographic	Characteristics of the natural physical environment (including hills).
Plan Approval Authority	The Plan Approval Authority is defined as that department within a local government that has been delegated authority to approve stormwater site plans.
Planned unit development (PUD)	A special classification authorized in some zoning ordinances, where a unit of land under control of a single developer may be used for a variety of uses and densities, subject to review and approval by the local governing body. The locations of the zones are usually decided on a case-by-case basis.

Plat — A map or representation of a subdivision showing the division of a tract or parcel of land into lots, blocks, streets, or other divisions and dedications.

Plunge pool — A device used to dissipate the energy of flowing water that may be constructed or made by the action of flowing. These facilities may be protected by various lining materials.

Point discharge — The release of collected and/or concentrated surface and stormwater runoff from a pipe, culvert, or channel.

Point of compliance — The location at which compliance with a discharge performance standard or a receiving water quality standard is measured.

Pollution — Contamination or other alteration of the physical, chemical, or biological properties, of waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to the public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.

Pollution-generating hard surface (PGHS) — Those hard surfaces considered to be a significant source of pollutants in stormwater runoff. See the listing of surfaces under pollution-generating impervious surface.

Pollution-generating impervious surface (PGIS) — Those impervious surfaces considered to be a significant source of pollutants in stormwater runoff. Such surfaces include those which are subject to: vehicular use; industrial activities (as further defined in this glossary); or storage of erodible or leachable materials, wastes, or chemicals, and which receive direct rainfall or the run-on or blow-in of rainfall; metal roofs unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating); or roofs that are subject to venting significant amounts of dusts, mists, or fumes from manufacturing, commercial, or other indoor activities.

Pollution-generating pervious surface (PGPS) — Any non-impervious surface subject to vehicular use, industrial activities (as further defined in this glossary); or storage of erodible or leachable materials, wastes or chemicals, and that receive direct rainfall or run-on or blow-in of rainfall, use of pesticides and fertilizers, or loss of soil. Typical PGPS include permeable pavement subject to vehicular use, lawns and landscaped areas including: golf courses, parks, cemeteries, and sports fields (natural and artificial turf).

Predeveloped Condition — The native vegetation and soils that existed at a site prior to the influence of Euro-American settlement. The pre-developed condition shall be assumed to be forested land cover unless reasonable, historic information is provided that indicates the site was prairie prior to settlement.

Prediction For the purposes of this document an expected outcome based on the results of hydrologic modeling and/or the judgment of a trained professional civil engineer or geologist.

Pretreatment The removal of material such as solids, grit, grease, and scum from flows prior to physical, biological, or physical treatment processes to improve treatability. Pretreatment may include screening, grit removal, settling, oil/water separation, or application of a Basic Treatment BMP prior to infiltration.

Priority peat systems Unique, irreplaceable fens that can exhibit water pH in a wide range from highly acidic to alkaline, including fens typified by Sphagnum species, Ledum groenlandicum (Labrador tea), Drosera rotundifolia (sundew), and Vaccinium oxycoccos (bog cranberry); marl fens; estuarine peat deposits; and other moss peat systems with relatively diverse, undisturbed flora and fauna. Bog is the common name for peat systems having the Sphagnum association described, but this term applies strictly only to systems that receive water income from precipitation exclusively.

Professional civil engineer A person registered with the state of Washington as a professional engineer in civil engineering.

Project Any proposed action to alter or develop a site. The proposed action of a permit application or an approval, which requires drainage review.

Project site That portion of a property, properties, or right of way subject to land disturbing activities, new hard surfaces, or replaced hard surfaces.

Properly Functioning Soil System (PFSS) Equivalent to engineered soil/landscape system. This can also be a natural system that has not been disturbed or modified.

Puget Sound basin Puget Sound south of Admiralty Inlet (including Hood Canal and Saratoga Passage); the waters north to the Canadian border, including portions of the Strait of Georgia; the Strait of Juan de Fuca south of the Canadian border; and all the lands draining into these waters as mapped in Water Resources Inventory Areas numbers 1 through 19, set forth in WAC 173-500-040.

R/D See Retention/detention facility.

Rain garden A non-engineered shallow, landscaped depression, with compost-amended native soils and adapted plants. The depression is designed to pond and temporarily store stormwater runoff from adjacent areas, and to allow stormwater to pass through the amended soil profile.

Rare, threatened, or endangered species Plant or animal species that are regional relatively uncommon, are nearing endangered status, or whose existence is in immediate jeopardy and is usually restricted to highly specific habitats. Threatened and endangered species are officially listed by federal and state authorities, whereas rare species are unofficial species of concern that fit the above definitions.

Rational method A means of computing storm drainage flow rates (Q) by use of the formula Q = CIA, where C is a coefficient describing the physical drainage area, I is the rainfall intensity and A is the area. This method is no longer used in the technical manual.

Reach A length of channel with uniform characteristics.

Receiving waters Bodies of water or surface water systems to which surface runoff is discharged via a point source of stormwater or via sheet flow. Ground water to which surface runoff is directed by infiltration.

Recharge The addition of water to the zone of saturation (i.e., an aquifer).

Recommended BMPs As used in Book 3, recommended BMPs are those BMPs that are not mandatory at new development and redevelopment sites or at existing business sites. However, they may improve pollutant control efficiency, and may provide better source control of pollutants.

Redevelopment On a site that is already substantially developed (i.e., has 35% or more of existing hard surface coverage), the creation or addition of hard surfaces; the expansion of a building footprint or addition or replacement of a structure; structural development including construction, installation or expansion of a building or other structure; replacement of hard surface that is not part of a routine maintenance activity; and land disturbing activities.

Regional An action (here, for stormwater management purposes) that involves more than one discrete property.

Regional detention facility A stormwater quantity control structure designed to correct existing surface water runoff problems of a basin or subbasin. The area downstream has been previously identified as having existing or predicted significant and regional flooding and/or erosion problems.

This term is also used when a detention facility is sited to detain stormwater runoff from a number of new developments or areas within a catchment.

Release rate The computed peak rate of surface and stormwater runoff from a site.

Replaced hard surface For structures, the removal and replacement of hard surfaces down to the foundation. For other hard surfaces, the removal down to bare soil or base course and replacement.

Replaced impervious surface For structures, the removal and replacement of impervious surfaces down to the foundation. For other impervious surfaces, the removal down to bare soil or base course and replacement.

Required BMPs As used in Book 3, required BMPs are those operational and structural source control BMPs that are mandatory at new development and redevelopment sites, where applicable, and at commercial, industrial, and multifamily properties, where applicable.

Residential density The number of dwelling units per unit of surface area. Net density includes only occupied land. Gross density includes unoccupied portions of residential areas, such as roads and open space.

Responsible official The Clark County Manager or their designee.

Restoration Actions performed to reestablish wetland functional characteristics and processes that have been lost by alterations, activities, or catastrophic events in an area that no longer meets the definition of a wetland.

Retention The process of collecting and holding surface and stormwater runoff with no surface outflow.

Retention/detention facility (R/D) A type of drainage facility designed either to hold water for a considerable length of time and then release it by evaporation, plant transpiration, and/or infiltration into the ground; or to hold surface and stormwater runoff for a short period of time and then release it to the surface and stormwater management system.

Retrofitting The renovation of an existing structure or facility to meet changed conditions or to improve performance.

Return frequency A statistical term for the average time of expected interval that an event of some kind will equal or exceed given conditions (e.g., a stormwater flow that occurs every 2 years).

Rhizome A modified plant stem that grows horizontally underground.

Riffles Fast sections of a stream where shallow water races over stones and gravel. Riffles usually support a wider variety of bottom organisms than other stream sections.

Rill A small intermittent watercourse with steep sides, usually only a few inches deep. Often rills are caused by an increase in surface water flow when soil is cleared of vegetation.

Riprap A facing layer or protective mound of rocks placed to prevent erosion or sloughing of a structure or embankment due to flow of surface and stormwater runoff.

Riparian Pertaining to the banks of streams, wetlands, lakes, or tidewater.

Riser A vertical pipe extending from the bottom of a pond BMP that is used to control the discharge rate from a BMP for a specified design storm.

Road-related Development Land-disturbing activity where the sole objective is the development or redevelopment of roads, sidewalks, and bike lanes.

Rodenticide A substance used to destroy rodents.

Runoff Water originating from rainfall and other precipitation that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes and

	wetlands as well as shallow ground water. As applied in this manual, it also means the portion of rainfall or other precipitation that becomes surface flow and interflow.
SCS	Soil Conservation Service (now the Natural Resources Conservation Service), U.S. Department of Agriculture.
SCS Method	See NRCS Method.
NRCS Method	A single-event hydrologic analysis technique for estimating runoff based on the Curve Number method. The Curve Numbers are published by NRCS in *Technical Release No. 55: Urban Hydrology for Small Watersheds, 1986*. With the change in name to the Natural Resource Conservation Service, the method may be referred to as the NRCS Method.
Secondary Containment	Placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest tank within the containment structure.
SEPA	See State Environmental Policy Act.
Salmonid	A member of the fish family Salmonidae. Chinook, coho, chum, sockeye and pink salmon; cutthroat, brook, brown, rainbow, and steelhead trout; Dolly Varden, kokanee, and char are examples of salmonid species.
Sand filter	A man-made depression or basin with a layer of sand that treats stormwater as it percolates through the sand and is discharged via a central collector pipe.
Saturation point	In soils, the point at which a soil or an aquifer will no longer absorb any amount of water without losing an equal amount.
Scour	Erosion of channel banks due to excessive velocity of the flow of surface and stormwater runoff.
Sediment	Fragmented material that originates from weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.
Sedimentation	The depositing or formation of sediment.
Sensitive emergent vegetation communities	Assemblages of erect, rooted, herbaceous vegetation, excluding mosses and lichens, at least some of whose members have relatively narrow ranges of environmental requirements, such as hydroperiod, nutrition, temperature, and light. Examples include fen species such as sundew and, as well as a number of species of Carex (sedges).
Sensitive life stages	Stages during which organisms have limited mobility or alternatives in securing the necessities of life, especially including reproduction, rearing, and migration periods.
Sensitive scrub-shrub	Assemblages of woody vegetation less than 6 meters in height, at

