Stormwater Management Manual for Western Washington

Volume I - Minimum Technical Requirements and Site Planning
Volume II - Construction Stormwater Pollution Prevention
Volume III - Hydrologic Analysis and Flow Control Design/BMPs
Volume IV - Source Control BMPs
Volume V - Runoff Treatment BMPs

Prepared by:

Washington State Department of Ecology
Water Quality Program

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Photo Credits

Cover (clockwise from lower left): This aerial photo of a local lake shows what can happen when it rains and stormwater controls are not used to control sediment runoff (photo by Erik Stockdale); above-ground fuel tanks with containment of tanks and valves (photo by Keith Johnson); a temporary sediment pond at a construction site is used to control runoff (NWRO file photo); a temporary erosion control pond (photo by Erik Stockdale); silt fence at construction site (photo from USGS Water Science Picture Gallery); transit facility treatment pond, followed by infiltration (photo by Stan Ciuba). Spine (top): constructed wetland (photo by Gary Kruger); temporary on-site conveyance channel designed to prevent erosion (photo by Lisa Austin); stormwater pond using a limited space in housing development (photo by Erik Stockdale).

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Volume I
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Chapter 1 - Introduction

1.1 Objective

The objective of this manual is to provide guidance on the measures necessary to control the quantity and quality of stormwater produced by new development and redevelopment such that they comply with water quality standards and contribute to the protection of beneficial uses of the receiving waters. The water quality standards include: Chapter 173-200 WAC, Water Quality Standards for Ground Waters of the State of Washington; Chapter 173-201A, Water Quality Standards for Surface Waters of the State of Washington; and Chapter 173-204, Sediment Management Standards. Application of appropriate minimum requirements and Best Management Practices (BMPs) identified in this manual are necessary but sometimes insufficient measures to achieve the objective. (See Section 1.7, Effects of Urbanization)

This manual establishes minimum requirements for development and redevelopment projects of all sizes and provides guidance concerning how to prepare and implement stormwater site plans. These requirements are, in turn, satisfied by the application of BMPs from Volumes II through V. Projects that follow this approach will apply reasonable, technology-based BMPs and water quality-based BMPs to reduce the adverse impacts of stormwater. This manual is applicable to all types of land development – including residential, commercial, industrial, and roads. Manuals with a more-specific focus, such as a Highway Runoff Manual, that have been determined to be equivalent to this manual, may provide more appropriate guidance to the intended audience.

Federal, state, and local permitting authorities with jurisdiction can require more stringent measures that are deemed necessary to meet locally established goals, state water quality standards, or other established natural resource or drainage objectives.

This manual can also be helpful in identifying options for retrofitting BMPs to existing development. Retrofitting stormwater BMPs into existing developed areas will be necessary in many cases to meet federal Clean Water Act and state Water Pollution Control Act (Chapter 90.48 RCW) requirements.

The Department of Ecology (Ecology) does not have guidance specifically for retrofit situations (not including redevelopment situations). Application of BMPs from this manual is encouraged. However, there can be site constraints that make the strict application of these BMPs difficult.

1.2 Expanded Applicability to Western Washington

With this update of this stormwater manual, the applicability has been broadened to include all of western Washington. This includes the area bounded on the south by the Columbia River, on the west by the Pacific Ocean, on the north by the Canadian border, and on the east by the Cascade Mountains crest.

The Ecology stormwater manual was originally developed in response to a directive of the Puget Sound Water Quality Management Plan (PSWQA 1987 et seq.). The Puget Sound Water Quality Authority (since replaced by the Puget Sound Action Team, PSAT) recognized the need for overall guidance for stormwater quality improvement. It incorporated requirements in its plan to implement a cohesive, integrated stormwater management approach through the development and implementation of programs by local jurisdictions, and the development of rules, permits and guidance by Ecology.

The Puget Sound Water Quality Management Plan included a stormwater element (SW-2.1) requiring Ecology to develop a stormwater technical manual for use by local jurisdictions. This manual was originally developed to meet this requirement. Ecology has found that the concepts developed for the Puget Sound Basin are applicable throughout western Washington.

Further information describing how this manual relates to the Puget Sound Water Quality Management Plan is included in Section 1.6, below.

1.3 Organization of this Manual

1.3.1 Overview of Manual Content

To accomplish the objective described in Section 1.1, the manual includes the following:

- *Minimum Requirements* that cover a range of issues, such as preparation of Stormwater Site Plans, pollution prevention during the construction phase of a project, control of potential pollutant sources, treatment of runoff, control of stormwater flow volumes, protection of wetlands, and long-term operation and maintenance. The Minimum Requirements applicable to a project vary depending on the type and size of the proposed project.

- *Best Management Practices (BMPs)* that can be used to meet the minimum requirements. BMPs are defined as schedules of activities, prohibitions of practices, maintenance procedures, managerial practices, or structural features that prevent or reduce adverse impacts to waters of Washington State. BMPs are divided into those for short-term control of stormwater from construction sites, and those addressing long-term management of stormwater at developed sites. Long-term BMPs are further subdivided into those covering management of the volume and timing of stormwater flows, prevention of pollution from potential sources, and treatment of runoff to remove sediment and other pollutants.

- *Guidance on how to prepare and implement Stormwater Site Plans*. The Stormwater Site Plan is a comprehensive report that describes existing site conditions, explains development plans, examines potential offsite effects, identifies applicable Minimum Requirements, and proposes stormwater controls for both the construction phase and long-term stormwater management. The project proponent submits the Stormwater Site Plan to state and local permitting authorities with jurisdiction, who use the plan to evaluate a proposed project for compliance with stormwater requirements.

1.3.2 Organization of this Manual

Volume I of this manual serves as an introduction and covers several key elements of developing the Stormwater Site Plan. The remaining volumes of this manual cover BMPs for specific aspects of stormwater management. Volumes II through V are organized as follows:

- Volume II covers BMPs for short-term stormwater management at construction sites;
- Volume III covers hydrologic analysis and BMPs to control flow volumes from developed sites;
- Volume IV addresses BMPs to minimize pollution generated by potential pollution sources at developed sites; and
- Volume V presents BMPs to treat runoff that contains sediment or other pollutants from developed sites.

1.3.3 Organization of Volume I

Following this introduction, Volume I contains three additional chapters. Chapter 2 identifies the Minimum Requirements for stormwater management at all new development and redevelopment projects. In addition, Chapter 2 describes the relationship between the Minimum Requirements and the Puget Sound Water Quality Management Plan. Chapter 3 describes the Stormwater Site Plan, and provides step-by-step guidance on how to develop these plans. Chapter 4 describes the process for selecting BMPs for long-term management of stormwater flows and quality. Appendices are included to support these topics. Volume I also includes the Glossary for all five volumes of the stormwater manual.

1.4 How to Use this Manual

This manual has applications for a variety of users. Project proponents should start by reading Chapter 3 of Volume I. It explains how to complete stormwater site plans.

Local government officials may adopt and apply the requirements, thresholds, definitions, BMP selection processes, and BMP design criteria of this manual, or an equivalent manual. Staff at local governments and agencies with permitting jurisdiction may use this manual in reviewing Stormwater Site Plans, checking BMP designs, and providing technical advice to project proponents.

Federal, State, and local permits may refer to this manual or the BMPs contained in this manual. In those cases, affected permit-holders or applicants should use this manual for specific guidance on how to comply with those permit conditions.

1.5 Development of Best Management Practices for Stormwater Management

1.5.1 Best Management Practices (BMPs)

The method by which the manual controls the adverse impacts of development and redevelopment is through the application of Best Management Practices.

Best Management Practices are defined as 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. The types of BMPs are source control, treatment, and flow control. BMPs that involve construction of engineered structures are often referred to as facilities in this manual. For instance, the BMPs referenced in the menus of Chapter 3 in Volume V are called treatment facilities.

The primary purpose of using BMPs is to protect beneficial uses of water resources through the reduction of pollutant loads and concentrations, and through reduction of discharges (volumetric flow rates) causing stream channel erosion. If it is found that, after the implementation of BMPs advocated in this manual, beneficial uses are still threatened or impaired, then additional controls may be required.

1.5.2 Source Control BMPs

Source control BMPs **prevent** pollution, or other adverse effects of stormwater, from occurring. Ecology further classifies source control BMPs as operational or structural. Examples of source control BMPs include methods as various as using mulches and covers on disturbed soil, putting roofs over outside storage areas, and berming areas to prevent stormwater run-on and pollutant runoff.

It is generally more cost effective to use source controls to **prevent** pollutants from entering runoff, than to treat runoff to remove pollutants. However, since source controls cannot prevent all impacts, some combination of measures will always be needed.

1.5.3 Treatment BMPs

Treatment BMPs include facilities that remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, and soil adsorption. Treatment BMPs can accomplish significant levels of pollutant load reductions if properly designed and maintained.

1.5.4 Flow Control BMPs

Flow control BMPs typically control the rate, frequency, and flow duration of stormwater surface runoff. The need to provide flow control BMPs depends on whether a development site discharges to a stream system or wetland, either directly or indirectly. Stream channel erosion control can be accomplished by BMPs that detain runoff flows and also by those which physically stabilize eroding streambanks. Both types of measures may be necessary in urban watersheds. Only the former is covered in this manual.

Construction of a detention pond is the most common means of meeting flow control requirements. Construction of an infiltration facility is the preferred option but is feasible only where more porous soils are available. The concept of detention is to collect runoff from a developed area and release it at a slower rate than it enters the collection system. The reduced release rate requires temporary storage of the excess amounts in a pond with release occurring over a few hours or days. The volume of storage needed is dependent on 1) the size of the drainage area; 2) the extent of disturbance of the natural vegetation, topography, and soils and creation of effective impervious surfaces (surfaces that drain to a stormwater collection system); and 3) how rapidly the water is allowed to leave the detention pond, i.e., the target release rates.

The 1992 Ecology manual focused primarily on controlling the peak flow release rates for recurrence intervals of concern – the 2, 10, and 100-year rates. This level of control did not adequately address the increased duration at which those high flows occur because of the increased volume of water from the developed condition as compared to the pre-developed conditions. To protect stream channels from increased erosion, it is necessary to control the durations over which a stream channel experiences geomorphically significant flows such that the energy imparted to the stream channel does not increase significantly. Geomorphically significant flows are those that are capable of moving sediments. This target will translate into lower release rates and significantly larger detention ponds than the previous Ecology standard. The size of such a facility can be reduced by changing the extent to which a site is disturbed.

In regard to wetlands, it is necessary to not alter the natural hydroperiod. This means control of flows from a development such that the wetland is within certain elevations at different times of the year and short-term elevation changes are within the prescribed limits. If the amount of surface water runoff draining to a wetland is increased because of land conversion from forested to impervious areas, it may be necessary to bypass some water around the wetland in the wet season. (Bypassed stormwater must still meet flow control and treatment requirements applicable to the receiving water.) If however, the wetland was fed by local ground water elevations during the dry season, the impervious surface additions and the bypassing practice may cause variations from the dry season elevations.

Estimates of what should be done to maintain the natural hydroperiod require the use of a continuous runoff model. It remains to be seen whether the available continuous runoff models are sufficiently accurate to determine successful flow management strategies. Even if the modeling approaches are sufficient, it will be a challenge to simulate pre-development hydrology after significant development has occurred.

1.6 Relationship of this Manual to Federal, State, and Local Regulatory Requirements

1.6.1 The Manual's Role as Technical Guidance

The *Stormwater Management Manual for Western Washington* is not a regulation. The Manual does not have any independent regulatory authority and it does not establish new environmental regulatory requirements. Its "Requirements" and BMP's become required through:

- Ordinances and rules established by local governments; and
- Permits and other authorizations issued by local, state, and federal authorities.

Current law and regulations require the design, construction, operation and maintenance of stormwater systems that prevent pollution of State waters. The Manual is a guidance document which provides local governments, State and Federal agencies, developers and project proponents with a stormwater management strategy to apply at the project level. If this strategy is implemented correctly, in most cases it should result in compliance with existing regulatory requirements for stormwater – including compliance with the Federal Clean Water Act, Federal Safe Drinking Water Act and State Water Pollution Control Act.

The Manual provides generic, technical guidance on measures to control the quantity and quality of stormwater runoff from new development and redevelopment projects. These measures are considered to be necessary to achieve compliance with State water quality standards and to contribute to the protection of the beneficial uses of the receiving waters (both surface and ground waters). Stormwater management techniques applied in accordance with this Manual are presumed to meet the technology-based treatment requirement of State law to provide all known available and reasonable methods of treatment, prevention and control (AKART; RCW 90.52.040 and RCW 90.48.010).

This technology-based treatment requirement does not excuse any discharge from the obligation to apply additional stormwater management practices as necessary to comply with State water quality standards. The State water quality standards include: Chapter 173-200 WAC, Water Quality Standards for Ground Waters of the State of Washington; Chapter 173-201A, Water Quality Standards for Surface Waters of the State of Washington; and Chapter 173-204, Sediment Management Standards.