vegetation communities	least some of whose members have relatively narrow ranges of environmental requirements, such as hydroperiod, nutrition, temperature, and light. Examples include fen species such as Labrador tea, bog laurel, and cranberry.
Settleable solids	Those suspended solids in stormwater that separate by settling when the stormwater is held in a quiescent condition for a specified time.
Sheet erosion	The relatively uniform removal of soil from an area without the development of conspicuous water channels.
Sheet flow	Runoff that flows over the ground surface as a thin, even layer, not concentrated in a channel.
Shoreline development	The proposed project as regulated by the Shoreline Management Act. Usually the construction over water or within a shoreline zone (generally 200 feet landward of the water) of structures such as buildings, piers, bulkheads, and breakwaters, including environmental alterations such as dredging and filling, or any project which interferes with public navigational rights on the surface waters.
Short circuiting	The passage of runoff through a BMP in less than the design treatment time.
Siltation	The process by which a river, lake, or other waterbody becomes clogged with sediment. Silt can clog gravel beds and prevent successful salmon spawning.
Site	The area defined by the legal boundaries of a parcel or parcels of land that is (are) subject to new development or redevelopment. For road projects, the length of the project site and the right-of-way boundaries define the site.
Slope	Degree of deviation of a surface from the horizontal; measured as a numerical ratio, percent, or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second is the vertical distance (rise), as 2:1. A 2:1 slope is a 50 percent slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90° slope being vertical (maximum) and 45° being a 1:1 or 100 percent slope.
Sloughing	The sliding of overlying material. It is the same effect as caving, but it usually occurs when the bank or an underlying stratum is saturated or scoured.
Soil	The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. See also topsoil, engineered soil/landscape system, and properly functioning soil system.
Soil group, hydrologic	A classification of soils by the Soil Conservation Service into four runoff potential groups. The groups range from A soils, which are very

	permeable and produce little or no runoff, to D soils, which are not very permeable and produce much more runoff.
Soil horizon	A layer of soil, approximately parallel to the surface, which has distinct characteristics produced by soil-forming factors.
Soil profile	A vertical section of the soil from the surface through all horizons, including C horizons.
Soil structure	The relation of particles or groups of particles which impart to the whole soil a characteristic manner of breaking; some types are crumb structure, block structure, platy structure, and columnar structure.
Soil permeability	The ease with which gases, liquids, or plant roots penetrate or pass through a layer of soil.
Soil stabilization	The use of measures such as rock lining, vegetation or other engineering structures to prevent the movement of soil when loads are applied to the soil.
Soil Texture Class	The relative proportion, by weight, of particle sizes, based on the USDA system, of individual soil grains less than 2 mm equivalent diameter in a mass of soil. The basic texture classes in the approximate order of increasing proportions of fine particles include: sand, loamy sand, sandy loam, loam, silt loam, silt, clay loam, sandy clay, silty clay, and clay.
Sorption	The physical or chemical binding of pollutants to sediment or organic particles.
Source control BMP	A structure or operation that is intended to prevent pollutants from coming into contact with stormwater through physical separation of areas or careful management of activities that are sources of pollutants. This manual separates source control BMPs into two types. *Structural Source Control BMPs* are physical, structural, or mechanical devices or facilities that are intended to prevent pollutants from entering stormwater. *Operational BMPs* are non-structural practices that prevent or reduce pollutants from entering stormwater. See Book 3 for details.
Spill control device	A Tee section or turn down elbow designed to retain a limited volume of pollutant that floats on water, such as oil or antifreeze. Spill control devices are passive and must be cleaned-out for the spilled pollutant to actually be removed.
Spillway	A passage such as a paved apron or channel for surplus water over or around a dam or similar obstruction. An open or closed channel, or both, used to convey excess water from a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of excess water.

Standard Detail — An engineering design for a facility object or facility, stamped by a registered professional engineer in the state of Washington, provided by Clark County for use in engineering designs for the convenience of design and review engineers that must be used exactly as shown in Clark County's official standard details book.

State Environmental Policy Act (SEPA)

RCW 43.21C

The Washington State law intended to minimize environmental damage. SEPA requires that state agencies and local governments consider environmental factors when making decisions on activities, such as development proposals over a certain size and comprehensive plans. As part of this process, environmental documents are prepared and opportunities for public comment are provided.

Steep slope — Slopes of 40 percent gradient or steeper within a vertical elevation change of at least ten feet. A slope is delineated by establishing its toe and top, and is measured by averaging the inclination over at least ten feet of vertical relief. For the purpose of this definition:

The toe of a slope is a distinct topographic break in slope that separates slopes inclined at less than 40% from slopes 40% or steeper. Where no distinct break exists, the toe of a steep slope is the lower-most limit of the area where the ground surface drops ten feet or more vertically within a horizontal distance of 25 feet; AND

The top of a slope is a distinct topographic break in slope that separates slopes inclined at less than 40% from slopes 40% or steeper. Where no distinct break exists, the top of a steep slope is the upper-most limit of the area where the ground surface drops ten feet or more vertically within a horizontal distance of 25 feet.

Storage routing — A method to account for the attenuation of peak flows passing through a detention facility or other storage feature.

Storm drains — The enclosed conduits that transport surface and stormwater runoff toward points of discharge (sometimes called storm sewers).

Storm frequency — The time interval between major storms of predetermined intensity and volumes of runoff for which storm sewers and other structures are designed and constructed to handle hydraulically without surcharging and backflooding, e.g., a 2-year, 10-year or 100-year storm.

Storm sewer — A sewer that carries stormwater and surface water, street wash and other wash waters or drainage, but excludes sewage and industrial wastes. Also called a storm drain.

Stormwater — That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, pipes and other features of a stormwater drainage system into a defined surface waterbody, or a constructed infiltration facility.

Stormwater drainage — Constructed and natural features which function together as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate,

system	divert, treat or filter stormwater.
Stormwater facility	A constructed component of a stormwater drainage system, designed or constructed to perform a particular function, or multiple functions. Stormwater facilities include, but are not limited to, pipes, swales, ditches, culverts, street gutters, detention ponds, retention ponds, constructed wetlands, infiltration devices, catch basins, oil/water separators, and biofiltration swales.
Stormwater Management Manual for Western Washington (SMMWW)	A manual, prepared by Ecology, that contains BMPs to prevent, control or treat pollution in stormwater and reduce other stormwater-related impacts to waters of the State. The Stormwater Manual is intended to provide guidance on measures necessary in western Washington to control the quantity and quality of stormwater runoff from new development and redevelopment.
Stormwater Program	Either the Basic Stormwater Program or the Comprehensive Stormwater Program (as appropriate to the context of the reference) called for under the Puget Sound Water Quality Management Plan.
Stormwater Site Plan	The comprehensive report containing all of the technical information and analysis necessary for Clark County to evaluate a proposed new development or redevelopment project for compliance with stormwater requirements.
Stream gaging	The quantitative determination of stream flow using gages, current meters, weirs, or other measuring instruments at selected locations. See Gaging station.
Streambanks	The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.
Streams	Those areas where surface waters flow sufficiently to produce a defined channel or bed. A defined channel or bed is an area that demonstrates clear evidence of the passage of water and includes, but is not limited to, indicated by hydraulically sorted sediments or the removal of vegetative litter or loosely rooted vegetation by the action of moving water. The channel or bed need not contain water year-round. This definition is not meant to include irrigation ditches, canals, stormwater runoff devices or other entirely artificial watercourses unless they are used to convey streams naturally occurring prior to construction. Those topographic features that resemble streams but have no defined channels (i.e. swales) shall be considered streams when hydrologic and hydraulic analyses done pursuant to a development proposal predict formation of a defined channel after development.
Structure	A catchbasin or manhole in reference to a storm drainage system.
Structural source control BMPs	Physical, structural, or mechanical devices or facilities that are intended to prevent pollutants from entering stormwater. Structural

source control BMPs typically include:

- Enclosing and/or covering the pollutant source (building or other enclosure, a roof over storage and working areas, temporary tarp, etc.).
- Segregating the pollutant source to prevent run-on of stormwater, and to direct only contaminated stormwater to appropriate treatment BMPs.

Stub-out A short length of pipe provided for future connection to a storm drainage system.

Subbasin A drainage area that drains to a water-course or waterbody named and noted on common maps and which is contained within a basin.

Subcatchment A subdivision of a drainage basin (generally determined by topography and pipe network configuration).

Subdrain A pervious backfilled trench containing stone or a pipe for intercepting ground water or seepage.

Subgrade A layer soil used as the underlying base for a BMP.

Subsoil The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below the plowed soil (or its equivalent of surface soil), in which roots normally grow. Although a common term, it cannot be defined accurately. It has been carried over from early days when "soil" was conceived only as the plowed soil and that under it as the "subsoil."

Substantial completion Substantial completion means: a) following inspection, stormwater facilities are operational and constructed to county standards; b) streets are constructed and at least one lift of asphalt is installed when paving is required; and c) the project is in full compliance with CCC 40.386.

Substrate The natural soil base underlying a BMP.

Surcharge The flow condition occurring in closed conduits when the hydraulic grade line is above the crown of the sewer.

Surface and stormwater Water originating from rainfall and other precipitation that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes, and wetlands as well as shallow ground water.

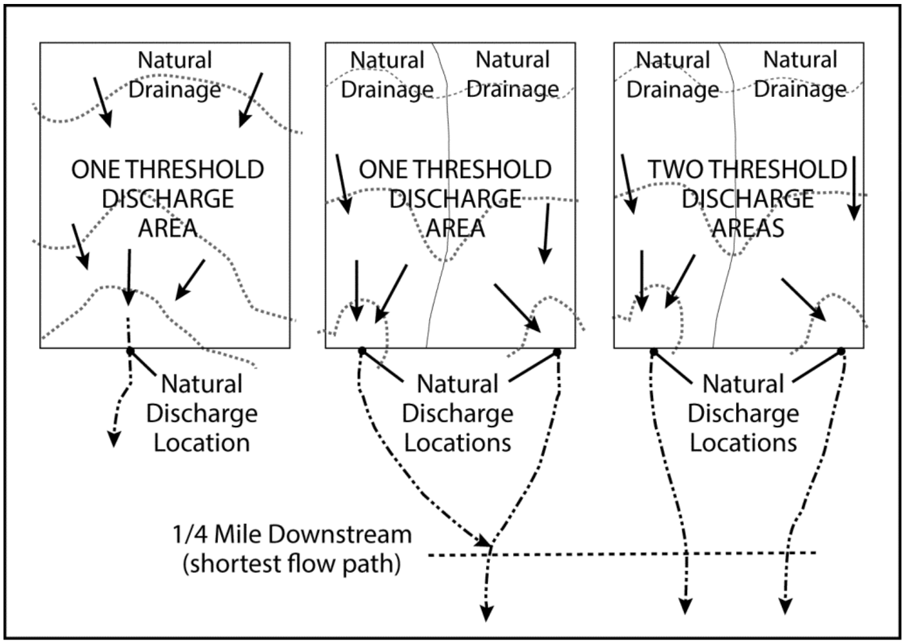
Surface and stormwater management system Drainage facilities and any other natural features that collect, store, control, treat and/or convey surface and stormwater.

Suspended solids Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles (and associated pollutants) as well as solids in stormwater.

Swale — A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than one foot.

Terrace — An embankment or combination of an embankment and channel across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Threshold Discharge Area (TDA) — An on-site area draining to a single natural discharge location or multiple natural discharge locations that combines within one-quarter mile downstream (as determined by the shortest flowpath). The purpose of this definition is to clarify how the thresholds of this manual are applied to project sites with multiple discharge points.



Tightline — A continuous length of pipe that conveys water from one point to another (typically down a steep slope) with no inlets or collection points in between.

Tile, Drain — Pipe made of burned clay, concrete, or similar material, in short lengths, usually laid with open joints to collect and carry excess water from the soil.

Tile drainage — Land drainage by means of a series of tile lines laid at a specified depth and grade.

Till — A layer of poorly sorted soil deposited by glacial action that generally has very low infiltration rates.

Time of concentration — The time period necessary for surface runoff to reach the outlet of a subbasin from the hydraulically most remote point in the tributary drainage area.

Topography	General term to include characteristics of the ground surface such as plains, hills, mountains, degree of relief, steepness of slopes, and other physiographic features.
Topsoil	The upper portion of a soil, usually dark colored and rich in organic material. It is more or less equivalent to the upper portion of an A horizon in an ABC soil.
Total dissolved solids	The dissolved salt loading in surface and subsurface waters.
Total Petroleum Hydrocarbons (TPH)	TPH-Gx: The qualitative and quantitative method (extended) for volatile (“gasoline”) petroleum products in water; and TPH-Dx: The qualitative and quantitative method (extended) for semi-volatile (“diesel”) petroleum products in water.
Total solids	The solids in water, sewage, or other liquids, including the dissolved, filterable, and nonfilterable solids. The residue left when the moisture is evaporated and the remainder is dried at a specified temperature, usually 130°C.
Total suspended solids	That portion of the solids carried by stormwater that can be captured on a standard glass filter.
Total Maximum Daily Load (TMDL) – Water Cleanup Plan	A calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant’s sources. A TMDL (also known as a Water Cleanup Plan) is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonable variation in water quality. Water quality standards are set by states, territories, and tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation (swimming), and aquatic like support (fishing), and the scientific criteria to support that use. The Clean Water Act, section 303, establishes the water quality standards and TMDL programs.
Toxic	Poisonous, carcinogenic, or otherwise directly harmful to life.
Tract	A legally created parcel of property designated for special nonresidential and noncommercial uses.
Trash rack	A structural device used to prevent debris from entering a spillway or other hydraulic structure.
Travel time	The estimated time for surface water to flow between two points of interest.
Treatment BMP or Facility	A BMP that is intended to remove pollutants from stormwater. A few examples of treatment BMPs are Wetponds, oil/water separators, biofiltration swales, and constructed wetlands.

Treatment liner	A layer of soil that is designed to slow the rate of infiltration and provide sufficient pollutant removal so as to protect ground water quality.
Treatment train	A combination of two or more treatment facilities connected in series.
Turbidity	Dispersion or scattering of light in a liquid, caused by suspended solids and other factors; commonly used as a measure of suspended solids in a liquid.
Underdrain	Plastic pipes with holes drilled through the top, installed on the bottom of an infiltration BMP, which are used to collect and remove excess runoff.
Undisturbed buffer	A zone where development activity shall not occur, including logging, and/or the construction of utility trenches, roads, and/or surface and stormwater facilities.
Undisturbed low gradient uplands	Forested land, sufficiently large and flat to infiltrate surface and storm runoff without allowing the concentration of water on the surface of the ground.
Unstable slopes	Those sloping areas of land which have in the past exhibited, are currently exhibiting, or will likely in the future exhibit, mass movement of earth.
Unusual biological community types	Assemblages of interacting organisms that are relatively uncommon regionally.
Urbanized area	Areas designated and identified by the U.S. Bureau of Census according to the following criteria: an incorporated place and densely settled surrounding area that together have a maximum population of 50,000.
U.S. EPA	The United States Environmental Protection Agency.
Values	Wetland processes or attributes that are valuable or beneficial to society (also see Functions). Wetland values include support of commercial and sport fish and wildlife species, protection of life and property from flooding, recreation, education, and aesthetic enhancement of human communities.
Variance	See Exception.
Vegetation	All organic plant life growing on the surface of the earth.
Vegetated Flow Path	When used for dispersion BMPs, the route stormwater follows between two points over land that contains undisturbed native vegetation or an area that meets BMP T5.13.
Vehicular Use	Regular use of an impervious or pervious surface by motor vehicles. The following are subject to regular vehicular use: roads, un-vegetated road shoulders, bike lanes within the traveled lane of a roadway,

	driveways, parking lots, unrestricted access fire lanes, vehicular equipment storage yards, and airport runways. The following are not considered subject to regular vehicular use: paved bicycle pathways separated from and not subject to drainage from roads for motor vehicles, restricted access fire lanes, and infrequently used maintenance access roads.
Waterbody	Surface waters including rivers, streams, lakes, marine waters, estuaries, and wetlands.
Water Cleanup Plan	See Total Maximum Daily Load
Water quality	A term used to describe the chemical, physical, and biological characteristics off water, usually in respect to its suitability for a particular purpose.
Water quality design storm	The 24-hour rainfall amount with a 6-month return frequency. Commonly referred to as the 6-month, 24-hour storm.
Water quality standards	Minimum requirements of purity of water for various uses; for example, water for agricultural use in irrigation systems should not exceed specific levels of sodium bicarbonate, pH, total dissolved salts, etc. In Washington, the Department of Ecology sets water quality standards.
Watershed	A geographic region within which water drains into a particular river, stream, or body of water. Watersheds can be as large as those identified and numbered by the State of Washington Water Resource Inventory Areas (WRIAs) as defined in Chapter 173-500 WAC.
Water table	The upper surface or top of the saturated portion of the soil or bedrock layer, indicates the uppermost extent of ground water.
Weir	Device for measuring or regulating the flow of water.
Weir notch	The opening in a weir for the passage of water.
Wetlands	Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from non-wetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from non-wetland areas to mitigate the conversion of wetlands.

Wetland edge Delineation of the wetland edge shall be based on the U.S. Army Corps of Engineers Wetlands Delineation Manual, Technical Report Y-87-1, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Miss. (1987)

Wetponds and wetvaults Drainage facilities for water quality treatment that contain permanent pools of water that are filled during the initial runoff from a storm event. They are designed to optimize water quality by providing retention time in order to settle out particles of fine sediment to which pollutants such as heavy metals absorb, and to allow biologic activity to occur that metabolizes nutrients and organic pollutants.

Wetpool A pond or constructed wetland that stores runoff temporarily and whose normal discharge location is elevated so as to maintain a permanent pool of water between storm events.

Wet Season October 1 to April 30

Winter Season December 21 to March 21

Zoning ordinance An ordinance based on the police power of government to protect the public health, safety, and general welfare. It may regulate the type of use and intensity of development of land and structures to the extent necessary for a public purpose. Requirements may vary among various geographically defined areas called zones. Regulations generally cover such items as height and bulk of buildings, density of dwelling units, off-street parking, control of signs, and use of land for residential, commercial, industrial, or agricultural purposes. A zoning ordinance is one of the major methods for implementation of a comprehensive plan.

Appendix 1-B

Alternative Flow Control Standards from Basin Plans

Mill Creek Alternative Flow Control Standard

Projects draining to Mill Creek downstream of NE 67th Avenue shall use the following pre-developed land cover based upon interpretation of Clark County 2002 aerial photography:

- Areas that are forested in 2002 shall be modeled as pre-developed forest.
- Areas that are impervious surfaces, landscaped areas and pasture shall be modeled as pre-developed pasture.

Projects draining to Mill Creek upstream of NE 67th Avenue shall use forested pre-developed land cover unless reasonable historic information is provided that indicates the site was prairie prior to settlement.

Appendix 1-C

Infiltration Test Methods

Infiltration Test Methods

ASCE Approach: Single-Ring Falling Head Infiltration Test

This section describes both the field test procedure and calculations necessary for determining the field-measured coefficient of permeability. This coefficient must be adjusted using correction factors before being used for designing infiltration facilities.

Test Procedure

This test procedure is based in large part on mathematical equations derived from Darcy's Law for saturated flow in homogeneous isotropic media. Begin the infiltration test procedure by embedding a 6-inch-diameter, 15-inch-long, rigid standpipe 6 inches (L, as shown in Figure 1) into the ground at the depth and location of the proposed test. The standpipe should be as thin-walled as practical, and the pipe should be carefully pressed or inserted vertically into the soil. Saturate or presoak the soil by maintaining measurable water in the standpipe for at least 4 hours. (A 4-hour presoak phase is assumed to allow adequate soil saturation to properly measure and calculate the coefficient of permeability. This should be verified by ensuring that the cumulative water drop in inches during the saturation period exceeds the standpipe embedment depth.) Figure 1 shows the test configuration and relevant parameters.

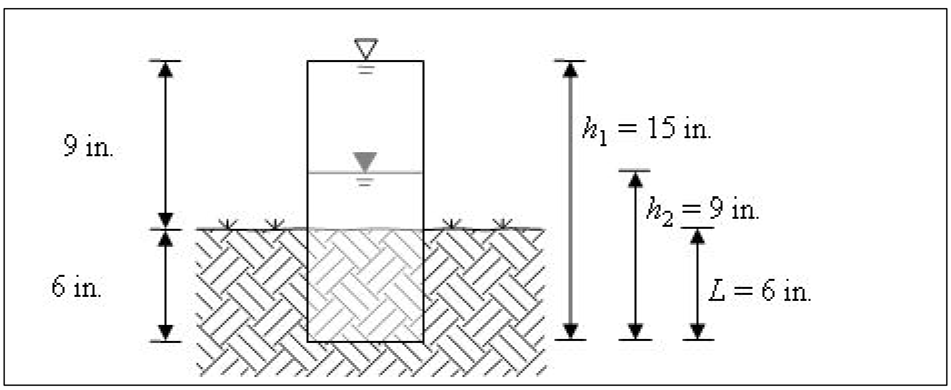


Figure 1: Single-Ring Falling Head Infiltration Test Procedure

(Source: ASCE 2009)

After the saturation period, fill the pipe to the top (i.e., the pipe will contain a 9-inch vertical column of free water). Note that although the pipe contains 9 inches of water, the initial system head (h_1) is 15 inches because head is measured from the top of the free water surface to the bottom of the soil specimen inside the pipe. Perform as many repeated 6-inch drawdown trials as can be completed in a 1-hour time period (i.e., allow the water in the pipe to drop from 15 to 9 inches [h_1 to h_2], and then repeat the process). Conclude the field test and record the following parameters:

field observed drawdown rate

L = length of flow (in)
t = time (hr)
h_1 = initial head (in)
h_2 = final head (in)

If the water level does not drop 6 inches in a 1-hour time period, the test can be concluded after 1 hour by recording the drawdown rate as the drop over the 1-hour time period. The applicable test parameters (L, t, h_1, and h_2) should also be recorded. In this case, h_2 would equal h_1 minus the amount of water drop observed over the 1-hour time period.

If desired, 6-inch drawdown trials may be performed during the saturation period. If three consecutive 6-inch drawdown trials indicate the rate has stabilized to within 5 percent variation between all three trials, the test may be concluded and the average rate of the three tests may be recorded as the drawdown rate. The applicable test parameters should also be recorded.