Following this Manual is not the only way to properly manage stormwater runoff. A municipality may adopt, or a project proponent may choose to implement other methods to protect water quality; but in those cases, they assume the responsibility of providing technical justification that the chosen methods will protect water quality (see Section 1.6.3, Presumptive versus Demonstrative Approaches to Protecting Water Quality below).

1.6.2 More Stringent Measures and Retrofitting

Federal, State, and local government agencies with jurisdiction can require more stringent measures that are deemed necessary to meet locally established goals, State water quality standards, or other established natural resource or drainage objectives. Water cleanup plans or Total Maximum Daily Loads (TMDLs) may identify more stringent measures needed to restore water quality in an impaired water body.

This Manual is not a retrofit manual, but it can be helpful in identifying options for retrofitting BMPs to existing development. Retrofitting stormwater BMPs into existing developed areas may be necessary to meet federal Clean Water Act and state Water Pollution Control Act (Chapter 90.48 RCW) requirements. In retrofit situations there frequently are site constraints that make the strict application of these BMPs difficult. In these instances, the BMPs presented here can be modified using best professional judgment to provide reasonable improvements in stormwater management.

1.6.3 Presumptive versus Demonstrative Approaches to Protecting Water Quality

Wherever a discharge permit or other water-quality-based project approval is required, project proponents may be required to document the technical basis for the design criteria used to design their stormwater management BMPs. This includes: how stormwater BMPs were selected; the pollutant removal performance expected from the selected BMPs; the scientific basis, technical studies, and(or) modeling which supports the performance claims for the selected BMPs; and an assessment of how the selected BMP will comply with State water quality standards and satisfy State AKART requirements and Federal technology-based treatment requirements.

The Manual is intended to provide project proponents, regulatory agencies and others with technically sound stormwater management practices which are *presumed* to protect water quality and instream habitat – and meet the stated environmental objectives of the regulations described in this chapter. Project proponents always have the option of not following the stormwater management practices in this Manual. However, if a project proponent chooses not to follow the practices in the Manual then the project proponent may be required to individually *demonstrate* that the project will not adversely impact water quality by collecting and providing appropriate supporting data to show that the alternative approach is protective of water quality and satisfies State and federal water quality laws.

Figure 1.1 graphically depicts the relation between the *presumptive approach* (the use of this Manual) and the *demonstrative approach* for achieving the environmental objectives of the standards. Both the presumptive and demonstrative approaches are based on best available science and result from existing Federal and State laws that require stormwater treatment systems to be properly designed, constructed, maintained and operated to:

1. Prevent pollution of state waters and protect water quality, including compliance with state water quality standards;
2. Satisfy state requirements for all known available and reasonable methods of prevention, control and treatment (AKART) of wastes prior to discharge to waters of the State; and
3. Satisfy the federal technology based treatment requirements under 40 CFR part 125.3.

Relation between environmental science and standards in stormwater regulations. Both the presumptive and demonstrative approaches are based on using best available science to protect water quality. See the glossary for definitions.

STANDARDS

Water Pollution Control Act

(Chapter 90.48 RCW)

Discharges to state waters shall not cause pollution, which is defined as an alteration of the physical, chemical or biological properties of State waters which would impair beneficial uses. Requires the use of AKART and BMPs approved by Ecology.

Federal Clean Water Act

Restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

- State water quality standards (water-quality based treatment requirements)
- Federal technology-based treatment requirements
- NPDES permits
- 303(d) impaired water body list and water clean-up plans

Others

Endangered Species Act

- Properly functioning conditions

Hydraulics Code (HPA)

Safe Drinking Water Act (UIC)

Presumptive Approach

The Stormwater Management Manual for Western Washington provides a default set of stormwater practices based on current science which satisfy State and Federal stormwater requirements.

Considerations:

- More predictable, practices are approved across jurisdictions
- Costly studies, etc. are not required as they may be under the demonstration approach

Demonstrative Approach

Project sponsor and approval agency individually review and condition proposed projects to meet federal and state stormwater standards based on current science.

Considerations:

- Lacks predictability and can be very time consuming
- For large, complex projects may reduce costs and/or improve environmental protection

Hydrology

- When native vegetation is removed and replaced with impervious surfaces (roads or buildings) there is an increase in stormwater runoff and other drastic alterations to the natural hydrology.
- Increased flows lead to increased flooding and stream bank and stream bed erosion.
- Unless mitigated, adverse high flow impacts occur at even low levels of urban development: 4% to 10% total impervious area.
- Transportation infrastructure (including parking areas) represents between 50% and 75% of the impervious surface area within any single watershed.

Water Quality

- More than a third of the State's urban streams, creeks and embayments are impaired due to stormwater runoff.
- Stormwater runoff from construction activities can contain large amounts of sediments and suspended solids which are harmful to fish and other aquatic life.
- Untreated stormwater from roads and urban areas can adversely impact water quality due to sediments, toxic metals, pesticides, herbicides, oils and greases, and possible human pathogens including fecal coliform bacteria.
- Untreated stormwater runoff from roads and urban areas can be toxic to aquatic life including fish.

SCIENCE

Under the demonstration approach, the timeline and expectations for providing technical justification of stormwater management practices will depend on the complexity of the individual project and the nature of the receiving environment. In each case, the project proponent may be asked to document to the satisfaction of the permitting agency or other approval authority that the practices they have selected will result in compliance with the water quality protection requirements of the permit or other local, State, or Federal water-quality-based project approval condition. This approach may be more cost effective for large, complex or unusual types of projects.

Project proponents that choose to follow the stormwater management approaches contained in approved stormwater technical manuals are presumed to have satisfied this demonstration requirement and do not need provide technical justification to support the selection of BMPs for the project. Following the stormwater management practices in this Manual means adhering to the guidance provided for proper selection, design, construction, implementation, operation and maintenance of BMPs. Approved stormwater technical manuals include this Manual and other equivalent stormwater management guidance documents approved by Ecology (See Section 1.6.3). This approach will generally be more cost effective for typical development and redevelopment projects.

The following sub-sections will explain the relationship of the manual to various programs, permits, and planning efforts.

1.6.4 The Puget Sound Water Quality Management Plan

Stormwater Comprehensive Programs

The Puget Sound Water Quality Management Plan (the Plan) directs every city and county in the Puget Sound Basin to develop and implement a comprehensive stormwater management program. The Plan recognizes that stormwater programs will vary among jurisdictions, depending on the jurisdiction's population, density, threats posed by stormwater, and results of watershed planning efforts. Under the Plan, cities and counties are encouraged to form intergovernmental cooperative agreements in order to pool resources and carry out program activities most efficiently.

Comprehensive stormwater management programs under the Plan are to include:

- ***Stormwater Controls for New Development and Redevelopment*** – Local governments are directed to adopt ordinances that require the use of best management practices (BMPs) to control stormwater flows, provide treatment, and prevent erosion and sedimentation from all new development and redevelopment projects. They are also directed to adopt and require the use of Ecology's stormwater technical manual (or an approved alternative manual) to meet these objectives. All new development in the basin, particularly new development sited outside of urban growth areas, are to seek to achieve no net detrimental change in natural surface runoff and infiltration.

- ***Stormwater Site Plan Review*** – Local governments are directed to review new development and redevelopment projects to ensure that stormwater control measures are adequate and consistent with local requirements.
- ***Inspection of Construction Sites*** **–** Local governments are directed to regularly inspect construction sites and to adopt ordinances to ensure clear authority to inspect construction sites, to require maintenance of BMPs, and to enforce violations. They are also directed to provide local inspectors with training on erosion and sediment control practices.
- ***Maintenance of Permanent Facilities*** **–** Local governments are directed to adopt ordinances that require all permanent stormwater facilities to be regularly maintained to ensure performance. They are also directed to develop necessary provisions, such as agreements or maintenance contracts, to ensure that facilities on private land (e.g., residential subdivisions and commercial complexes) are maintained. The Plan directs local government to provide training for professionals who maintain stormwater facilities.
- ***Source Control*** **–** Local governments are directed to develop and implement a program to control sources of pollutants from new development and redevelopment projects and from existing developed lands, using BMPs from Ecology's stormwater technical manual, or an equivalent manual. Source control activities are to include pollution from roadways and landscaping activities. Integrated pest management practices are to be used to manage roadside vegetation.
- ***Illicit Discharges and Water Quality Response*** **–** Local governments are directed to adopt ordinances to prohibit dumping and illicit discharges and to carry out activities to detect, eliminate and prevent illicit discharges, and respond to spills and water quality violations.
- ***Identification and Ranking of Problems*** **–** The Plan directs local government to identify and rank existing problems that degrade water quality, aquatic species and habitat, and natural hydrologic processes. Local governments may choose to achieve this through watershed or basin planning or another process. Local governments are directed to conduct a hydrologic analysis and map stormwater drainages, outfalls, and impervious surfaces by watershed and to develop plans and schedules and identify funding to fix the problems.

- ***Public Education and Involvement* –** The Plan directs local government to educate and involve citizens, businesses, elected officials, site designers, developers, builders and other members of the community to build awareness and understanding of stormwater and water quality issues. Local governments are to provide practical alternatives to actions that degrade water quality and biological resources.

- ***Low Impact Development Practices* –** Local governments are directed to adopt ordinances that allow and encourage low impact development practices. These are practices that infiltrate stormwater (using proper safeguards to protect ground water) on-site rather than collecting, conveying and discharging stormwater off-site. The goals of low impact development practices are to enhance overall habitat functions, reduce runoff, recharge aquifers, maintain historic in-stream flows and reduce maintenance costs.

- ***Watershed or Basin Planning* –** The Plan directs local government to participate in watershed or basin planning processes, such as planning under Chapter 400-12 WAC or Chapter 90.82 RCW. The objective is to coordinate efforts, pool resources, ensure consistent methodologies and standards, maintain and restore watershed health, and protect and enhance natural hydrology and processes - including natural surface runoff, infiltration and evapotranspiration. Basin plans are to address water quality, aquatic habitat, ground water recharge and water re-use. Basin plans may prescribe stronger stormwater management measures to protect sensitive resources in a certain basin or sub-basin. Stormwater management measures in all basins are to at least meet the minimum requirements of Ecology's technical manual. Cities and counties are directed to incorporate recommendations from watershed or basin plans and specific requirements from Total Maximum Daily Load (TMDL) Water Cleanup Plan processes into their stormwater programs, land use comprehensive plans and site development ordinances.

- ***Funding* –** The Plan directs local government to create local funding capacity, such as a utility, to ensure adequate, ongoing funding for program activities and to provide funding to contribute to regional stormwater projects.

- ***Monitoring* –** The Plan directs local government to monitor program implementation and environmental conditions and trends over time to measure the effectiveness of program activities. Local governments are directed to periodically share monitoring results with local and state agencies, citizens and others.

Stormwater Technical Manual

The Plan states that "A single technical stormwater manual for the region provides uniform standards and a central repository for BMPs". The Plan directs Ecology to maintain the region's technical stormwater manual for new development and redevelopment. Publication of this manual partially fulfills Ecology's responsibilities under the Puget Sound Water Quality Management Plan.

Alternative Technical Manuals

Cities and counties that choose to develop an alternative technical manual are directed to submit their manual to Ecology. The submittal is to include an outline of significant differences between the manuals and demonstrate how the alternative manual is substantively equivalent to Ecology's. The Plan directs Ecology to work with jurisdictions to ensure that all alternative manuals meet or exceed the standards in Ecology's technical manual. Jurisdictions choosing to develop an alternative manual are directed to use Ecology's technical manual in the interim.

Ecology published guidance for equivalency reviews ("Guidance for Local Governments When Submitting Manuals and Associated Ordinances for Equivalency Review," 3/94, Publication #94-45). The criteria in that guidance are replaced with the following criteria.

1. The Minimum Requirements (Chapter 2) for new development and redevelopment, or their equivalents, must be included in ordinance or enforceable rules adopted by the local government. More stringent requirements may be used, and/or the Minimum Requirements may be tailored to local circumstances through the use of basin plans or other similar water quality and quantity planning efforts.

2. The thresholds for and definitions of new development, redevelopment, land disturbing activities, impervious surfaces, maintenance, and pollution-generating surfaces should provide equivalent protection of receiving waters or equivalent levels of pollution treatment as those provided by Ecology's criteria.

3. The substantially equivalent manual must include BMP selection and site planning processes that have outcomes that provide equivalent or greater protection to those in Ecology's manual.

4. The types of BMPs and design criteria for those BMPs specified by local governments must provide equivalent or greater protection than those contained in Volumes II through V of Ecology's manual.

5. Adjustment and Variance criteria similar to those in Volume I must be included.

Where Ecology is uncertain that a local government requirement provides equivalent or better protection, it may provisionally approve the local requirement. The provisions would require the local government to implement an approved monitoring effort to assess the performance of the local requirement.

Ecology has used bold highlighting of statements in Chapter 2 of Volume I for which local governments must have equivalent statements if they are to comply with criteria 1,2, and 5 above.