Calculations

After the field test procedure has been performed and the relevant test parameters recorded, the coefficient of permeability is calculated using Equation 1. The coefficient of permeability obtained from Equation 1 is the approximate rate at which water can be expected to infiltrate vertically into a given soil surface under long-term saturated flow conditions. This value should be reported by the geotechnical engineer/geologist as the soil coefficient of permeability for the tested location.

Equation 1

$$k = (L/t) * \ln(h_1/h_2)$$

where:

k = coefficient of permeability (in/hr)
L = length of flow (in)
t = time (hr)
h_1 = initial head (in)
h_2 = final head (in)

The recommended test configuration and procedure has been developed so that the observed drawdown rate can be divided in half to achieve the approximate coefficient of permeability. However, different test configurations can be used to fit varying site conditions or test depths. In all cases, the coefficient of permeability shall be calculated using Equation 1 and the principles outlined in the following procedure.

Modification to the Recommended Single-Ring Falling Head Infiltration Test Procedures

The recommended test configuration described above has been designed to produce an observed drawdown rate that is approximately twice the coefficient of permeability due to careful selection of the test configuration and geometry. It is important to note that the coefficient of permeability will equal approximately one-half of the observed drawdown rate only when full 6-inch drawdown trials are conducted, and the relevant test parameters equal those indicated in the standpipe schematic shown in Figure 1. However, the test configuration, standpipe length, embedment depth, and other parameters may be modified by an experienced geotechnical professional, provided that Equation 1 is used to calculate the coefficient of permeability. This provides the professional consultant with flexibility to modify or tailor the test configuration, based on site-specific conditions. When the test configuration or procedure is modified, implications of the modifications such as the ones listed below must be considered.

- Standpipe diameters smaller than 6 inches may be adversely affected by the presence of large gravels or cobbles.
- Standpipe embedments of less than 6 inches in some granular soils may result in an inadequate seal around the pipe and subsequent seepage around the pipe tip, which may result in an overestimate of the coefficient of permeability.

Excessive head in the standpipe may result in an overestimate of the coefficient of permeability. The head shall be limited to one-half the height of the anticipated water depth in the proposed infiltration system (e.g., a field test for a pond with a maximum retained water depth of 3 feet shall have a maximum head of 1.5 feet).

Alternative Test Procedure – Auger Borehole

While the test pit and falling head method recommended above are the preferred methods for infiltration testing, they are neither feasible nor practical in some environments. Examples of such environments include cohesionless soils where open test pits pose a collapse hazard, systems at depths deeper than the reach of standard construction excavation equipment, or developed sites with existing asphalt or concrete pavements.

In such situations, infiltration testing is often conducted in exploratory hollow-stem auger boreholes by geotechnical engineers and geologists. Auger borehole infiltration testing is an acceptable alternative to the suggested methods, provided the test method and calculation of the coefficient of permeability follow the test procedure below.

Test Procedure – Auger Borehole

Advance an auger borehole to the desired elevation of the infiltration test. The auger must be hollow-stem, or the boring must be cased to prevent lateral leakage. Sample subsurface soils at depth to confirm that appropriately granular soils are present at or below the auger tip. Log the boring (as described in Section 4.4) in accordance with Unified Soil Classification System (USCS) specifications, and collect a soil sample from the zone where the infiltration test is performed.

As the tip of the auger reaches the test zone, apply down pressure to the drill pipe and advance the auger slightly into the soil to form a seal. Withdraw the inner plug and rod from the hollow-stem auger to expose the test zone soil inside the auger. Measure and record the inner auger diameter (d). Pour water into the standpipe or auger and saturate the soils, as described for the standard test.

After the presoak period, establish an initial head of water in the auger (h_1). Depending on the soil gradation, range of expected infiltration rates, and proposed depth of retained water in the future infiltration system, the head level may vary based on the geotechnical professional's recommendations. However, an initial head in excess of 4 feet or greater than the future depth of retained water in the system is not recommended. Also, water levels should not rise above joints between auger sections, so water does not leak out of the joints and skew drawdown readings.

Begin conducting the infiltration test by recording the time (t) required for the head in the auger to drop from the initial head (h_1) to the final head (h_2). Refill the standpipe or auger and conduct multiple test runs until relatively constant rates are achieved (less than 5 percent variation between three consecutive trials). An electric water level probe, indicator rod with pegs set at a 6-inch interval, or a float and tape may be used to accurately measure the drop in head over elapsed time. Figure 2 shows the auger borehole test configuration and relevant parameters.

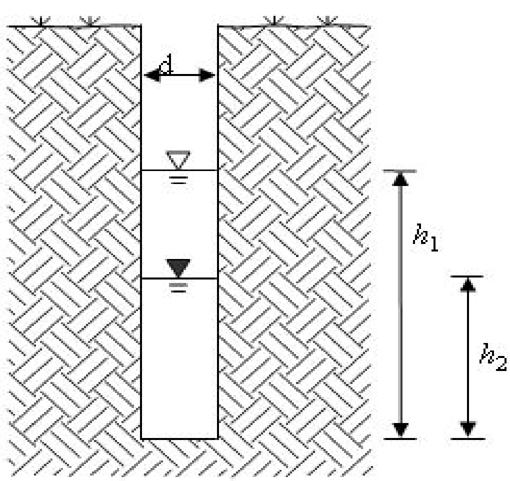


Figure 2: Single-Ring Falling Head Infiltration Test Procedure (Auger Borehole Method)

(Source: ASCE 2009 d, h_1, h_2, and t).

Calculations – Auger Borehole

After the field test procedure has been performed and the relevant test parameters recorded, the coefficient of permeability should be calculated using Equation 2 (Lambe and Whitman 1969). Equation 2 applies only for coefficient of permeability calculations using the auger borehole method. The value obtained from Equation 2 should be reported by the geotechnical professional as the soil coefficient of permeability for the tested location.

Equation 2

$$k = (\pi * d)/(11 * t) * \ln(h_1/h_2)$$

where:
k = coefficient of permeability (in/hr)
d = diameter of borehole (in)
t = time (hr)
h_1 = initial head (in)
h_2 = final head (in)

Test Limitations

It should be noted that the coefficient of permeability calculations identified above are based on ideal homogenous isotropic media. Because Clark County soils are often fluvially deposited, stratified, and interbedded, they are frequently neither homogenous nor isotropic. This may result in permeability coefficients that vary with depth and direction. Groundwater mounding or an elevated seasonal groundwater table may also affect the infiltration rate. In rare cases, the soil's ability to infiltrate water may be determined by its horizontal rather than vertical coefficient of permeability. The design professional should verify whether these are reasonable assumptions to allow for an approximate estimate of the soil coefficient of permeability. If not, specialized testing or analysis may be required.

Infiltration systems can be expected to undergo long-term degradation of infiltration capacity as a result of siltation, debris collection, and soil crusting; therefore, a correction factor must be calculated into the coefficient of permeability for the design of infiltration systems. Correction factors as described in Section 4.5.4 must be applied to the calculated coefficient of permeability to determine the allowable design infiltration rate.

The test limitations described above for the suggested standard methods also apply to the auger borehole method. In addition, the borehole method assumes flush soil at the bottom of the auger and groundwater levels sufficiently below the depth of the test. Soil swelling, segregation, and consolidation are assumed to be negligible. Hydraulic loss in the auger is also assumed to be negligible.

Large-Scale Pilot Infiltration Test (PIT)

Large-scale in-situ infiltration measurements, using the Pilot Infiltration Test (PIT) described below can be used for estimating the measured (initial) coefficient of permeability of the soil profile beneath the proposed infiltration facility. It is not a standard test but rather a field procedure recommended by a Technical Advisory Committee put together by the Washington State Department of Ecology.

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. Lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be approximately 100 square feet. Accurately document the size and geometry of the test pit.
- Install a vertical measuring rod (minimum 5-ft. long) marked in half-inch increments in the center of the pit bottom.
- Use a rigid 6-inch diameter pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates.
- Add water to the pit at a rate that will maintain a water level between 6 and 12 inches above the bottom of the pit. A rotameter can be used to measure the flow rate into the pit.

  Note: The depth should not exceed the proposed maximum depth of water expected in the completed facility. For infiltration facilities serving large drainage areas, designs with multiple feet of standing water can have infiltration tests with greater than 1 foot of standing water.

- Every 15-30 min, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.
- Keep adding water to the pit until one hour after the flow rate into the pit has stabilized (constant flow rate; a goal of 5% variation or less variation in the total flow) while maintaining the same pond water level. The total of the pre-soak time plus one hour after the flow rate has stabilized should be no less than 6 hours.
- After the flow rate has stabilized for at least one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty. Consider running this falling head phase of the test several times to estimate the dependency of infiltration rate with head.
- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the

engineer or certified soils professional. Mounding is an indication that a mounding analysis is necessary.

Data Analysis

Calculate and record the saturated hydraulic conductivity rate in inches per hour in 30 minutes or one-hour increments until one hour after the flow has stabilized.

Note: Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

Apply appropriate correction factors to determine the site-specific design infiltration rate. See the discussion of correction factors for infiltration facilities in Section 4.5.4 and the discussion of correction factors for bioretention facilities and permeable pavement in Section 3.4.

Example

The area of the bottom of the test pit is 8.5-ft. by 11.5-ft. Water flow rate was measured and recorded at intervals ranging from 15 to 30 minutes throughout the test. Between 400 minutes and 1,000 minutes the flow rate stabilized between 10 and 12.5 gallons per minute or 600 to 750 gallons per hour, or an average of (9.8 + 12.3) / 2 = 11.1 inches per hour.

Small-Scale Pilot Infiltration Test

A smaller-scale PIT can be substituted for the large-scale PIT in any of the following instances.

- The drainage area to the infiltration site is less than 1 acre.
- The testing is for the LID BMPs of bioretention or permeable pavement that either serve small drainage areas and /or are widely dispersed throughout a project site.
- The site has a high infiltration rate, making a full-scale PIT difficult, and the site geotechnical investigation suggests uniform subsurface characteristics.

Infiltration Test

- Excavate the test pit to the estimated surface elevation of the proposed infiltration facility. In the case of bioretention, excavate to the estimated elevation at which the imported soil mix will lie on top of the underlying native soil. For permeable pavements, excavate to the elevation at which the imported subgrade materials, or the pavement itself, will contact the underlying native soil. If the native soils (road subgrade) will have to meet a minimum subgrade compaction requirement, compact the native soil to that requirement prior to testing. Note that the permeable pavement design guidance recommends compaction not exceed 90% - 92%. Finally, lay back the slopes sufficiently to avoid caving and erosion during the test. Alternatively, consider shoring the sides of the test pit.
- The horizontal surface area of the bottom of the test pit should be 12 to 32 square feet. It may be circular or rectangular, but accurately document the size and geometry of the test pit.
- Install a vertical measuring rod adequate to measure the ponded water depth and that is marked in half-inch increments in the center of the pit bottom.
- Use a rigid pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the pond bottom. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates. Use a 3 inch diameter pipe for pits on the smaller end of the recommended surface area, and a 4 inch pipe for pits on the larger end of the recommended surface area.
- Pre-soak period: Add water to the pit so that there is standing water for at least 6 hours. Maintain the pre-soak water level at least 12 inches above the bottom of the pit.
- At the end of the pre-soak period, add water to the pit at a rate that will maintain a 6-12 inch water level above the bottom of the pit over a full hour. The depth should not exceed the proposed maximum depth of water expected in the completed facility.
- Every 15 minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point (between 6 inches and 1 foot) on the measuring rod. The specific depth should be the same as the maximum designed ponding depth (usually 6 – 12 inches).
- After one hour, turn off the water and record the rate of infiltration (the drop rate of the standing water) in inches per hour from the measuring rod data, until the pit is empty.