1.6.5 Phase I - NPDES and State Waste Discharge Stormwater Permits for Municipalities

Certain municipalities and other entities are subject to permitting under the U.S. Environmental Protection Agency (EPA) Phase I Stormwater Regulations (40 CFR Part 122). In Western Washington, Ecology has issued joint NPDES and State Waste Discharge permits to regulate the discharges of stormwater from the municipal separate storm sewer systems operated by the following cities and counties:

- Clark County,
- King County,
- Pierce County,
- Snohomish County,
- Seattle, and
- Tacoma.

The Washington Department of Transportation is also a Phase I municipal stormwater permittee for its stormwater discharges within the jurisdictions of the above cities and counties.

As a condition (Special Condition S7.b.8.a.) of the permits issued in July 1995, these entities are required to implement stormwater programs that must include:

> "… ordinances (except WSDOT's program), minimum requirements and best management practices (BMPs) equivalent to those found in Volumes I-IV of Ecology's *Stormwater Management Manual for the Puget Sound Basin* (1992 edition, and as amended by its replacement)…."

These entities had until the end of the permit terms, July 2000 to comply with this requirement.

Ecology has administratively extended these municipal permits until it can reissue updated permits. In the development of those permits, Ecology will consider incorporating the minimum requirements and thresholds and referencing the BMP's within this manual. Ecology will also add a deadline or deadlines within the term of the permit for compliance with the condition.

1.6.6 Phase II - NPDES and State Waste Discharge Stormwater Permits for Municipalities

The EPA adopted Phase II stormwater regulations in December 1999. Those rules identify additional municipalities as subject to NPDES municipal stormwater permitting requirements. Over 100 municipalities in Washington are subject to the requirements. Federal regulations required issuance of Phase II permits by December 2002, and required the Phase II communities to submit their stormwater programs to comply with permit requirements by March 2003. Ecology made a standard permit application format available to municipalities and encouraged all to apply by March 2003. Ecology anticipates issuing the Phase II permit for Western Washington in 2005.

The USEPA regulations specify minimum measures for the stormwater programs developed to comply with the Phase II permits. One of those measures is the adoption of a program for "post-construction stormwater management in new development and redevelopment." Another is a program for "construction site stormwater runoff control." To at least partially fulfill these requirements, portions of this manual that apply will be used as the starting point for permit requirements. Ecology will propose using the federal phase II thresholds for the phase II municipal stormwater permits rather than the lower thresholds in this manual. A schedule (or schedules) for compliance will be necessary. Municipalities within the Puget Sound Basin should have already completed these tasks as required by the Puget Sound Water Quality Management Plan, and as encouraged by the State's strategy for salmon recovery.

1.6.7 Municipalities Not Subject to the Puget Sound Water Quality Management Plan nor NPDES Stormwater Permits for Municipalities

Municipalities not subject to the Puget Sound Plan nor NPDES stormwater permits for municipalities are encouraged to adopt stormwater programs at least equivalent to the Puget Sound Basic Stormwater Program. This would include adoption of ordinances, minimum requirements described in the 1994 Puget Sound Plan, and BMPs equivalent to those in Ecology's manual. Any municipalities in areas where urban stormwater has been identified as a limiting factor to salmon recovery are expected to have an equivalent stormwater manual as part of a Comprehensive Stormwater Program as defined by the Puget Sound Water Quality Management Plan.

1.6.8 Industrial Stormwater Permit (i.e. NPDES and State Waste Discharge Baseline General Permit for Stormwater Discharges Associated With Industrial Activities)

Businesses subject to the Baseline General Permit for Stormwater Discharges Associated With Industrial Activities have to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the terms of that permit. The current permit was issued in August 2002, and modified in December 2004. The modified permit allows permittees to follow a presumptive approach or a demonstration approach (see section 1.6.3 for a detailed explanation) to compliance with the permit. Permittees who choose the presumptive approach select BMP's from an approved stormwater manual. The permit identifies the Stormwater Management Manual for Western Washington and the Regional Road Maintenance ESA Program Guidelines as the applicable stormwater manuals for all facilities in western Washington.

Under the presumptive approach, new facilities are to apply the minimum technical requirements and BMP's appropriate for their facility as found in the most recent version of the Western Washington manual or an equivalent manual. Existing facilities are to use the most recent version of this manual when updating their SWPPP to accommodate changes at their facility or when additional BMPs are required to maintain compliance with permit conditions. Facilities undergoing new development or re-development are to apply the applicable minimum requirements of the most recent edition of this manual when beginning final design of the project to the development site.

1.6.9 Construction Stormwater Permit (i.e. NPDES and State Waste Discharge General Permit for Stormwater Discharges Associated With Construction Activity)

Construction sites that will disturb five acres or more and will have a discharge of stormwater from the project site to surface water must apply for Ecology's construction stormwater permit. The permit requires application of stabilization and structural practices to reduce the potential for erosion and the discharge of sediments from the site. The stabilization and structural practices cited in the permit are similar to the minimum requirements for sedimentation and erosion control in Volume I of the SWMM.

The permit also requires construction sites within the Puget Sound basin to "select from BMPs described in Volume II of the most recent edition of Ecology's Stormwater Management Manual (SWMM) that has been available at least 120 days prior to the BMP selection." Sites outside the basin are required to select BMPs from the manual, from the Erosion and Sediment Control Handbook, by Goldman et al, or to select other appropriate BMPs. The permit also states that where Ecology has determined that the local government requirements for construction sites are at least as stringent as Ecology's, Ecology will accept compliance with the local requirements.

The existing construction stormwater general permit expires in November 2005. However, that permit was appealed. The parties to the case have entered into a settlement agreement (stipulation and order for dismissal) that stipulates that the construction stormwater general permit must be revised and reissued according to specified dates. Ecology expects the permit will be available by September 2005.

This revised permit will incorporate identified changes and implement applicable USEPA Phase II regulations. According to those regulations, coverage under the Construction General Permit is required for any clearing, grading, or excavating that will disturb one or more acres of land area, and that will discharge stormwater from the site into surface water(s), or into storm drainage systems that discharge to a surface water.

In developing the revised permit, Ecology anticipates drawing upon Minimum Requirement #2 and the BMP's in this volume.

1.6.10 Endangered Species Act

With the listing of multiple species of salmon as threatened or endangered across much of Washington State, and the probability of more listings in the future, implementation of the requirements of the Endangered Species Act will have a dramatic effect on urban stormwater management. The manner in which that will occur is still evolving. Provisions of the Endangered Species Act that may apply directly to stormwater management include the Section 4(d) rules, Section 7 consultations, and Section 10 Habitat Conservation Plans (HCP).

Under Section 4(d) of the statute, the federal government issues regulations to provide for the conservation of the species. A 4(d) rule may require new development and redevelopment to comply with specific requirements. It remains to be seen whether the federal government will cite the requirements of this manual in a 4(d) rule.

Under Section 7 of the statute, all federal agencies must insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species (or a species proposed for listing), nor result in the destruction or adverse modification of designated critical habitat. The responsibility for initially determining whether jeopardy is likely to occur rests with the "action" agency. If an action "may affect" a listed species, the "action" agency must consult with the National Marine Fisheries Service (NMFS), or the U.S. Fish and Wildlife Service (USFWS) depending on the species involved, to determine whether jeopardy is likely to occur. Where NMFS or USFWS believes that jeopardy would result, it must specify reasonable and prudent alternatives to the action that would avoid jeopardy if any such alternatives are available. If the "action" agency rejects these, the action cannot proceed. This manual may play a role in these jeopardy decisions and the alternatives cited to avoid jeopardy.

Under Section 10 of the ESA, through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit an "incidental take" of individuals of that species as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). This provision of the ESA may help resolve conflicts between development pressures and endangered species protection. A "Habitat Conservation Plan" (HCP) is an example of this type of agreement. Under an HCP, the applicant's plan must:

- Outline the impact that will likely result from the taking;
- List steps the applicant will take to minimize and mitigate such impacts, and funding available to implement such steps; and
- Include alternative actions the applicant considered and reasons alternative acts are not being used.

The federal government may grant a permit if it finds that the taking will be incidental; the applicant will minimize and mitigate impacts of taking; and the applicant will ensure that adequate funding for the conservation plan will be provided. The USFWS and NMFS may require additional measures as necessary or appropriate for purposes of the plan. This manual may play a key role in any proposed Habitat Conservation Plans.

1.6.11 Section 401 Water Quality Certifications

For projects that require a fill or dredge permit under Section 404 of the Clean Water Act, Ecology must certify to the permitting agency, the U.S. Army Corps of Engineers, that the proposed project will not violate water quality standards. In order to make such a determination, Ecology may do a more specific review of the potential impacts of a stormwater discharge from the construction phase of the project and from the completed project. As a result of that review, Ecology may condition its certification to require:

- Application of the minimum requirements and BMPs in this manual; or
- Application of more stringent requirements.

1.6.12 Hydraulic Project Approvals (HPAs)

Under Chapter 77.55 RCW, the Hydraulics Act, the Washington State Department of Fish and Wildlife has the authority to require actions when stormwater discharges related to a project would change the natural flow or bed of state waters. The implementing mechanism is the issuance of a Hydraulics Project Approval (HPA) permit. In exercising this authority, Fish and Wildlife may require:

- Compliance with the provisions of this manual; or
- Application of more stringent requirements that they determine are necessary to meet their statutory obligations to protect fish and wildlife.

1.6.13 Aquatic Lands Use Authorizations

The Department of Natural Resources (DNR), as the steward of public aquatic lands, may require a stormwater outfall to have a valid use authorization, and to avoid or mitigate resource impacts. Through its use authorizations, which are issued under authority of Chapter 79.90 through 96, and in accordance with Chapter 332-30 WAC, DNR may require:

- Compliance with the provisions of this manual; or
- Application of more stringent requirements that they determine are necessary to meet their statutory obligations to protect the quality of the state's aquatic lands.

1.6.14 Requirements Identified through Watershed/Basin Planning or Total Maximum Daily Loads

A number of the requirements of this manual can be superseded by the adoption of ordinances and rules to implement the recommendations of watershed plans or basin plans. Local governments may initiate their own watershed or basin planning processes to identify more stringent or alternative requirements. They may also choose to develop a watershed plan in accordance with the Watershed Management Act (Chapter 90.82 RCW) that includes the optional elements of water quality and habitat. They may also choose to develop a basin plan in accordance with Chapter 400-12 WAC. As long as the actions or requirements identified in those plans and implemented through local or state ordinances or rules comply with applicable state and federal statutes (e.g., the federal Clean Water Act and the Endangered Species Act), they can supersede the requirements in this manual. The decisions concerning whether such locally derived requirements comply with federal and state statutes rest with the regulatory agencies responsible for implementing those statutes.

A requirement of this manual can also be superseded or added to through the adoption of actions and requirements identified in a Total Maximum Daily Load (TMDL) that is approved by the EPA. However, it is likely that at least some TMDLs will require use of the BMPs in this manual.

1.6.15 Underground Injection Control Authorizations

To implement provisions of the federal Safe Drinking Water Act, Ecology has adopted rules (Chapter 173-218 WAC) for an underground injection control (UIC) program. Depending upon the manner in which it is accomplished, the discharge of stormwater into the ground can be classified as a Class V injection well. Federal UIC regulations, 40 CFR Part 144, were revised in 2000 to include subsurface distribution systems, drywells, catch basins, and similar devices that discharge to the ground. To date, Ecology's activity under this program has been primarily in regard to registering all UIC wells.

1.6.16 Other Local Government Requirements

Local governments have the option of applying more stringent requirements than those in this manual. They are not required to base those more stringent requirements on a watershed/basin plan or their obligations under a TMDL. Project proponents should always check with the local governmental agency with jurisdiction to determine the stormwater requirements that apply to their project.

1.7 Effects of Urbanization

1.7.1 Background Conditions

Prior to the Euro-American settlement, western Washington primarily was forested in alder, maple, fir, hemlock and cedar. The area's bountiful rainfall supported the forest and the many creeks, springs, ponds, lakes and wetlands. The forest system provided protection by intercepting rainfall in the canopy, reducing the possibility of erosion and the deposition of sediment in waterways. The trees and other vegetative cover evapotranspirated at least 40% of the rainfall. The forest duff layer absorbed large amounts of runoff releasing it slowly to the streams through shallow ground water flow.

1.7.2 Hydrologic Changes

As settlement occurs and the population grows, trees are logged and land is cleared for the addition of impervious surfaces such as rooftops, roads, parking lots, and sidewalks. Maintained landscapes that have much higher runoff characteristics typically replace the natural vegetation. The natural soil structure is also lost due to grading and compaction during construction. Roads are cut through slopes and low spots are filled. Drainage patterns are irrevocably altered. All of this results in drastic changes in the natural hydrology, including:

- Increased volumetric flow rates of runoff;
- Increased volume of runoff;

- Decreased time for runoff to reach a natural receiving water;
- Reduced ground water recharge;
- Increased frequency and duration of high stream flows and wetlands inundation during and after wet weather;
- Reduced stream flows and wetlands water levels during the dry season; and
- Greater stream velocities.

Figure 1.1 illustrates some of these hydrologic changes. As a consequence of these hydrology changes, stream channels are eroded by high flows and can lose summertime base flows. Increased flooding occurs. Streams lose their hydraulic complexity. Habitat is degraded and receiving water species composition is altered as explained below.

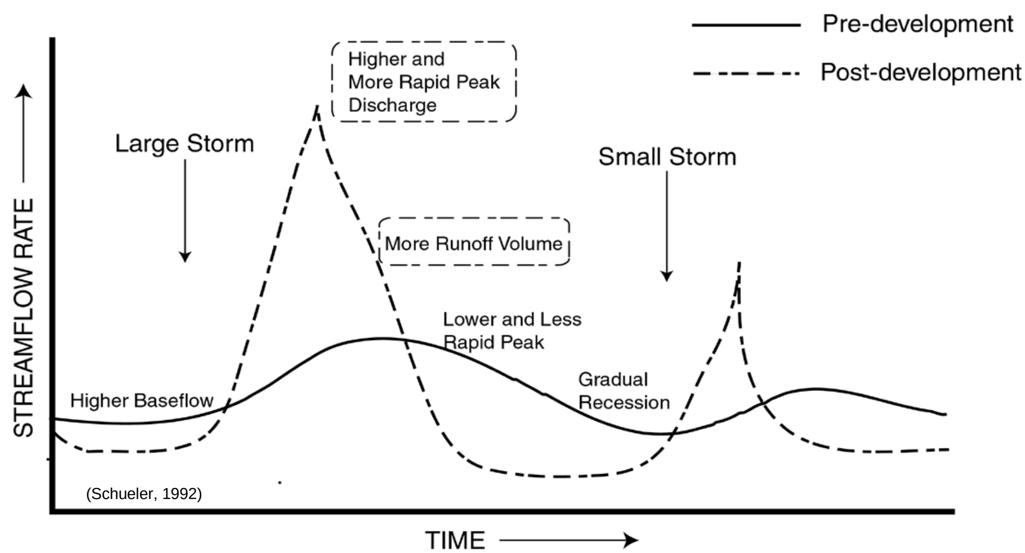

Figure 1.1 – Changes in Hydrology After Development

Figure 1.2 (Booth and Jackson, 1997) illustrates one observed relationship between the level of development in a basin (as measured by effective, not total, impervious area), the changes in the recurrence of modeled stream flows, and the resultant streambank instability and channel erosion. These data show that even a crude measure of stream degradation, “channel instability,” shows significant changes at relatively low levels of urban development. More sensitive measures, such as biological indicators (see section 1.7.4), document degradation at even lower levels of human activity.

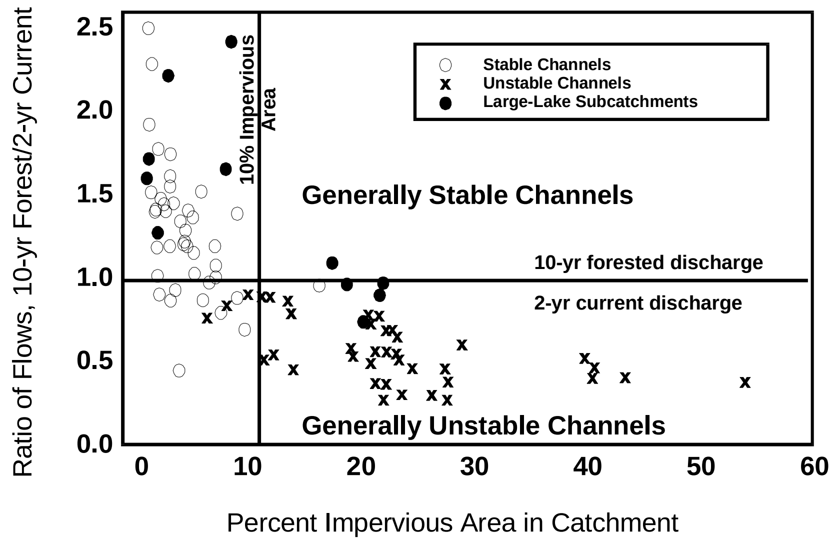

Figure 1.2 - Channel Stability and Land Use: Hylebos, East Lake Sammamish, Issaquah Basins

1.7.3 Water Quality Changes

Urbanization also causes an increase in the types and quantities of pollutants in surface and ground waters. Runoff from urban areas has been shown to contain many different types of pollutants, depending on the nature of the activities in those areas. Table 1.1, from an analysis of Oregon urban runoff water quality monitoring data collected from 1990 to 1996, shows mean concentrations for a limited number of pollutants from different land uses. (Strecker et al, 1997)

Table 1.1 Mean Concentrations of Selected Pollutants in Runoff from Different Land Uses

Land Use	TSS mg/l	Total Cu mg/l	Total Zn mg/l	Dissolved Cu mg/l	Total P mg/l
In-pipe Industry	194	0.053	0.629	0.009	0.633
Instream Industry	102	0.024	0.274	0.007	0.509
Transportation	169	0.035	0.236	0.008	0.376
Commercial	92	0.032	0.168	0.009	0.391
Residential	64	0.014	0.108	0.006	0.365
Open	58	0.004	0.025	0.004	0.166

Note:
In-pipe industry means the samples were taken in stormwater pipes. Instream industry means the samples were taken in streams flowing through industrial areas. Samples for all other categories were taken within stormwater pipes.

The runoff from roads and highways is 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.

Regardless of the eventual land use conversion, the sediment load produced by a construction site can turn the receiving waters turbid and be deposited over the natural sediments of the receiving water.

The pollutants added by urbanization can be dissolved in the water column or can be attached to particulates that settle in streambeds, lakes, wetlands, or marine estuaries. A number of urban bays in Puget Sound have contaminated sediments due to pollutants associated with particulates in stormwater runoff.

Urbanization also tends to cause changes in water temperature. Heated stormwater from impervious surfaces and exposed treatment and detention ponds discharges to streams with less riparian vegetation for shade. Urbanization also reduces ground water recharge, which reduces sources of cool ground water inputs to streams. In winter, stream temperatures may lower due to loss of riparian cover. There is also concern that the replacement of warmer ground water inputs with colder surface runoff during colder periods may have biological impacts.

1.7.4 Biological Changes

The hydrologic and water quality changes result in changes to the biological systems that were supported by the natural hydrologic system. In particular, aquatic life is greatly affected by urbanization. Habitats are drastically altered when a stream changes its physical configuration and substrate due to increased flows. Natural riffles, pools, gravel bars and other areas are altered or destroyed. These and other alterations produce a habitat structure that is very different from the one in which the resident aquatic life evolved. For example, spawning areas, particularly those of salmonids, are lost. Fine sediments imbed stream gravels and suffocate salmon redds. The complex food web is destroyed and is replaced by a biological system that can tolerate the changes. However, that biological community is typically not as complex, is less desirable, and is unstable due to the ongoing rapid changes in the new hydrologic regime.

Significant and detectable changes in the biological community of Puget Sound lowland streams begin early in the urbanization process. May *et al* (1997) reported changes in the 5-10% total impervious area range of a watershed. Figure 1.3 from May *et al* (1997) shows the relationship observed between the Benthic Index of Biotic Integrity (B-IBI) developed by Kleindl (1995) and Karr (1991), and the extent of watershed urbanization as estimated by the percentage of total impervious area (% TIA). Also shown in the figure is the correlation between the abundance ratio of juvenile coho salmon to cutthroat trout (Lucchetti and Fuerstenberg 1993) and the extent of urbanization.

The biological communities in wetlands are also severely impacted and altered by the hydrological changes. Relatively small changes in the natural water elevation fluctuations can cause dramatic shifts in vegetative and animal species composition.

In addition, the toxic pollutants in the water column such as pesticides, soaps, and metals can have immediate and long-term lethal impacts. Toxic pollutants in sediments can yield similar impacts with the lesions and cancers in bottom fish of urban bays serving as a prime example.

A rise in water temperature can have direct lethal effects. It reduces the maximum available dissolved oxygen and may cause algae blooms that further reduce the amount of dissolved oxygen in the water.

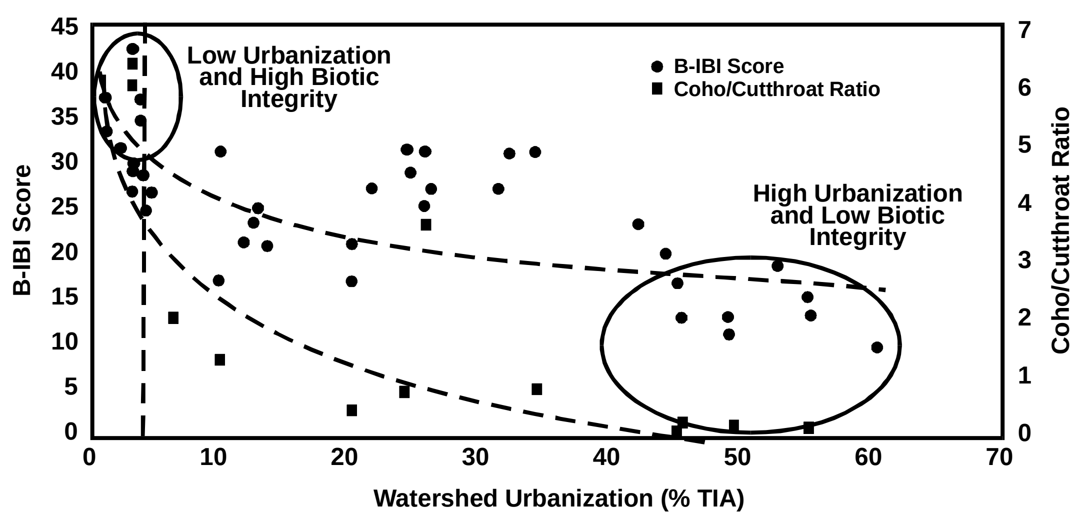

Figure 1.3 – Relationship Between Basin Development and Biotic Integrity in Puget Sound Lowland Streams

1.7.5 The Role of Land Use and Lifestyles

The manual's scope is limited to managing the surface runoff generated by a new development or redevelopment project. The manual does not intend to delve deeply into site development standards or where development should be allowed. Those are land use decisions that should not be directed by this stormwater manual. The manual applies after the decision to develop a site has been made. The manual can provide site development strategies to reduce the pollutants generated and the hydrologic disruptions caused by development.

The engineered stormwater conveyance, treatment, and detention systems advocated by this and other stormwater manuals can reduce the impacts of development to water quality and hydrology. But they cannot replicate the natural hydrologic functions of the natural watershed that existed before development, nor can they remove sufficient pollutants to replicate the water quality of pre-development conditions. Ecology understands that despite the application of appropriate practices and technologies identified in this manual, some degradation of urban and suburban receiving waters will continue, and some beneficial uses will continue to be impaired or lost due to new development. This is because land development, as practiced today, is incompatible with the achievement of sustainable ecosystems. Unless development methods are adopted that cause significantly less disruption of the hydrologic cycle, the cycle of new development followed by beneficial use impairments will continue.

In recent years, researchers (May et al, 1997) and regulators (e.g., Issaquah Creek Basin and Nonpoint Action Plan, 1996) have speculated on the amount of natural land cover and soils that should be preserved in a watershed to retain sufficient hydrologic conditions to prevent stream channel degradation, maintain base flows, and contribute to achieving properly functioning conditions for salmonids. There is some agreement that preserving a high percentage (possibly 65 to 75%) of the land cover and soils in an undisturbed state is necessary. To achieve these high percentages in urban, urbanizing, and suburban watersheds, a dramatic reduction is necessary in the amount of impervious surfaces and artificially landscaped areas to accommodate our preferred housing, play, and work environments, and most significantly, our transportation choices.

Surfaces created to provide "car habitat" comprise the greatest portion of impervious areas in land development. Therefore, to make appreciable progress in reducing impervious surfaces in a watershed, we must reduce the density of our road systems, alter our road construction standards, reduce surface parking, and rely more on transportation systems that do not require such extensive impervious surfaces (rail, bicycles, walking).

Reducing the extent of impervious surfaces and increasing natural land cover in watersheds are also necessary to solve the water quality problems of sediment, temperature, toxicants, and bacteria. Changing public attitudes toward chemical use and preferred housing are also necessary to achieve healthy water ecosystems.

Until we are successful in applying land development techniques that result in matching the natural hydrologic functions and cycles of watersheds, management of the increased surface runoff is necessary to reduce the impact of the changes. Figure 1.3 illustrates that significant biological impacts in streams can occur at even low levels of development associated with rural areas where stormwater runoff has not been properly managed. Improving our stormwater detention, treatment, and source control management practices should help reduce the impacts of land development in urban and rural areas. We must also improve the operation and maintenance of our engineered systems so that they function as well as possible. This manual is Ecology's latest effort to apply updated knowledge in these areas.

The question yet to be answered is whether better management – including improved treatment and detention techniques – of the increased surface runoff from developed areas can work in combination with preservation of high percentages of natural vegetation and soils on a watershed scale to yield a minimally altered hydrologic and water quality regime that protects the water-related natural resources.