- A self-logging pressure sensor may also be used to determine water depth and drain-down.
- At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by the engineer or certified soils professional. The soils professional should judge whether a mounding analysis is necessary.

Data Analysis

See the explanation under the guidance for large-scale pilot infiltration tests.

Soil Grain Size Analysis Method

For each defined layer below the infiltration pond to a depth below the pond bottom of 2.5 times the maximum depth of water in the pond, but not less than 10 feet, estimate the initial coefficient of permeability(COP) in cm/sec using the following relationship (see Massmann 2003, and Massmann et al., 2003). For large infiltration facilities serving drainage areas of 10 acres or more, soil grain size analyses should be performed on layers up to 50 feet deep (or no more than 10 feet below the water table).

Equation 3

$$log_{10}(COP) = -1.57+1.90D_{10}+0.015D_{60}-0.013D_{90}-2.08f_{fines}$$

Where, D_{10}, D_{60} and D_{90} are the grain sizes in mm for which 10 percent, 60 percent and 90 percent of the sample is more fine and f_{fines} is the fraction of the soil (by weight) that passes the number-200 sieve (COP is in cm/s).

For bioretention facilities, analyze each defined layer below the top of the final bioretention area subgrade to a depth of at least 3 times the maximum ponding depth, but not less than 3 feet (1 meter). For permeable pavement, analyze for each defined layer below the top of the final subgrade to a depth of at least 3 times the maximum ponding depth within the base course, but not less than 3 feet (1 meter).

If the licensed professional conducting the investigation determines that deeper layers will influence the rate of infiltration for the facility, soil layers at greater depths must be considered when assessing the site's hydraulic conductivity characteristics. Massmann (2003) indicates that where the water table is deep, soil or rock strata up to 100 feet below an infiltration facility can influence the rate of infiltration. Note that only the layers near and above the water table or low permeability zone (e.g., a clay, dense glacial till, or rock layer) need to be considered, as the layers below the ground water table or low permeability zone do not significantly influence the rate of infiltration. Also note that this equation for estimating COP assumes minimal compaction consistent with the use of tracked (i.e., low to moderate ground pressure) excavation equipment.

If the soil layer being characterized has been exposed to heavy compaction (e.g., due to heavy equipment with narrow tracks, narrow tires, or large lugged, high pressure tires) the hydraulic conductivity for the layer could be approximately an order of magnitude less than what would be estimated based on grain size characteristics alone (Pitt, 2003). In such cases, compaction effects must be taken into account when estimating hydraulic conductivity.

For clean, uniformly graded sands and gravels, the reduction in COP due to compaction will be much less than an order of magnitude. For well-graded sands and gravels with moderate to high silt content, the reduction in COP will be close to an order of magnitude. For soils that contain clay, the reduction in COP could be greater than an order of magnitude.

If greater certainty is desired, the in-situ saturated conductivity of a specific layer can be obtained through the use of a pilot infiltration test (PIT). Note that these field tests generally provide a COP combined with a hydraulic gradient. In some of these tests, the hydraulic gradient may be close to 1.0; therefore, in effect, the test infiltration rate result is the same as the hydraulic conductivity. In other cases, the hydraulic gradient may be close to the gradient that is likely to occur in the full-scale infiltration facility. The hydraulic gradient will need to be evaluated on a case-by-case basis when interpreting the results of field tests. It is important to recognize that the gradient in the test may not be the same as the gradient likely to occur in the full-scale infiltration facility in the long-term (i.e., when ground water mounding is fully developed).

Once the COP for each layer has been identified, determine the effective average COP below the pond. COP estimates from different layers can be combined using the harmonic mean:

Equation 4

$$K_{equiv} = \frac{d}{\sum \frac{d_i}{K_i}}$$

Where, d is the total depth of the soil column, d_i is the thickness of layer "i" in the soil column, and K_i is the coefficient of permeability of layer "i" in the soil column. The depth of the soil column, d, typically would include all layers between the pond bottom and the water table. However, for sites with very deep water tables (>100 feet) where ground water mounding to the base of the pond is not likely to occur, it is recommended that the total depth of the soil column in Equation 4 be limited to approximately 20 times the depth of pond, but not more than 50 feet. This is to ensure that the most important and relevant layers are included in the hydraulic conductivity calculations. Deep layers that are not likely to affect the infiltration rate near the pond bottom should not be included in Equation 4.

Equation 4 may over-estimate the effective COP value at sites with low conductivity layers immediately beneath the infiltration pond. For sites where the lowest conductivity layer is within five feet of the base of the pond, it is suggested that this lowest COP value be used as the equivalent hydraulic conductivity rather than the value from Equation 4. Using the layer with the lowest COP is advised for designing bioretention facilities or permeable pavements. The harmonic mean given by Equation 4 is the appropriate effective hydraulic conductivity for flow that is perpendicular to stratigraphic layers, and will produce conservative results when flow has a significant horizontal component such as could occur due to ground water mounding.

Appendix 1-D

Clark County Historic Prairie Areas

Prairie Areas
Prior to European Settlement
Clark County, WA

Source: Pre-Settlement Prairie Areas in Vancouver, WA (Otak, 2009)

Legend

Historic Prairie

Appendix 1-E

LID Feasibility Checklist

LID Feasibility Checklist

Project Title and Case Number: ____

Applicant: ____

Date: _________________ **TDA #:** ________________

***Instructions**: Fill out a LID Feasibility Checklist for each TDA on the project. Submit the completed checklist with the Preliminary TIR (see Section 1.8.1.5).*

Step 1: Indicate which mandatory list of LID BMPs is applicable to the project in accordance with Minimum Requirement #5 and the flow chart in Figure 2.1 in Book 1. Check the corresponding box in Section 1 below. For projects meeting the LID Performance Standard, this checklist does not apply.

Step 2: Indicate which type(s) of surfaces will be present within the TDA in Section 2.

Step 3: Consider feasibility criteria and setbacks in Section 3.

Section 1: Required LID BMPs

☐ List #1 (Table 3.1) ☐ List #2 (Table 3.2) ☐ BMPs in Table 3.3

Section 2: Surfaces

☐ Roofs ☐ Hard surfaces other than roofs

Section 3: Feasibility Criteria

For each type of surface selected in Section 2, consider BMPs in the order indicated in the required list or table selected in Section 1.

For each question, place a mark in either the Yes or No column. For each No answer, move on to the subsequent question within the BMP. If a Yes answer is given, then the BMP is not feasible in the TDA and is not required in accordance with Minimum Requirement #5. If No answers are given to all questions, then the BMP is feasible in the TDA and must be implemented in accordance with Minimum Requirement #5. When feasibility of the BMP has been determined, then select the appropriate box in the Determination section.

For each type of surface, stop at the first BMP that is feasible.

Answers to questions must consider site-specific information, and some may require professional written evaluation as justification. Please see Book 1, Chapter 2 for more information.

FULL DISPERSION BMP T5.30A	Roof		Surfaces	
Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
Will the project protect and maintain less than 65% of the TDA in a forested native condition?				
Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%				
Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……………………………………………………………………………				

	DISPERSION TO PASTURE OR CROPLAND BMP T5.30B	Roof		Surfaces	
	Applicability and Setbacks	YES	NO	YES	NO
	Is the project site 22,000 square feet or less?				
	Will the project protect and maintain less than 75% of the site or TDA as pasture or cropland or be covered in more than 15% impervious surfaces?				
	Does use of the pasture or cropland for purposes other than plant growth (e.g. unpaved roads, equipment storage, animal pens, haystacks, wheel lines, campsites, trails, etc.) take up more than 10% of the area to be used for dispersion?				
	Does the site prohibit a minimum dispersion flow path through pasture or cropland of 300 feet?				
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Is the only location available for the discharge less than 100 feet upgradient of a septic system?				
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 5%?				
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined in CCC 40.430?				
	Is the only area available to place the dispersion device or required flowpath less than 10 feet from any structure, property line, or sensitive area?				
	Are crops other than grass, grain, row crops (including berries, nursery stock, and orchards) grown in the proposed flowpath?				
	Is the pasture/cropland under different ownership than the project site?				
	If the crop or pasture land is predominantly covered in soils with an infiltration rate greater than 4 inches per hour, was the pasture or cropland cleared after November 2009?				
	Is there less than 3 feet between the surface elevation along the dispersion flowpath and the average annual maximum groundwater elevation?				
Determination: Is this BMP feasible? ……………………………………………………………………………………					

	ROOF DOWNSPOUT FULL INFILTRATION BMPs T5.10A and T5.10B	Roof			
	Feasibility Criteria and Setbacks	YES	NO		
Note: this BMP is not applicable to surfaces other than roofs.	Has a qualified professional determined that soils in the infiltration zone at the location of the infiltration BMP do not fall within USDA textural classes of coarse sand to medium sand, loam, or cobbles and gravels?				
	Is there less than 3 feet of permeable soil from the proposed finished ground elevation at the drywell or trench location to the seasonal high groundwater table?				
	Is there less than 1 foot of soil from the proposed bottom elevation of the roof downspout control to the groundwater elevation?				
	Is the proposed location on a slope of 25% (4:1) or greater and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet from a closed or active landfill and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any small on-site sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground, and cannot reasonably be located elsewhere?				
	Is the proposed location less than 100 feet upgradient of a septic system unless topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?				
	Is the proposed location less than 10 feet from any structure, property line, or sensitive area and cannot reasonably be located elsewhere? [Note: this setback may be waived at the applicant's request in certain situations in accordance with Book 1, Section 2.5.1.4.]				
	Is the proposed location less than 200 feet from the top of any slope greater than 40% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……………………………………………………………………………………					

DOWNSPOUT DISPERSION BMP T5.10C		Roof			
	Setbacks	YES	NO		
Note: this BMP is not applicable to surfaces other than roofs.	Is the proposed location less than 10 feet from any sewage disposal drainfield, including reserve areas and grey water reuse systems, and cannot reasonably be located elsewhere?				
	Is the proposed discharge location less than 100 feet upgradient of a septic system drainfield, unless site topography clearly prohibits subsurface flows from intersecting the drainfield and cannot reasonably be located elsewhere?				
	Is the proposed discharge point less than 10 feet from any structure or property line and cannot reasonably be located elsewhere?				
	Is the proposed discharge point less than 50 feet from the top of any slope greater than 15% and cannot reasonably be located elsewhere? [Note: The Responsible Official may consider reducing this setback to 15 feet based on a geotechnical evaluation. If requested, submit a geotechnical report with this checklist for County review.]				
Determination: Is this BMP feasible? ……………………………………………………………………………………					