In summary, implementing improved engineering techniques and drastic changes in where and how land is developed and how people live and move across the land are necessary to achieve the goals in the federal Clean Water Act - to preserve, maintain, and restore the beneficial uses of our nation's waters.

Chapter 2 - Minimum Requirements for New Development and Redevelopment

This Chapter identifies the ten Minimum Requirements for stormwater management applicable to new development and redevelopment sites. The 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
6. Runoff Treatment
7. Flow Control
8. Wetlands Protection
9. Basin/Watershed Planning
10. Operation and Maintenance

Depending on the type and size of the proposed project, different combinations of these minimum requirements apply. In general, small sites are required to control erosion and sedimentation from construction activities and to apply simpler approaches to treatment and flow control of stormwater runoff from the developed site. Controlling flows from small sites is important because the cumulative effect of uncontrolled flows from many small sites can be as damaging as those from a single large site.

Large sites must provide erosion and sedimentation control during construction, permanent control of stormwater runoff from the developed site through selection of appropriate BMPs and facilities, and other measures to reduce and control the onsite and offsite impacts of the project. Sites being redeveloped must generally meet the same minimum requirements as new development for the new impervious surfaces and pervious surfaces converted from natural vegetation to lawn or landscaped areas. Redevelopment sites must also provide erosion control, source control, and on-site stormwater management for the portion of the site being redeveloped. In addition, if the redevelopment meets certain cost or space (as applied to roads) thresholds, updated stormwater management for the redeveloped pervious and impervious surfaces must be provided. There may also be situations in which additional controls are required for sites, regardless of type or size, as a result of basin plans or special water quality concerns.

Development sites are to demonstrate compliance with these requirements through the preparation of Stormwater Site Plans (SSP). The plans are described in detail in Chapter 3. Two major components of these plans are a Construction Stormwater Pollution Prevention Plan (SWPPP) and a Permanent Stormwater Control Plan (PSCP). The Construction SWPPP shall identify how the project intends to control pollution generated during the construction phase only, primarily erosion and sediment. The PSCP shall identify how the project intends to provide permanent BMPs for the control of pollution from stormwater runoff after construction has been completed. Sites must submit these plans for review by the local government if they add or replace 2,000 square feet or more of impervious surface, or disturb 7,000 square feet or more of land.

Section 2.4 provides additional information on applicability of the Minimum Requirements to different types of sites.

2.1 Relationship to Puget Sound Water Quality Management Plan

This manual, now expanded to be applicable throughout western Washington, was originally developed to comply with the 1991 Puget Sound Water Quality Management Plan. That plan (as amended in 2000) requires all counties and cities within the Puget Sound drainage basin to adopt stormwater programs which include minimum requirements for new development and redevelopment set by the Plan and in guidance developed by the Department of Ecology (Ecology). The programs are to include ordinances that address:

> *"... at a minimum: (1) the control of off-site water quality and quantity effects; (2) the use of best management practices for source control and treatment; (3) the effective treatment, using best management practices, of the storm size and frequency (design storm) as specified in the manual for proposed development; (4) the use of infiltration, with appropriate precautions, as the first consideration in stormwater management; (5) the protection of stream channels, fish, shellfish habitat, other aquatic habitat, and wetlands; (6) erosion and sedimentation control for new construction and redevelopment projects; and (7) local enforcement of these stormwater controls."*

Ecology considers the above description to be generic to proper stormwater management in any region within the state of Washington.

Throughout this Chapter, guidance to meet the requirements of the Puget Sound Water Quality Management Plan is written in bold and supplemental guidelines that serve as advice and other materials are <u>not</u> in bold. To have an equivalent manual, local governments must adopt into ordinance and/or enforceable rules, the definitions, thresholds, minimum requirements, and adjustment and variance criteria that are displayed in bold. Alternative definitions, thresholds, minimum requirements, and adjustment and variance criteria are acceptable if they provide equivalent protection of receiving waters and equivalent levels of treatment and control.

2.2 Exemptions

Forest practices regulated under Title 222 WAC, except for Class IV General forest practices that are conversions from timber land to other uses, are exempt from the provisions of the minimum requirements.

Commercial agriculture:

Commercial agriculture practices involving working the land for production are generally exempt. However, the conversion from timberland to agriculture, and the construction of impervious surfaces are not exempt.

Road Maintenance:

The following road maintenance practices are exempt: pothole and square cut patching, overlaying existing asphalt or concrete pavement with asphalt or concrete without expanding the area of coverage, shoulder grading, reshaping/regrading drainage systems, crack sealing, resurfacing with in-kind material without expanding the road prism, and vegetation maintenance.

The following road maintenance practices are considered redevelopment, and therefore are not categorically exempt. The extent to which the manual applies is explained for each circumstance.

- Removing and replacing a paved surface to base course or lower, or repairing the roadway base: If impervious surfaces are not expanded, Minimum Requirements #1 - #5 apply. However, in most cases, only Minimum Requirement #2, Construction Stormwater Pollution Prevention, will be germane. Where appropriate, project proponents are encouraged to look for opportunities to use permeable and porous pavements.
- 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 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 redevelopment projects are met.

Underground utility projects:

Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics are only subject to Minimum Requirement #2, Construction Stormwater Pollution Prevention.

All other new development is subject to one or more of the Minimum Requirements (see Section 2.4).

2.3 Definitions Related to Minimum Requirements

A full listing and definition of stormwater-related words and phrases that are used in this manual is given in the glossary. A few of the key definitions are listed here for ease in understanding the requirements that follow.

- ***Arterial -*** A road or street primarily for through traffic. A major arterial connects an Interstate Highway to cities and counties. A minor arterial connects major arterials to collectors. A collector connects an arterial to a neighborhood. A collector is not an arterial. A local access road connects individual homes to a collector.

- ***Effective Impervious surface -*** Those impervious surfaces that are connected via sheet flow or discrete conveyance to a drainage system. Impervious surfaces on residential development sites are considered ineffective if the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 – "Full Dispersion," as described in Chapter 5 of Volume V.

- ***Highway –*** A main public road connecting towns and cities

- ***Impervious surface -*** A hard surface area that either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A hard 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 movement of earth, or 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 are not considered land-disturbing activity.

- ***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 and 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. For further details on the application of this manual to various road management functions, please see Section 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 impervious 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.

- ***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); or storage of erodible or leachable materials, wastes, or chemicals, and which receive direct rainfall or the run-on or blow-in of rainfall. Erodible or leachable materials, wastes, or chemicals are those substances which, when exposed to rainfall, measurably alter the physical or chemical characteristics of the rainfall runoff. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage. Metal roofs are also considered to be PGIS unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating).

A surface, whether paved or not, shall be considered subject to vehicular use if it is regularly used by motor vehicles. The following are considered regularly-used surfaces: roads, unvegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.

The following are not considered regularly-used surfaces: paved bicycle pathways separated from and not subject to drainage from roads for motor vehicles, fenced fire lanes, and infrequently used maintenance access roads.

- ***Pollution-generating pervious surfaces (PGPS)* -** Any non-impervious surface subject to use of pesticides and fertilizers or loss of soil. Typical PGPS include lawns, landscaped areas, golf courses, parks, cemeteries, and sports fields.

- ***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 impervious surfaces, or replaced impervious surfaces.

- **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.

- ***Redevelopment* -** On a site that is already substantially developed (i.e., has 35% or more of existing impervious surface coverage), the creation or addition of impervious 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 impervious surface that is not part of a routine maintenance activity; and land disturbing activities.

- ***Replaced impervious surface*** **-** For structures, the removal and replacement of any exterior impervious surfaces or 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. See Volume IV for details.

- ***Threshold Discharge Area*** **-** An onsite 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 flowpath). The examples in Figure 2.1 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.

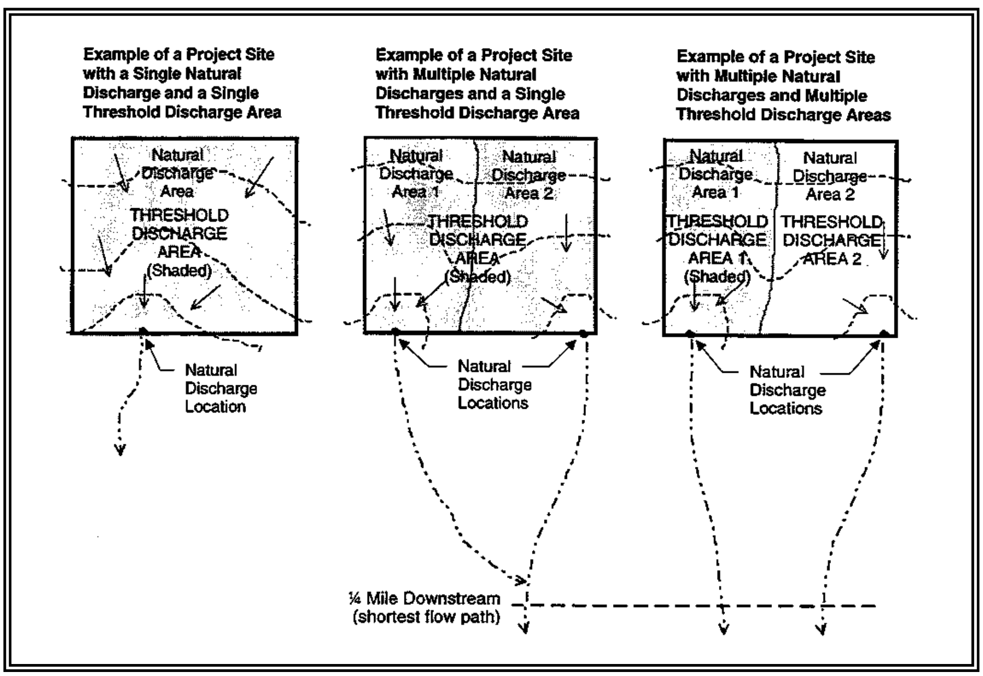

Figure 2.1 Threshold Discharge Areas

2.4 Applicability of the Minimum Requirements

Not all of the Minimum Requirements apply to every development or redevelopment project. The applicability varies depending on the type and size of the project. This section identifies thresholds that determine the applicability of the Minimum Requirements to different projects. The flow charts in Figures 2.2 and 2.3 can be used to determine which requirements apply. The Minimum Requirements themselves are presented in Section 2.5.