SHEET FLOW DISPERSION BMP T5.12 and CONCENTRATED FLOW DISPERSION BMP T5.11		Roof		Surfaces	
	Feasibility Criteria and Setbacks	YES	NO	YES	NO
	Does a professional geotechnical evaluation recommend dispersion not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Is the only location available for the discharge location less than 100 feet upgradient of a septic system drainfield on the site?				
	Is the only area available for the required length of the BMP's flowpath on a slope greater than 20%				
	Is the only area available for the required length of the BMP's flowpath above an erosion hazard or toward a landslide hazard area?				
	Is the only area available to place the dispersion device (not the flowpath) located in a critical area or critical area buffer?				
	Is the only area available to place the dispersion device (not the flowpath) located on a slope greater than 20% or within 50 feet of a geohazard as defined by CCC 40.430?				
	Is the only area available for the BMP less than 10 feet from any structure, property line, or sensitive area?				
Determination: Is this BMP feasible? ……………………………………………………………………………………					

RAIN GARDEN BMP T5.14A and BIORETENTION BMP T5.14B		Roof		Surfaces	
	Infeasibility Criteria and Setbacks	YES	NO	YES	NO
	Has the Responsible Official determined that the BMP is not compatible with surrounding drainage systems (e.g. projects draining to existing stormwater collection system whose elevation or locale precludes connection to a properly functioning bioretention system)?				
	Is the land for the BMP within an area designated as an erosion hazard or landslide hazard by the geotechnical report or county critical areas mapping?				
	Can the site not reasonably be designed to locate the BMP on slopes less than 8%?				
	On properties with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and any of the following criteria:				
	o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?				
	o Is the site is in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?				
	o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?				
	o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?				
	[End soil / groundwater contamination sub-list.]				
	For a bioretention system or a rain garden that would serve a drainage area that is 1) less than 5,000 sq. ft. of pollution-generating impervious surface, and 2) less than 10,000 sq. ft. of impervious surface, and 3) less than ¾ acres of pervious surface, is the minimum vertical separation of one foot to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?				
	For a bioretention system that would 1) serve a drainage area that is a) 5,000 sq. ft. or more of pollution-generating impervious surface, or b) 10,000 sq. ft. or more of impervious surface, or c) ¾ acres or more of pervious surface, and 2) cannot reasonably be broken down into amounts smaller than indicated in (1), is the minimum vertical separation of three feet to seasonal high water table, bedrock or other impervious layer unable to be achieved below the BMP?				
	Does field testing indicates that soils have a measured (a.k.a. initial) native soil coefficient of permeability less than 0.3 inches per hour?				
	Is the BMP less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief and cannot reasonably be located elsewhere?				
Questions continue on following page.	Is the BMP less than 100 feet from a landfill (active or closed) and cannot reasonably be located elsewhere?				

Is the BMP less than 100 feet from a drinking water well or a spring used for drinking water and cannot reasonably be located elsewhere?				
Is the BMP less than 10 feet from any small on-site sewage disposal drain field, including reserve areas, and grey water reuse systems and cannot reasonably be located elsewhere? For setbacks from a “large on-site sewage disposal system,” see Chapter 246-272B WAC.				
Is the BMP less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground and when the capacity of the tank and pipe system is less than 1100 gallons and cannot reasonably be located elsewhere?				
Is the BMP less than 100 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is underground and when the capacity of the tank and pipe system is greater than 1100 gallons and cannot reasonably be located elsewhere?				
For a bioretention system or rain garden that would serve a drainage area of less than 5,000 sq. ft. of pollution-generating impervious surface and less than 10,000 sq. ft. of impervious surface, is the BMP less than 10 feet away from any structure or property line and cannot reasonably be located elsewhere?				
For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 20 feet from the downslope side of any foundation, structure or property line and cannot reasonably be located elsewhere?				
For a bioretention system that would serve a drainage area of 5,000 sq. ft. or greater of pollution-generating impervious surface or 10,000 sq. ft. or greater of impervious surface or 3/4 acre or more of pervious surfaces, is the BMP less than 100 feet from the upslope side of any foundation and cannot reasonably be located elsewhere?				
The following require professional technical evaluation.				
Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
Would infiltrating water threaten existing below grade basements?				
Would infiltrating water threaten shoreline structures such as bulkheads?				
Is the only area available for siting the BMP one that does not allow for a safe overflow pathway to the municipal separate storm sewer system or to a private storm sewer system?				
Is the site a redevelopment project that lacks usable space for the BMP?				
Is the site a public road project that lacks sufficient space within existing public right-of-way for the BMP?				
Determination: Is this BMP feasible? ……………………………………………………………………………………				

PERMEABLE PAVEMENT BMP T5.15	**Roof**		**Surfaces**	
Feasibility Criteria and Setbacks	**YES**	**NO**	**YES**	**NO**
Is the surface to be paved a roadway with a projected average daily traffic volume of more than 400 vehicles?				
Is the surface to be paved a roadway that will be subject to through truck traffic (not including such traffic as weekly garbage and recycling pick-up, daily school bus use, or frequent use by mail/parcel delivery trucks and maintenance vehicles)?				
Is the surface to be paved a multi-level parking garage, a bridge, or roadway over a culvert?				
Is the area for permeable pavement likely to have long-term excessive sediment deposition after construction (e.g. construction and landscaping material yards)?				
Is the area for permeable pavement designated as an erosion hazard or landslide hazard?				
Is the surface to be paved on a property with known soil or groundwater contamination (typically federal Superfund sites or state cleanup sites under the Model Toxics Control Act (MTCA)) and meets any of the following criteria:				
o Is the proposed BMP within 100 feet of an area known to have deep soil contamination?				
o Is the site in an area where groundwater modeling indicates infiltration will likely increase or change the direction of the migration of pollutants in groundwater?				
o Is the proposed BMP located in an area where surface soils have been found to be contaminated, and contaminated soils are still in place within 10 horizontal feet of the infiltration area?				
o Is the BMP within any area where it would be prohibited by an approved cleanup plan under the state Model Toxics Control Act or Federal Superfund Law, or an environmental covenant under Chapter 64.70 RCW?				
[End soil / groundwater contamination sub-list.]				
Can the site not reasonably be designed to have a porous asphalt surface at less than 5% slope, or a pervious concrete surface at less than 10% slope, or a permeable interlocking concrete pavement surface (where appropriate) at less than 12% slope, or a grid system at less than the manufacturer's recommended maximum slope limit (generally between 6% to 12%)?				

Questions continue on the following page.

	Would seasonal high groundwater or an underlying impermeable/low permeable layer create saturated conditions within 1 foot of the bottom of the lowest gravel base course?				
	Are underlying soils unsuitable for supporting traffic loads when saturated? (Soils meeting a California Bearing Ratio of 5% are considered suitable for residential access roads.)				
	Is the measured coefficient of permeability in the area for permeable pavement less than 0.3 inches per hour?				
	Is the project replacing existing impervious surface, unless the existing surface is a non-pollution generating surface over a soil with a saturated hydraulic conductivity of four inches per hour or greater?				
	Is the site defined as a high-use site in Appendix 1-A?				
	Is the area for permeable pavement used for an "industrial activity" as identified in 40 CFR 122.26(b)(14)?				
	Is the risk of concentrated pollutant spills more likely such as gas stations, truck stops, and industrial chemical storage sites?				
	Is the area for permeable pavement where routine, heavy applications of sand will occur in frequent snow zones to maintain traction during weeks of snow and ice accumulations?				
	If the area for permeable pavement would be a pollution-generating hard surface (e.g. roads, driveways, parking lots) does the soil underneath the proposed location fail any of the following criteria: - At least one foot depth of soil with the following characteristics: - Cation Exchange Capacity ≥ 5 milliequivalents CEC/100 g dry soil (USEPA Method 9081) - Organic Content > 1% - Measured coefficient of permeability < 9 inches/hour				
	Is the area to be paved less than 50 feet from the top of a slope greater than 20% or with more than 10 feet of vertical relief?				
	Is the area to be paved less than 100 feet from an active or closed landfill?				
	If the surface to be paved is a pollution-generating hard surface, is the area to be paved less than 100 feet from a drinking water well or a spring used for drinking water?				
	Is the area to be paved less than 10 feet from on-site sewage drainage?				
	Is the area to be paved less than 10 feet from an underground storage tank and its connecting pipes that is used to store petroleum products, chemicals, or liquid hazardous wastes in which 10% or more of the storage volume of the tank and connecting pipes is beneath the ground?				
	The following require professional technical evaluation.				
	Does a professional geotechnical evaluation recommend infiltration not be used due to reasonable concerns about erosion, slope failure or down gradient flooding?				
	Does the site have groundwater that drains into an erosion hazard or landslide hazard area?				
	Would infiltrating and ponded water below new permeable pavement area compromise adjacent impervious pavement?				
	Is the only area available for siting the BMP threatening the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, pre-existing structures and basements, or pre-existing road or parking lot surfaces?				
	Would infiltrating water threaten existing below grade basements?				
	Would infiltrating water threaten shoreline structures such as bulkheads?				
	Is the area to be paved downslope of steep, erosion prone areas that are likely to deliver sediment?				
	Is the area to be paved over fill soils that can become unstable when saturated?				
	Is the area to be paved on excessively steep slopes and would the water within the aggregate base layer or at the sub-grade surface be uncontrollable by detention structures and therefore may cause erosion and structural failure, or would surface runoff velocities preclude adequate infiltration at the pavement surface?				
	Is the area to be paved in an area needed to support heavy loads at an industrial facility (such as a port) that exceed the strength of the permeable pavement?				
	Would installation of permeable pavement threaten the safety or reliability of pre-existing underground utilities, pre-existing underground storage tanks, or pre-existing road sub-grades?				
Determination: Is this BMP feasible? ……………………………………………………………………………………					

Appendix 1-F

Construction SWPPP Checklist

Construction Stormwater Pollution Prevention Plan Checklist

Project Name: ____________________
City Reference No. ____________________
Construction Permit No. ____________________
Review Date: ____________________
On-site Inspection Review Date: ____________________
Construction SWPPP Reviewer: ____________________

Section I – Construction SWPPP Narrative

Construction Stormwater Pollution Prevention Elements

1. ___ Describe how each of the Construction Stormwater Pollution Prevention Elements has been addressed though the Construction SWPPP.
2. ___ Identify the type and location of BMPs used to satisfy the required element.
3. ___ Provide written justification identifying the reason an element is not applicable to the proposal.