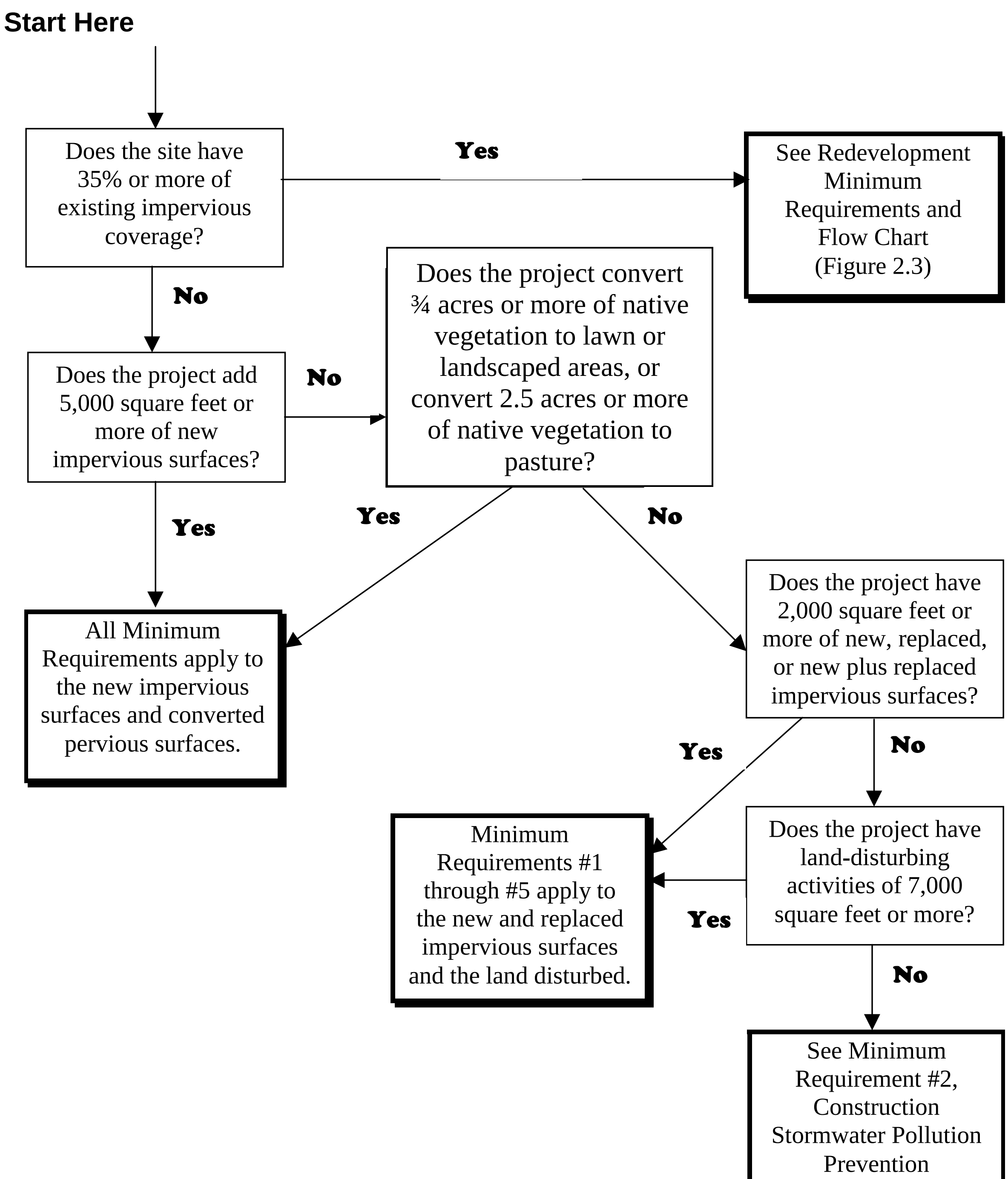

Figure 2.2 – Flow Chart for Determining Requirements for New Development

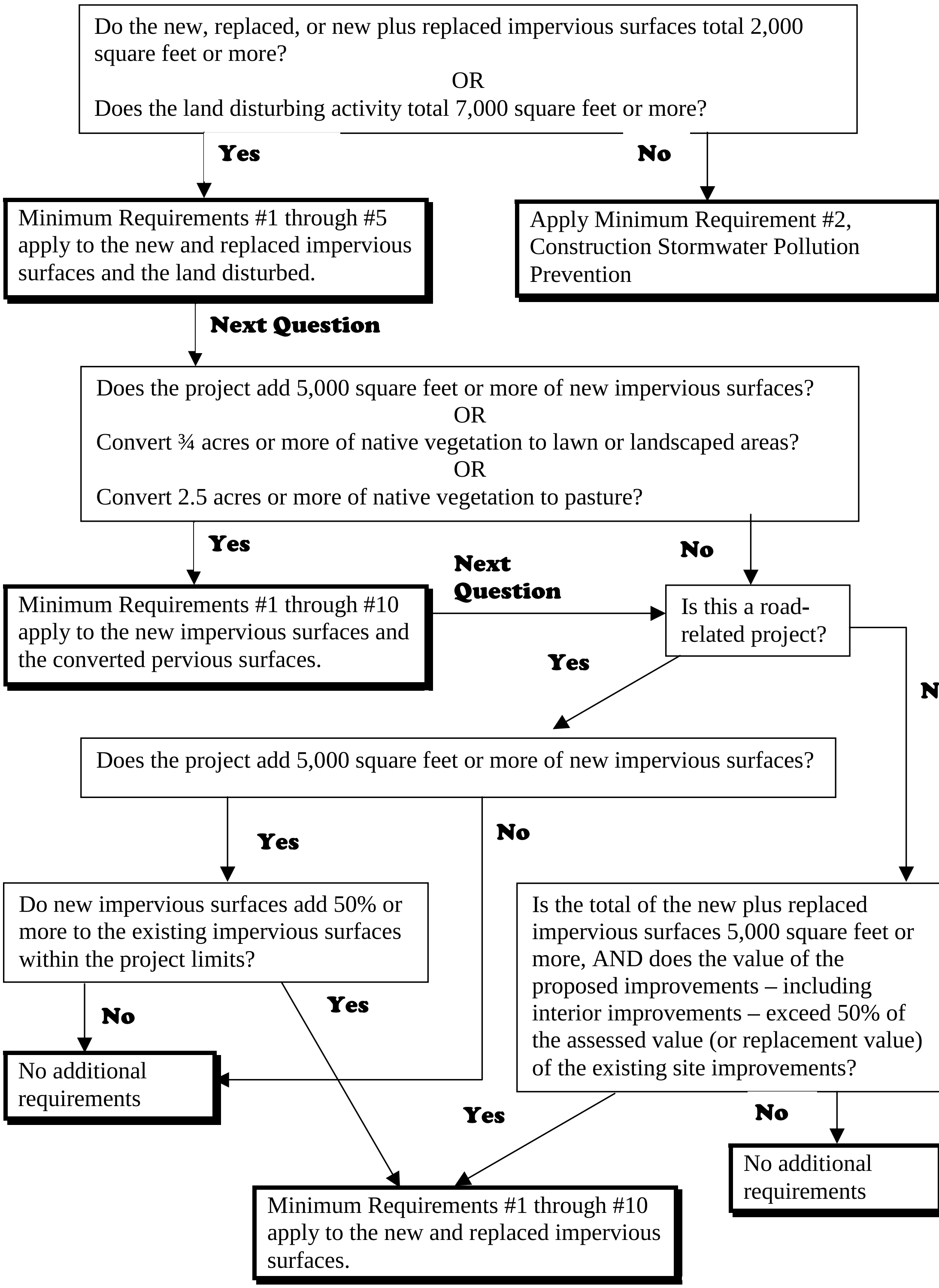

Figure 2.3 – Flow Chart for Determining Requirements for Redevelopment

2.4.1 New Development

All new development shall be required to comply with Minimum Requirement #2.

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

- **Creates or adds 2,000 square feet, or greater, of new, replaced, or new plus replaced impervious surface area, or**
- **Has land disturbing activity of 7,000 square feet or greater,**

The following new development shall comply with Minimum Requirements #1 through #10 for the new impervious surfaces and the converted pervious surfaces:

- **Creates or adds 5,000 square feet, or more, of new impervious surface area, or**
- **Converts ¾ acres, or more, of native vegetation to lawn or landscaped areas, or**
- **Converts 2.5 acres, or more, of native vegetation to pasture.**

Supplemental Guidelines

Basin planning is encouraged and may be used to tailor certain of the Minimum Requirements to a specific basin (Minimum Requirement #9). Treatment and flow control requirements may be achieved through construction of regional facilities. Such facilities must be operational prior to and must have capacity for new development.

Appendix C of Volume III directs users to model various low impact development techniques as landscaped area, 50% landscaped area, or pasture. Those same modeling credits may be used when summing project areas to determine whether the thresholds in Figures 2.2 and 2.3 are exceeded.

Where new development projects require improvements (e.g., frontage improvements) that are not within the same threshold discharge area, the local government may allow the Minimum Requirements to be met for an equivalent (flow and pollution characteristics) area that drains to the same receiving water.

2.4.2 Redevelopment

All redevelopment shall be required to comply with Minimum Requirement #2. In addition, all redevelopment that exceeds certain thresholds shall be required to comply with additional Minimum Requirements as follows.

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

- **The new, replaced, or total of *new plus rep*laced impervious surfaces is 2,000 square feet or more, or**
- **7,000 square feet or more of land disturbing activities.**

The following redevelopment shall comply with Minimum Requirements #1 through #10 for the new impervious surfaces and converted pervious areas:

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

If the runoff from the new impervious surfaces and converted pervious surfaces is not separated from runoff from other surfaces on the project site, the stormwater treatment facilities must be sized for the entire flow that is directed to them.

The local government may allow the Minimum Requirements to be met for an equivalent (flow and pollution characteristics) area within the same site. For public roads' projects, the equivalent area does not have to be within the project limits, but must drain to the same receiving water.

<u>Additional Requirements for the Project Site</u>

For road-related projects, runoff from the replaced and new impervious surfaces (including pavement, shoulders, curbs, and sidewalks) shall meet all the Minimum Requirements if the new impervious surfaces total 5,000 square feet or more and total 50% or more of the existing impervious 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 all the Minimum Requirements for the new and replaced impervious surfaces if the total of new plus replaced impervious 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.

A local government may exempt or institute a stop-loss provision for redevelopment projects from compliance with Minimum Requirements for treatment, flow control, and wetlands protection as applied to the replaced impervious surfaces if the local government has adopted a plan and a schedule that fulfills those requirements in regional facilities.

Objective

Redevelopment projects have the same requirements as new development projects in order to minimize the impacts from new surfaces. To not discourage redevelopment projects, replaced surfaces aren't required to be brought up to new stormwater standards unless the noted cost or space thresholds are exceeded. As long as the replaced surfaces have similar pollution-generating potential, the amount of pollutants discharged shouldn't be significantly different. However, if the redevelopment project scope is sufficiently large that the cost or space criteria noted above are exceeded, it is reasonable to require the replaced surfaces to be brought up to current stormwater standards. This is consistent with other utility standards. When a structure or a property undergoes significant remodeling, local governments often require the site to be brought up to new building code requirements (e.g., onsite sewage disposal systems, fire systems).

Supplemental Guidelines

If runoff from new impervious surfaces, converted pervious surfaces, and replaced impervious surfaces (if the applicable cost or space threshold has been exceeded) is not separated from runoff from other existing surfaces within the project site or the site, the guidance in Volume III for offsite inflow shall be used to size the detention facilities.

Local governments can select from various bases for identifying projects that must retrofit the replaced impervious surfaces on the project site. Those can include:

- Exceeding 50% of the assessed value of the existing improvements;
- Exceeding 50% of the replacement value of the existing site improvements as determined by the Marshall Value System, or a similar valuation system; and
- Exceeding a certain dollar value of improvements; and
- Exceeding a certain ratio of the new impervious surfaces to the total of replaced plus new impervious surfaces.

A local government's thresholds for the application of stormwater controls to replaced impervious surfaces must be at least as stringent as Ecology's thresholds. Local governments should be prepared to demonstrate that by comparing the number and types of historical projects that would have been regulated using the Ecology thresholds versus the local government's thresholds.

Local governments are allowed to institute a stop-loss provision on the application of stormwater requirements to replaced impervious surfaces. A stop-loss provision is an upper limit on the extent to which a requirement is applied. For instance, there could be a maximum percentage of the estimated total project costs that are dedicated to meeting stormwater requirements. A project would not have to incur additional stormwater costs above that maximum though the standard redevelopment requirements will not be fully achieved. The allowance for a stop-loss provision pertains to the extent that treatment, flow control and wetlands protection requirements are imposed on replaced impervious surfaces. It does not apply to meeting stormwater requirements for new impervious surfaces.

Local governments can also establish criteria for allowing redevelopment projects to pay a fee in lieu of constructing water quality or flow control facilities on a redeveloped site. At a minimum, the fee should be the equivalent of an engineering estimate of the cost of meeting all applicable stormwater requirements for the project. The local government should use such funds for the implementation of stormwater control projects that would have similar benefits to the same receiving water as if the project had constructed its required improvements. Expenditure of such funds is subject to other state statutory requirements.

Ecology cautions local governments about the potential long-term consequences of allowing a fee-in-lieu of stormwater facilities. Sites that are allowed to pay a fee continue without stormwater controls. If it is determined, through future basin planning for instance, that controls on such sites are necessary to achieve water quality goals or legal requirements, the public may bear the costs for providing those controls.

Underground utility projects that replace the ground surface with in-kind material or materials with similar runoff characteristics should not be subject to redevelopment requirements except construction site erosion control.

Local governments are also encouraged to review all road projects for changes in elevations or drainage flowpath that could cause flooding, upland or stream erosion, or changes to discharges to wetlands. For example, adding curbs will result in redirecting flows and possibly causing new downstream impacts. The local government should set project-specific requirements to avoid or mitigate those impacts.

2.5 Minimum Requirements

This section describes the minimum requirements for stormwater management at development and redevelopment sites. Section 2.4 should be consulted to determine which requirements apply to any given project. Volumes II through V of this manual present Best Management Practices (BMPs) for use in meeting the Minimum Requirements.

Throughout this Chapter, guidance to meet the requirements of the Puget Sound Water Quality Management Plan is written in bold and supplemental guidelines that serve as advice and other materials are <u>not</u> in bold.

2.5.1 Minimum Requirement #1: Preparation of Stormwater Site Plans

All projects meeting the thresholds in Section 2.4 shall prepare a Stormwater Site Plan for local government review. Stormwater Site Plans shall be prepared in accordance with Chapter 3 of this volume.

Objective

The 2,000 square feet threshold for impervious surfaces and 7,000 square foot threshold for land disturbance are chosen to capture most single family home construction and their equivalent. Note that the scope of the stormwater site plan only covers compliance with Minimum Requirements #2 through #5 if the thresholds of 5,000 square feet of impervious surface or conversion of ¾ acre of native vegetation to lawn or landscape, or conversion of 2.5 acres of native vegetation to pasture are not exceeded.

Supplemental guidelines

Projects proposed by departments and agencies within the local government with jurisdiction must comply with this requirement. The local government shall determine the process for ensuring proper project review, inspection, and compliance by its own departments and agencies.

2.5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention (SWPP)

All new development and redevelopment shall comply with Construction SWPP Elements #1 through #12 below.

Projects in which the new, replaced, or new plus replaced impervious surfaces total 2,000 square feet or more, or disturb 7,000 square feet or more of land must prepare a Construction SWPP Plan (SWPPP) as part of the Stormwater Site Plan (see 2.5.1). Each of the twelve 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 of the SWPPP.

Projects that add or replace less than 2,000 square feet of impervious surface or disturb less than 7,000 square feet of land are not required to prepare a Construction SWPPP, but must consider all of the twelve Elements of Construction Stormwater Pollution Prevention and develop controls for all elements that pertain to the project site.

Element 1: Mark Clearing Limits

Prior to beginning land disturbing activities, including clearing and grading, all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area shall be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts.

- **Plastic, metal, or stake wire fence may be used to mark the clearing limits.**

The duff layer, native top soil, and natural vegetation shall be retained in an undisturbed state to the maximum extent practicable. If it is not practicable to retain the duff layer in place, it should be stockpiled on-site, covered to prevent erosion, and replaced immediately upon completion of the ground disturbing activities.

Element 2: Establish Construction Access

- **Construction vehicle access and exit shall be limited to one route, if possible, or two for linear projects such as roadways where more than one access is necessary for large equipment maneuvering.**
- **Access points shall be stabilized with a pad of quarry spalls or crushed rock prior to traffic leaving the construction site to minimize the tracking of sediment onto public roads.**
- **Wheel wash or tire baths should be located on-site, if applicable.**
- **If sediment is tracked off site, public roads shall be cleaned thoroughly at the end of each day, or more frequently during wet weather, if necessary to prevent sediment from entering waters of the state. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing will be allowed only after sediment is removed in this manner.**

- **Street wash wastewater shall be controlled by pumping back on-site, or otherwise be prevented from discharging into systems tributary to state surface waters.**

Element 3: **Control Flow Rates**

- **Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site, as required by local plan approval authority.**
- **Downstream analysis is necessary if changes in flows could impair or alter conveyance systems, stream banks, bed sediment or aquatic habitat. See Chapter 3 for offsite analysis guidance.**
- **Where necessary to comply with Minimum Requirement #7, stormwater retention/detention facilities shall be constructed as one of the first steps in grading. Detention facilities shall be functional prior to construction of site improvements (e.g. impervious surfaces).**
- **The local permitting agency may require pond designs that provide additional or different stormwater flow control if necessary to address local conditions or to protect properties and**
- **waterways downstream from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.**
- **If permanent infiltration ponds are used for flow control during construction, these facilities should be protected from siltation during the construction phase.**

Element 4: **Install Sediment Controls**

- **Prior to leaving a construction site, or prior to discharge to an infiltration facility, stormwater runoff from disturbed areas shall pass through a sediment pond or other appropriate sediment removal BMP. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard of Element #3, bullet #1. Full stabilization means concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion. The Local Permitting Authority shall inspect and approve areas stabilized by means other than pavement or quarry spalls.**
- **Sediment ponds, vegetated buffer strips, sediment barriers or filters, dikes, and other BMPs intended to trap sediment on-site shall be constructed as one of the first steps in grading. These**

BMPs shall be functional before other land disturbing activities take place.

- **Earthen structures such as dams, dikes, and diversions shall be seeded and mulched according to the timing indicated in Element #5.**
- **BMPs intended to trap sediment on site must be located in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages, often during non-storm events, in response to rain event changes in stream elevation or wetted area.**

Element 5: Stabilize Soils

- **All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from the erosive forces of raindrop impact and flowing water, and wind erosion.**
- **From October 1 through April 30, no soils shall remain exposed and unworked for more than 2 days. From May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days. This condition applies to all soils on site, whether at final grade or not. These time limits may be adjusted by the local permitting authority if it can be shown that the average time between storm events justifies a different standard.**
- **Soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on the weather forecast.**
- **Applicable practices include, but are not limited to, temporary and permanent seeding, sodding, mulching, plastic covering, soil application of polyacrylamide (PAM), the early application of gravel base on areas to be paved, and dust control.**
- **Soil stabilization measures selected should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or ground water.**
- **Soil stockpiles must be stabilized from erosion, protected with sediment trapping measures, and when possible, be located away from storm drain inlets, waterways and drainage channels.**
- **Linear construction activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall be conducted to meet the soil stabilization requirement. Contractors shall install the bedding materials, roadbeds, structures, pipelines, or utilities and re-stabilize the disturbed soils so that:**

- **from October 1 through April 30 no soils shall remain exposed and unworked for more than 2 days; and**
- **from May 1 to September 30, no soils shall remain exposed and unworked for more than 7 days.**

Element 6: Protect Slopes

- **Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion.**
- **Consider soil type and its potential for erosion.**
- **Reduce slope runoff velocities by reducing the continuous length of slope with terracing and diversions, reduce slope steepness, and roughen slope surface.**
- **Off-site stormwater (run-on) shall be diverted away from slopes and disturbed areas with interceptor dikes and/or swales. Off-site stormwater should be managed 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 shall handle the peak flow from a 10 year, 24 hour event assuming a Type 1A rainfall distribution. Alternatively, the 10-year and 25-year, 1-hour flow rates indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. Consult the local drainage requirements for sizing permanent pipe slope drains.**
- **Provide drainage to remove ground water intersecting the slope surface of exposed soil areas.**
- **Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.**
- **Check dams shall be placed at regular intervals within channels that are cut down a slope.**
- **Stabilize soils on slopes, as specified in Element #5.**

Element 7: Protect Drain Inlets

- **All storm drain inlets made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.**
- **All approach roads shall be kept clean. All sediment and street wash water shall not be allowed to enter storm drains without prior and adequate treatment unless treatment is provided before the storm drain discharges to waters of the State.**
- **Inlets should be inspected weekly at a minimum and daily during storm events. Inlet protection devices should be cleaned or**

removed and replaced when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

Element 8: **Stabilize Channels and Outlets**

- **All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from the expected 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 runoff model, increased by a factor of 1.6, may be used.**
- **Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.**

Element 9: **Control Pollutants**

- **All pollutants, including waste materials and demolition debris, that occur on-site shall be handled and disposed of in a manner that does not cause contamination of stormwater. Woody debris may be chopped and spread on site.**
- **Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site (see Chapter 173-304 WAC for the definition of inert waste). On-site fueling tanks shall include secondary containment.**
- **Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.**
- **Wheel wash or tire bath wastewater, shall be discharged to a separate on-site treatment system or to the sanitary sewer.**
- **Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations for application rates and procedures shall be followed.**
- **BMPs shall be used to prevent or treat contamination of stormwater runoff by pH modifying sources. These sources**

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, and concrete pumping and mixer washout waters. Stormwater discharges shall not cause or contribute to a violation of the water quality standard for pH in the receiving water.

- **Construction sites with significant concrete work shall adjust the pH of stormwater if necessary to prevent violations of water quality standards.**

Element 10: **Control De-Watering**

- **Foundation, vault, and trench de-watering water, which has similar characteristics to stormwater runoff at the site, shall be discharged into a controlled conveyance system prior to discharge to a sediment trap or sediment pond. Channels must be stabilized, as specified in Element #8.**
- **Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to state surface waters, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters. These clean waters should not be routed through a stormwater sediment pond.**
- **Highly turbid or otherwise contaminated dewatering water, such as from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater.**
- **Other disposal options, depending on site constraints, may include: 1) infiltration, 2) transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters, 3) Ecology-approved on-site chemical treatment or other suitable treatment technologies, 4) sanitary sewer discharge with local sewer district approval, if there is no other option, or 5) use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized dewatering.**

Element 11: **Maintain BMPs**

- **All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with BMP specifications.**
- **All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on site. Disturbed soil**

areas resulting from removal of BMPs or vegetation shall be permanently stabilized.

Element 12: **Manage The Project**

- **Phasing of Construction - Development projects shall be phased where feasible in order to prevent soil erosion and, to the maximum extent practicable, the transport of sediment from the site during construction. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities for any phase.**
- **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. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing disturbance/compaction of native soils except as needed for building purposes. 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 as may be required by local jurisdictions, shall be delineated on the site plans and the development site.**
- **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 the local permitting authority 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; and**
  2. **Limitations on activities and the extent of disturbed areas; and**
  3. **Proposed erosion and sediment control measures.**

  Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance. The local permitting authority shall take enforcement action - such as a notice of violation, administrative order, penalty, or stop-work order under 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; or**

- **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:

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; and**
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.**

- **Coordination with Utilities and Other Contractors - 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.**

  Inspection and Monitoring - All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. The person must have the skills to 1) assess the site conditions and construction activities that could impact the quality of stormwater, and 2) assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

- **For construction sites one acre or larger that discharge stormwater to surface waters of the state, a Certified Erosion and Sediment Control Specialist shall be identified in the Construction SWPPP and shall be on-site or on-call at all times. Certification may be obtained through an approved training program that meets the erosion and sediment control training standards established by Ecology.**

  Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

- **Maintaining an Updated Construction SWPPP - The Construction SWPPP shall be retained on-site or within reasonable access to the site.**

The SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.

The SWPPP shall be modified, if during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) calendar days following the inspection.

Objective

To control erosion and prevent sediment and other pollutants from leaving the site during the construction phase of a project.

Supplemental Guidelines

If a Construction SWPPP is found to be inadequate (with respect to erosion and sediment control requirements), then the Plan Approval Authority[1] within the Local Government should require that other BMPs be implemented, as appropriate.

The Plan Approval Authority may allow development of generic Construction SWPPP's that apply to commonly conducted public road activities, such as road surface replacement, that trigger this minimum requirement.

2.5.3 Minimum Requirement #3: Source Control of Pollution

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

Objective

The intention of source control BMPs is to prevent stormwater from coming in contact with pollutants. They are a cost-effective means of reducing pollutants in stormwater, and, therefore, should be a first consideration in all projects

[1] The Plan Approval Authority is defined as that department within a local government that has been delegated authority to approve stormwater site plans.

Supplemental Guidelines

An adopted and implemented basin plan (Minimum Requirement #9) or a Total Maximum Daily Load (TMDL, also known as a Water Clean-up Plan) may be used to develop more stringent source control requirements that are tailored to a specific basin.

Source Control BMPs include Operational BMPs and Structural Source Control BMPs. See Volume IV for design details of these BMPs. For construction sites, see Volume II, Chapter 4.

Structural source control BMPs should be identified in the stormwater site plan and should be shown on site plans submitted for local government review.

2.5.4 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 downgradient properties. All outfalls require energy dissipation.

Objective

To preserve and utilize natural drainage systems to the fullest extent because of the multiple stormwater benefits these systems provide; and to prevent erosion at and downstream of the discharge location.

Supplemental Guidelines

Creating new drainage patterns results in more site disturbance and more potential for erosion and sedimentation during and after construction. Creating new discharge points can create significant stream channel erosion problems as the receiving water body typically must adjust to the new flows. Diversions can cause greater impacts than would otherwise occur by discharging runoff at the natural location.

Where no conveyance system exists at the adjacent downgradient property line and the discharge was previously unconcentrated flow or significantly lower concentrated flow, then measures must be taken to prevent downgradient impacts. Drainage easements from downstream property owners may be needed and should be obtained prior to approval of engineering plans.

The following discharge requirement is recommended:

Where no conveyance system exists at the abutting downstream property line and the natural (existing) discharge is unconcentrated, any runoff concentrated by the proposed project must be discharged as follows:

a) If the 100-year peak discharge is less than or equal to 0.2 cfs under existing conditions and will remain less than or equal to 0.2 cfs under developed conditions, then the concentrated runoff may be discharged onto a rock pad or to any other system that serves to disperse flows.

b) If the 100-year peak discharge is less than or equal to 0.5 cfs under existing conditions and will remain less than or equal to 0.5 cfs under developed conditions, then the concentrated runoff may be discharged through a dispersal trench or other dispersal system, provided the applicant can demonstrate that there will be no significant adverse impact to downhill properties or drainage systems.

c) If the 100-year peak discharge is greater than 0.5 cfs for either existing or developed conditions, or if a significant adverse impact to downgradient properties or drainage systems is likely, then a conveyance system must be provided to convey the concentrated runoff across the downstream properties to an acceptable discharge point (i.e., an enclosed drainage system or open drainage feature where concentrated runoff can be discharged without significant adverse impact).

Stormwater control or treatment structures should not be located within the expected 25-year water level elevations for salmonid-bearing waters. Such areas may provide off-channel habitat for juvenile salmonids and salmonid fry. Designs for outfall systems to protect against adverse impacts from concentrated runoff are included in Volume V, Chapter 4.

2.5.5 Minimum Requirement #5: On-site Stormwater Management

Projects shall employ On-site Stormwater Management BMPs to infiltrate, disperse, and retain stormwater runoff onsite to the maximum extent feasible without causing flooding or erosion impacts. Roof Downspout Control BMPs, functionally equivalent to those described in Chapter 3 of Volume III, and Dispersion and Soil Quality BMPs, functionally equivalent to those in Chapter 5 of Volume V, shall be required to reduce the hydrologic disruption of developed sites.

Objective

To use inexpensive practices on individual properties to reduce the amount of disruption of the natural hydrologic characteristics of the site**.**

Supplemental Guidelines

“Flooding and erosion impacts” include impacts such as flooding of septic systems, crawl spaces, living areas, outbuildings, etc.; increased ice or algal growth on sidewalks/roadways; earth movement/settlement, increased landslide potential; erosion and other potential damage.