Thirteen Required Elements - Construction Stormwater Pollution Prevention Plan

1. ___ Mark Clearing Limits
2. ___ Establish Construction Access
3. ___ Control Flow Rates
4. ___ Install Sediment Controls
5. ___ Stabilize Soils
6. ___ Protect Slopes
7. ___ Protect Drain Inlets
8. ___ Stabilize Channels and Outlets
9. ___ Control Pollutants
10. ___ Control De-Watering
11. ___ Maintain BMPs
12. ___ Manage the Project
13. ___ Protect Low Impact Development BMPs

Project Description

1. ___ Total project area
2. ___ Total proposed impervious area
3. ___ Total proposed area to be disturbed, including off-site borrow and fill areas
4. ___ Total volumes of proposed cut and fill

Construction Stormwater Pollution Prevention Plan Checklist

Project Name: ____
Construction Permit No. ____
City Reference No. ____

Existing Site Conditions

1. ___ Description of the existing topography
2. ___ Description of the existing vegetation
3. ___ Description of the existing drainage

Adjacent Areas

1. Description of adjacent areas which may be affected by site disturbance or drain to project site.

___ a. Streams
___ b. Lakes
___ c. Wetlands
___ d. Residential Areas
___ e. Roads
___ f. Other

2. ___ Description of the downstream drainage path leading from the site to the receiving body of water. (Minimum distance of 400 yards.)

Critical Areas

1. ___ Description of critical areas that are on or adjacent to the site.
2. ___ Description of special requirements for working in or near critical areas.

Soils

1. Description of on-site soils.

___ a. Soil name(s)
___ b. Soil mapping unit
___ c. Erodibility
___ d. Settleability
___ e. Permeability
___ f. Depth
___ g. Texture
___ h. Soil Structure

Construction Stormwater Pollution Prevention Plan Checklist

Project Name: ____
Construction Permit No. ____
City Reference No. ____

Erosion Problem Areas

1. ___ Description of potential erosion problems on site.

Construction Phasing

1. ___ Construction sequence
2. ___ Construction phasing (if proposed)

Construction Schedule

1. ___ Provide a proposed construction schedule.
2. ___ Wet Season Construction Activities
   ___ a. Proposed wet season construction activities.
   ___ b. Proposed wet season construction restraints for environmentally sensitive/critical areas.

Financial/Ownership Responsibilities

1. ___ Identify the property owner responsible for the initiation of bonds and/or other financial securities.
2. ___ Describe bonds and/or other evidence of financial responsibility for liability associated with erosion and sedimentation impacts.

Engineering Calculations

1. ___Provide Design Calculations.
   ___ a. Sediment Ponds/Traps
   ___ b. Diversions
   ___ c. Waterways
   ___ d. Runoff/Stormwater Detention Calculations

Construction Stormwater Pollution Prevention Plan Checklist

Project Name: ____

Construction Permit No. ______________________________________

City Reference No. ____

Section II - Erosion and Sediment Control Plans

General

1. ___ Vicinity Map
2. ___ City/County of ________________ Clearing and Grading Approval Block
3. ___ Erosion and Sediment Control Notes

Site Plan

1. ___ Note legal description of subject property.
2. ___ Show North Arrow.
3. ___ Indicate boundaries of existing vegetation, e.g. tree lines, pasture areas, etc.
4. ___ Identify and label areas of potential erosion problems.
5. ___ Identify on-site or adjacent surface waters, critical areas and associated buffers.
6. ___ Identify FEMA base flood boundaries and Shoreline Management boundaries (if applicable).
7. ___ Show existing and proposed contours.
8. ___ Indicate drainage basins and direction of flow for individual drainage areas.
9. ___ Label final grade contours and identify developed condition drainage basins.
10. ___ Delineate areas that are to be cleared and graded.
11. ___ Show all cut and fill slopes indicating top and bottom of slope catch lines.

Conveyance Systems

1. ___ Designate locations for swales, interceptor trenches, or ditches.
2. ___ Show all temporary and permanent drainage pipes, ditches, or cut-off trenches required for erosion and sediment control.
3. ___ Provide minimum slope and cover for all temporary pipes or call out pipe inverts.
4. ___ Show grades, dimensions, and direction of flow in all ditches, swales, culverts and pipes.
5. ___ Provide details for bypassing off-site runoff around disturbed areas.
6. ___ Indicate locations and outlets of any dewatering systems.

Location of Detention BMPs

1. ___ Identify location of detention BMPs.

Construction Stormwater Pollution Prevention Plan Checklist

Project Name: ____

Construction Permit No. ______________________________________

City Reference No. ____

Erosion and Sediment Control Facilities

1. ___ Show the locations of sediment trap(s), pond(s), pipes and structures.
2. ___ Dimension pond berm widths and inside and outside pond slopes.
3. ___ Indicate the trap/pond storage required and the depth, length, and width dimensions.
4. ___ Provide typical section views through pond and outlet structure.
5. ___ Provide typical details of gravel cone and standpipe, and/or other filtering devices.
6. ___ Detail stabilization techniques for outlet/inlet.
7. ___ Detail control/restrictor device location and details.
8. ___ Specify mulch and/or recommended cover of berms and slopes.
9. ___ Provide rock specifications and detail for rock check dam(s), if applicable.
10. ___ Specify spacing for rock check dams as required.
11. ___ Provide front and side sections of typical rock check dams.
12. ___ Indicate the locations and provide details and specifications for silt fabric.
13. ___ Locate the construction entrance and provide a detail.

Detailed Drawings

1. ___ Any structural practices used that are not referenced in the Ecology Manual should be explained and illustrated with detailed drawings.

Other Pollutant BMPs

1. ___ Indicate on the site plan the location of BMPs to be used for the control of pollutants other than sediment, e.g., concrete wash water.

Monitoring Locations

1. ___ Indicate on the site plan the water quality sampling locations to be used for monitoring water quality on the construction site, if applicable.

Appendix 1-G

Legal Form Examples

Inspection and Maintenance Example

COVENANT RUNNING WITH THE LAND

Grantor (owner): ______________________________________

Grantee: Clark County

Abbreviated Legal Description: ______________________________________

Assessor's Property Tax Parcel/Account No(s).: ______________________________________

Subdivision/Site Plan Review Case No.: ______________________________________

A **Covenant** to Clark County, State of Washington, hereinafter "County," entered into in conjunction with the (Subdivision /Short Plat/Site Plan) Review # _________________, of certain real property as more particularly described in Exhibit A, hereinafter "Site," whereby the owner(s) of said real property on behalf of themselves and all their heirs, assigns and successors in interest into whose ownership said property may pass, together hereinafter referred to as "Grantor," covenant to the County that it will have access to the stormwater facilities as shown on an expanded portion of the plat of _______________________ , attached hereto and incorporated herein by reference as Exhibit B, hereinafter "Facilities."

Grantor herein covenants to Clark County and agrees on behalf of themselves and all of their heirs, assigns and successors in interest into whose ownership the Site might pass, as follows, it being specifically agreed and covenanted that this is a covenant running with the land described in Exhibit A:

1. That it is the sole and exclusive owner of the Site.

2. This Covenant has three purposes: to ensure that the Facilities are inspected, maintained, and repaired, as necessary, by the parties identified in the Final Stormwater Plan for the Site as responsible for long-term maintenance; to ensure that the County is allowed access to the Facilities as shown on Exhibit B for both routine and emergency inspection of the Facilities for compliance with the Clark County Stormwater Manual, and Chapters 13.26A and 40.386, Clark County Code, as they may be amended and in effect at the time, or as they have been superseded; and to provide access to the County for emergency maintenance or repairs to prevent flooding or pollution of other properties.
3. If the parties responsible for long-term maintenance fail to maintain the Facilities to applicable standards, the County shall issue a written notice specifying required actions to be taken in order to bring the Facilities into compliance. Required maintenance shall be performed according to the Clark County Stormwater Manual as in effect at the time, or requirements that have superseded that Manual. If these actions are not performed in a timely manner, the County may access the Facilities, perform necessary maintenance and repair, and bill the parties responsible for the maintenance in accordance with Title 32 CCC.
4. Nothing in this Covenant shall be construed to provide for public use of or entry into the Facilities area as shown on Exhibit B. However, representatives and agents of Clark County are hereby authorized to make reasonable entry upon such land for purposes related to administering this Covenant.
5. This Covenant and all of its provisions, and each of them shall be binding upon the owner and any and all of their heirs, assigns and successors in interest into whose ownership the Site may pass, and any obligations made herein by owners, shall be enforceable against all of their heirs, assigns and successors in interest into whose ownership the Site may pass.
6. The provisions of this Covenant are enforceable in law or equity by Clark County and its successors; provided, however, that in the event the Site is annexed into a City, the enforcement and modification of the Covenant shall be transferred to the annexing jurisdiction upon the effective date of the annexation, after which

Clark County shall not be required to review or consent to any modification or to be involved in any enforcement of the Covenant.

IN WITNESS WHEREOF, the parties hereto have caused this Covenant to be executed the day and year indicated below.

Dated this __________ day of _________, 20__.

GRANTOR

Entity name:______________________

By: _____________________________

Print name _______________________

Print title ________________________

GRANTOR

Entity name: _____________________

By: _____________________________

Print name _______________________

Print title ________________________

APPROVED AS TO FORM ONLY:
ANTHONY F. GOLIK, Prosecuting Attorney

By: ____________________________

____
Deputy Prosecuting Attorney

STATE OF WASHINGTON)
:SS
COUNTY OF CLARK)

I hereby certify that I know or have satisfactory evidence that ____________________ signed this instrument, and acknowledged it to be __________ free and voluntary act for the uses and purposes mention in this instrument.

Dated: ___________________________

____
Notary's Signature

My Appointment Expires:

Fencing Waiver Hold Harmless Example

RECORDING REQUESTED BY
AND WHEN RECORDED RETURN TO:
Public Works – Development Engineering
1300 Franklin Street
Post Office Box 9810
Vancouver, Washington 98660

Grantor:
Grantee:
Abbreviated Legal:
Assessor's Tax Parcel Nos.:
Prior Excise Tax No.:
Other Reference No(s).:

COVENANT RUNNING WITH THE LAND

A covenant to Clark County, State of Washington, hereinafter "County," entered into in conjunction with the construction of a ______________________________ on certain real property described herein below whereby the owner _____________________________ of said real property, hereinafter "Owner," on behalf on themselves and all their heirs, assigns, and successors-in-interest into whose ownership said parcel may pass, covenant to the County that the property located at approximately ____________________________ Washington, Tax Parcel No. _________ ____________________________, more particularly described in Exhibit "A", attached hereto and incorporated by this reference, will be subject to the terms and conditions set forth below.

Owner herein covenants and agrees with the County on behalf of themselves and their heirs, assigns and successors-in-interest into whose ownership the below described property might pass as follows, it being specified agreed and covenanted that this is a covenant running with the land hereinafter described.

1. The undersigned Owner is the sole and exclusive owner of the following described real property located in Clark County, State of Washington: Tax Parcel No. _________ ____________________________ and legally described in Exhibit "A", attached hereto and by this reference incorporated herein.

2. Owner is seeking or has been granted permit approval for this project identified as _________________________. As part of the project, a stormwater facility is required.

3. Clark County generally requires fencing around such stormwater facilities, and will waive the requirement upon the Owner assuming full responsibility and liability for any injuries

and other damages by any person because of the lack of fencing that the County would otherwise require.

4. Owner agrees to maintain the facility in compliance with the engineer approved plan attached as Exhibit "B".

5. Owner hereby assumes full responsibility for any injuries or damages suffered by any person or its property that are the result of the lack of fencing, and Owner further shall hold the County harmless for any and all damages relating to the lack of fencing around the stormwater facility. The Owner hereby agrees to indemnify the County for any judgment or costs for which the County may by adjudged to have responsibility because of the failure of the County to require fencing around the stormwater facility.

6. A copy of covenant will be filed with the Clark County Auditor so as to appear as a covenant within the chain of title of Tax Parcel No. _______________, as legally described in Exhibit "____" and recorded prior to final plat or occupancy (for commercial site plans) approval by the County.

7. If any provisions of this Covenant or the application of any provisions to any person or circumstance is declared invalid, then the rest of the Covenant, or the application of the provisions to other persons or circumstances, shall not be affected. The provisions of this Covenant are enforceable in law or in equity by the parties and their successors and assigns.

8. This Covenant and all of its provisions shall be binding upon the Owner and any and all their heirs, assigns and successors-in-interests into whose ownerships the above-described real property may pass, and any obligations undertaken by the Owner above described shall be enforceable against all of those heirs, assigns, and successors-in- interest into whose ownership the above-described real property may pass.

DATED this __________day of __________________, 20 __________

OWNER:

BY: ___________________________________

NAME: ________________________________

TITLE: ________________________________

Approved as to form:

____

Chris Horne
Chief Civil Deputy Prosecuting Attorney

STATE OF WASHINGTON
:SS
COUNTY OF CLARK

I hereby certify that I know or have satisfactory evidence that __________________________ signed this instrument and acknowledge it to be _________________ free and voluntary act for the use and purpose mention in this instrument.

Dated: ______________________________

By:

Notary's Signature

My Appointment Expires:

Appendix 1-H

Wetlands Guidelines

Guide Sheet 1: Criteria that excludes wetlands from serving as a treatment or flow control BMP/facility

The following types of wetlands are not suitable as a treatment or flow control BMPs/facilities. Engineering structural or hydrologic changes within the wetland itself to improve stormwater flows and water quality are not allowed. Do not increase or decrease the water regime in these wetlands beyond the prescribed limits. Provide these wetlands with the maximum protection from urban impacts:

1. The wetland is currently a Category I wetland because of special conditions (forested, bog, estuarine, Natural Heritage, coastal lagoon).

2. The wetland provides a high level of many functions. These are Category I and II wetlands as determined by the Washington State Wetland Rating System of Western Washington.

3. The wetland provides habitat for threatened or endangered species. Determining whether or not the conserved species will be affected by the proposed project requires a careful analysis in relation to the anticipated habitat changes. Consult with the appropriate agencies with jurisdiction over the specific threatened or endangered species on the site.

If a wetland type listed above needs to be included in a stormwater system then this activity is considered an impact. It will be treated as any other impact and will need to be mitigated according to the rules for wetland mitigation. Project proponents will have to demonstrate that they have done everything to avoid and minimize impacts before proceeding to compensatory mitigation.

The wetlands listed above cannot receive flows from a stormwater system unless the criteria in Book 1, Figure 1.5 are met.

Guide Sheet 2: Criteria for including wetlands as a treatment or flow control BMP/facility

A wetland can be physically or hydrologically altered to meet the requirements of a <u>treatment or flow control BMP/facility</u> if ALL of the following criteria are met:

Modifications that alter the structure of a wetland or its soils will require permits. Existing functions and values that are lost would have to be compensated/replaced.

1. It is classified in Category IV in the "Washington State Wetland Rating System of Western Washington," or a Category III wetland with a habitat score of 19 points or less.

2. You can demonstrate that there will be "no net loss" of functions and values of the wetland as a result of the structural or hydrologic modifications done to provide control of runoff and water

quality. This includes the impacts from the machinery used for the construction. Heavy equipment can often damage the soil structure of a wetland. However, the functions and values of degraded wetlands may sometimes be increased by such alterations and thus would be self-mitigating. Functions and values that are not replaced on site will have to be mitigated elsewhere.

   a. Modifications that alter the structure of a wetland or its soils will require permits. Check with the agency(ies) issuing the permits for the modification(s) to determine which method to use to establish "no net loss."

   b. A wetland will usually sustain fewer impacts if the required storage capacity can be met through a modification of the outlet rather than through raising the existing overflow.

3. The wetland does not contain a breeding population of any native amphibian species.

4. The hydrologic functions of the wetland can be improved as outlined in questions 3,4,5 of Chart 4 and questions 2,3,4 of Chart 5 in the "Guide for Selecting Mitigation Sites Using a Watershed Approach," (available here: http://www.ecy.wa.gov/biblio/0906032.html); or the wetland is part of a priority restoration plan that achieves restoration goals identified in a Shoreline Master Program or other local or regional watershed plan.

5. The wetland lies in the natural routing of the runoff, and the discharge follows the natural routing.

Definitions

The following terms are applicable only to this appendix (Appendix 1-H).

Baseline sampling	Sampling performed to define the existing environmental and biological conditions present before any modification occurs.
Bioengineering	Bioengineering for streams and wetlands --The use of living and nonliving plant materials in combination with naturea and synthetic support materials for slope stabilization, erosion reduction, and vegetative establishment.
Buffer	The area (either upland, open water, or another wetland) that surrounds a wetland and that reduces adverse impacts to it from adjacent development.
Constructed wetland	A wetland intentionally created from a non-wetland site.
Degraded wetland	A wetland whose functions and values have been reduced as a result of human activities
Enhancement	The manipulation of the physical, chemical, or biological characteristics of a wetland site to heighten, intensify or improve specific function(s) or to change the growth stage or composition of the vegetation present. Enhancement is undertaken for specified purposes such as water quality improvement, flood water retention or

wildlife habitat. Activities typically consist of planting vegetation, controlling non-native or invasive species, modifying site elevations or the proportion of open water to influence hydroperiods, or some combination of these. Enhancement results in a change in some wetland functions and can lead to a decline in other wetland functions, but does not result in a gain in wetland acres.

Estuarine wetland Generally, a vegetated wetland where the salinity of the surface or port waters is greater than 0.5 parts per thousand.

Functions The ecological (physical, chemical, and biological) processes or attributes of a wetland. Functions are often defined in terms of the processes that provide value to society, but they can be defined on processes that are not value based. Wetland functions include food chain support, provision of ecosystem diversity and fish and wildlife habitat, flood flow alteration, ground water recharge and discharge, water quality improvement, and soil stabilization.

Hydrodynamics The science involving the energy and forces acting on water or other liquids and the resulting impact on the motion of the liquid.

Hydroperiod The seasonal occurrence of flooding and/or soil saturation; encompasses the depth, frequency, duration, and seasonal pattern of inundation.

Invasive plant species Opportunistic plant species (either native or non-native) that colonize disturbed ecosystems and come to dominate the plant community in ways that are seen by us as reducing the values provided by the previous plant community. Most often, opportunistic plants are considered invasive if they reduce the value of an area as habitat for valuable species.

Landscape unit An area of land that has a specified boundary used for planning purposes that defines an area of interrelated physical, chemical, and biological processes. A watershed or drainage basin is a common type of landscape unit. A ground water aquifer is another type of landscape unit.

Modified wetland A wetland whose physical, hydrological, or water quality characteristics have been purposefully altered for a management purpose, such as by dredging, filling, forebay construction, and inlet or outlet control.

On-site An action (here, for stormwater management purposes) taken within the property boundaries of the site to which the action applies.

Post-project The conditions present across a landscape after a specific stormwater management project (e. g., raising the outlet, building an outlet control structure) are placed in the wetland or a land use change that occurs in the landscape unit that will potentially affect the wetland.

Pre-project The conditions present across a landscape before a specific stormwater management project (e. g., raising the outlet, building an

	outlet control structure) are placed in the wetland or a land use change occurs in the landscape unit that will potentially affect the wetland.
Redevelopment	Conversion of an existing development to another land use, or addition of a material improvement to an existing development.
Regional	An action (here, for stormwater management purposes) that involves more than one discrete property.
Re-establishment	Actions performed to reestablish wetland functional characteristics and processes that have been lost by alterations, activities, or catastrophic events in an area that no longer meets the definition of a wetland.
Values	Wetland processes or attributes that are valuable or beneficial to society (also see Functions). Wetland values include support of commercial and sport fish and wildlife species, protection of life and property from flooding, recreation, education, and aesthetic enhancement of human communities.
Wetlands	Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Wetlands do not include those artificial wetlands intentionally created from nonwetland sites, including, but not limited to, irrigation and drainage ditches, grass-lined swales, canals, detention facilities, wastewater treatment facilities, farm ponds, and landscape amenities, or those wetlands created after July 1, 1990, that were unintentionally created as a result of the construction of a road, street, or highway. Wetlands may include those artificial wetlands intentionally created from nonwetland areas to mitigate the conversion of wetlands. (Waterbodies not included in the definition of wetlands as well as those mentioned in the definition are still waters of the state.)

Minimum Requirement 8 Review Checklist

Minimum Requirement 8 Checklist

Note: An additional Wetland Determination maybe required for wetlands that are not located on the project site.

A. Is there a direct or indirect stormwater discharge to a wetland?

- ☐ Yes **– Go on to Question B**
- ☐ No –**Stop**

B. Is the wetland being included in a treatment or flow control BMP/Facility?

- ☐ Yes – Comply with Guide Sheets 1 and 2 in Appendix 1-K. **Stop**
- ☐ No **– Go on to Question C.**

C. Complete a Wetland Rating Form for the receiving wetland using the Washington State Wetland Rating System for Western Washington. Is the wetland classified by the rating form as Category I or Category II?

- ☐ Yes **– Complete the checklist below**
- ☐ No –**Stop**

D. Hydroperiod Analysis per Section 1.5.8

- ☐ Monthly change in total discharge volume is 15% or less (per the WWHM); and
- ☐ Change in total discharge volume from any single precipitation event is 20% or less (per the WWHM). **–Stop**
- ☐ Either discharge threshold exceeded. **– Go on to Section E**

E. Minimum Requirement 8 is not met

Appendix 1-I

Stormwater Site Plan Short Form

Appendix 1-I, Stormwater Site Plan Short Form, is bound separately and may be found on the Clark County web site at www.clark.wa.gov/environmental-services/stormwater-code-and-manual .

Appendix 1-J

Abbreviated Construction SWPPP

Appendix 1-J, Abbreviated Construction Stormwater Pollution Prevention Plan (SWPPP), is bound separately and may be found on the Clark County web site at www.clark.wa.gov/environmental-services/stormwater-code-and-manual .