Recent research indicates that current techniques in residential, commercial, and industrial land development cause gross disruption of the natural hydrologic cycle with severe impacts to water and water-related natural resources. Based upon gross level applications of continuous runoff modeling and assumptions concerning minimum flows needed to maintain beneficial uses, watersheds must retain the majority of their natural vegetation cover and soils, and developments must meet the Flow Control Minimum Requirement of this chapter, in order to avoid significant natural resource degradation in lowland streams.

The Roof Downspout Control BMPs described in Section 3.1 of Volume III, and the Dispersion and Soil Quality BMPs in Section 5.3.1 of Volume V are insufficient to prevent significant hydrologic disruptions and impacts to streams and their natural resources. Therefore, local governments should look for opportunities to encourage and require additional BMPs such as those in Appendix C in Volume III and Section 5.3.1 of Volume V through updates to their site development standards, critical areas ordinances, and land use plans.

2.5.6 Minimum Requirement #6: Runoff Treatment

Thresholds

The following require construction of stormwater treatment facilities (see Table 2.1):

- **Projects in which the total of effective, pollution-generating impervious surface (PGIS) 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) is three-quarters (3/4) of an acre or more in a threshold discharge area, and from which there is a surface discharge in a natural or man-made conveyance system from the site.**

Table 2.1 Treatment Requirements by Threshold Discharge Area				
	< ¾ acres of PGPS	**≥ ¾ acres PGPS**	**< 5,000 sf PGIS**	**≥ 5,000 sf PGIS**
Treatment Facilities		✔		✔
Onsite Stormwater BMPs	✔	✔	✔	✔

PGPS = pollution-generating pervious surfaces
PGIS = pollution-generating impervious surfaces
sf = square feet

Treatment Facility Sizing

Water Quality Design Storm Volume: 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 Chapter 2 of Volume III, for the 6-month, 24-hour storm. Alternatively, the 91st percentile, 24-hour runoff volume indicated by an approved continuous runoff model may be used.

Water Quality Design Flow Rate:

- ***Preceding Detention Facilities or when Detention Facilities are not required*: The flow rate at or below which 91% of the runoff volume, as estimated by an approved continuous runoff model, will be treated. Design criteria for treatment facilities are assigned to achieve the applicable performance goal at the water quality design flow rate (e.g., 80% TSS removal).**
- ***Downstream of Detention Facilities*: The full 2-year release rate from the detention facility.**

Alternative methods can be used if they identify volumes and flow rates that are at least equivalent.

That portion of any development project in which the above PGIS or PGPS thresholds are not exceeded in a threshold discharge area shall apply On-site Stormwater Management BMPs in accordance with Minimum Requirement #5.

Treatment Facility Selection, Design, and Maintenance

Stormwater treatment facilities shall be:

- **selected in accordance with the process identified in Chapter 4 of Volume I,**
- **designed in accordance with the design criteria in Volume V, and**
- **maintained in accordance with the maintenance schedule in Volume V.**

Additional Requirements

Direct discharge of untreated stormwater from pollution-generating impervious surfaces to ground water is prohibited, except for the discharge achieved by infiltration or dispersion of runoff from residential sites through use of On-site Stormwater Management BMPs.

Objective

The purpose of runoff treatment is to reduce pollutant loads and concentrations in stormwater runoff using physical, biological, and chemical removal mechanisms so that beneficial uses of receiving waters are maintained and, where applicable, restored. When site conditions are appropriate, infiltration can potentially be the most effective BMP for runoff treatment.

Supplemental Guidelines

See Volume V for more detailed guidance on selection, design, and maintenance of treatment facilities. The water quality design storm volume and flow rates are intended to capture and effectively treat about 90-95% of the annual runoff volume in western Washington. See Appendix I-B for background on their derivation.

Volume V includes performance goals for Basic, Enhanced, Phosphorus, and Oil Control treatment, and a menu of facility options for each treatment type. Treatment facilities that are selected from the appropriate menu and designed in accordance with their design criteria are presumed to meet the applicable performance goals.

An adopted and implemented basin plan (Minimum Requirement #9), or a Total Maximum Daily Load (TMDL - also known as a Water Clean-up Plan) may be used to develop runoff treatment requirements that are tailored to a specific basin. However, treatment requirements shall not be less than that achieved by facilities in the Basic Treatment Menu (see Volume V, Chapter 3).

Treatment facilities applied consistent with this manual are presumed to meet the requirement of state law to provide all known available and reasonable methods of treatment (RCW 90.52.040, RCW 90.48.010). This technology-based treatment requirement does not excuse any discharge from the obligation to apply whatever technology is necessary to comply with state water quality standards, Chapter 173-201A WAC; state ground water quality standards, Chapter 173-200 WAC; state sediment management standards, Chapter 173-204 WAC; and the underground injection control program, Chapter 173-218 WAC. Additional treatment to meet those standards may be required by federal, state, or local governments.

Infiltration through use of On-site Stormwater Management BMPs can provide both treatment of stormwater, through the ability of certain soils to remove pollutants, and volume control of stormwater, by decreasing the amount of water that runs off to surface water. Infiltration through engineered treatment facilities that utilize the natural soil profile can also be very effective at treating stormwater runoff, but pretreatment must be applied and soil conditions must be appropriate to achieve effective treatment while not impacting ground water resources. See Chapter 6 of Volume V for design details.

Discharge of pollution-generating surfaces into a dry well, after pretreatment for solids reduction, can be acceptable if the soil conditions provide sufficient treatment capacity. Dry wells into gravelly soils are not likely to have sufficient treatment capability. They must be preceded by at least a basic treatment BMP. See Volume V, Chapters 2 and 7 for details.

Impervious surfaces that are "fully dispersed" in accordance with BMP T5.30 in Volume V are not considered effective impervious surfaces. PGIS surfaces that are "dispersed" in accordance with the BMPs in Section 5.1 of Volume V are considered effective impervious surfaces. Porous pavers and Modular grid pavements are assigned a lower curve number (if using single event hydrology to size wetpools) and lower surface runoff calibrations (if

using continuous runoff modeling). See Volume III for a more complete description of hydrologic credits for Onsite Stormwater Management BMPs.

2.5.7 Minimum Requirement #7: Flow Control

Applicability

Projects must provide flow control to reduce the impacts of stormwater runoff from impervious surfaces and land cover conversions. The requirement below applies to projects that discharge stormwater directly, or indirectly through a conveyance system, into a fresh water - except for projects that discharge to a

water in Appendix I-E - Flow Control-Exempt Receiving Waters in accordance with 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 BMP's are applied to route natural runoff volumes from the project site to any downstream Type 5 stream or category IV wetland:**
  - **Design of flow splitting devices or drainage BMP's 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, durations ranging from 50% of the 2-year to the 50-year peak flow.**
  - **Flow splitting devices or drainage BMP's 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.

Local governments may petition Ecology to exempt projects in additional areas. A petition must justify the proposed exemption based upon a hydrologic analysis that demonstrates that the potential

stormwater runoff from the exempted area will not significantly increase the erosion forces on the stream channel nor have near field impacts.

Thresholds

The following require construction of flow control facilities and/or land use management BMPs that will achieve the standard requirement for western Washington (see Table 2.2):

- **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 native 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 impervious surfaces and converted pervious surfaces cause a 0.1 cubic feet per second increase in the 100-year flow frequency from a threshold discharge area as estimated using the Western Washington Hydrology Model or other approved model.**

That portion of any development project in which the above thresholds are not exceeded in a threshold discharge area shall apply Onsite Stormwater Management BMPs in accordance with Minimum Requirement #5.

Table 2.2 Flow Control Requirements by Threshold Discharge Area

	Flow Control Facilities	On-site Stormwater Management BMPs
< ¾ acres conversion to lawn/landscape, or < 2.5 acres to pasture		✔
≥ ¾ acres conversion to lawn/landscape, or ≥ 2.5 acres to pasture	✔	✔
< 10,000 square feet of effective impervious area		✔
≥ 10,000 square feet of effective impervious area	✔	✔
≥ 0.1 cubic feet per second increase in the 100-year flood frequency	✔	✔

Standard Requirement

The following requirement applies to the geographic areas west of the Cascades, including all of the following counties:

Clallam	Jefferson	Pacific	Snohomish
Clark	King	Pierce	Thurston
Cowlitz	Kitsap	San Juan	Wahkiakum
Grays Harbor	Lewis	Skagit	Whatcom
Island	Mason	Skamania	

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:

1) reasonable, historic information is provided that indicates the site was prairie prior to settlement (modeled as "pasture" in the Western Washington Hydrology Model); or,

2) the drainage area of the immediate stream and all subsequent downstream basins have had at least 40% total impervious area since 1985. 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.

This standard requirement is waived for sites that will reliably infiltrate all the runoff from impervious surfaces and converted pervious surfaces.

Western Washington Alternative Requirement

An alternative requirement may be established through application of watershed-scale hydrological modeling and supporting field observations. Possible reasons for an alternative flow control requirement include:

- **Establishment of a stream–specific threshold of significant bedload movement other than the assumed 50% of the 2-year peak flow;**

- **Zoning and Land Clearing Ordinance restrictions that, in combination with an alternative flow control standard, maintain or reduce the naturally occurring erosive forces on the stream channel; or**

- **A duration control standard is not necessary for protection, maintenance, or restoration of designated beneficial uses or Clean Water Act compliance.**

Additional Requirement

Flow Control BMPs shall be selected, designed, and maintained according to a local government manual deemed equivalent to this manual.

Objective

To prevent increases in the stream channel erosion rates that are characteristic of natural conditions (i.e., prior to disturbance by European settlement). The standard intends to maintain the total amount of time that a receiving stream exceeds an erosion-causing threshold based upon historic rainfall and natural land cover conditions. That threshold is assumed to be 50% of the 2-year peak flow. Maintaining the naturally occurring erosion rates within streams is vital, though by itself insufficient, to protect fish habitat and production.

Supplemental Guidelines

Reduction of flows through infiltration decreases stream channel erosion and helps to maintain base flow throughout the summer months. However, infiltration should only be used where ground water quality is not threatened by such discharges.

Volume III includes a description of the Western Washington Hydrology Model. The model provides credits for use of certain Onsite Stormwater Management BMPs described in Volume V, and other low impact development techniques described in Appendix C of Volume III. Using those BMPs and LID techniques reduces the size of the required flow control facilities.

Application of sufficient types of Onsite Stormwater Management BMPs can result in reducing the effective impervious area and the converted pervious areas such that a flow control facility is not required. Application of "Full Dispersion", BMP T5.30, also results in eliminating the flow control facility requirement for those areas that are "fully dispersed."

See the supplemental guidelines for Minimum Requirement #8 and directions concerning use of the Western Washington Hydrology Model for information about tracking wetland hydrologic conditions.

Diversions of flow from perennial streams and from wetlands can be considered if significant existing (i.e., pre-project) flooding, stream stability, water quality, or aquatic habitat problems would be solved or significantly mitigated by bypassing stormwater runoff rather than providing stormwater detention and discharge to natural drainage features. Bypassing should not be considered as an alternative to applicable flow control or treatment if the flooding, stream stability, water quality or habitat problem to be solved would be caused by the project. In addition, the proposal should not exacerbate other water quality/quantity problems such as inadequate low flows or inadequate wetland water elevations.

The existing problems and their solution or mitigation as a result of the direct discharge should be documented by a stormwater engineer or scientist after review of any available drainage reports, basin plans, or other relevant literature. The restrictions in this minimum requirement on conveyance systems that transfer water to an exempt receiving water are applicable in these situations. Approvals by all regulatory authorities with relevant permits applicable to the project are necessary.

In regard to implementation of the revised flow control requirement for highly urbanized basins, the Dept. of Ecology hopes to publish a listing of total impervious area for basins in western Washington. Lists will be developed from satellite images taken in 1990, 1995, and 2000. Images from 2005 may be available for TIA evaluation in 2006. Local governments will have to use historical records to estimate TIA for basins in 1985. Local governments can use these information sources to identify basins that meet the 40% TIA/20 year criterion.

The Dept. of Ecology hopes to publish guidance concerning basin studies to develop basin-specific flow control strategies intended to stabilize stream channels and provide flows intended to protect and restore beneficial uses such as fish resources. Until such guidance is published, the reader can review procedures used in the Des Moines Creek basin plan. The recommendations made in basin plans should be consistent with the requirements and intent of the federal Clean Water Act, the State Water Pollution Control Act, and any other applicable natural resources statutes, such as the Federal Endangered Species Act.

2.5.8 Minimum Requirement #8: Wetlands Protection

Applicability

The requirements below apply only to projects whose stormwater discharges into a wetland, either directly or indirectly through a conveyance system. These requirements must be met in addition to meeting Minimum Requirement #6, Runoff Treatment.

Thresholds

The thresholds identified in Minimum Requirement #6 – Runoff Treatment, and Minimum Requirement #7 – Flow Control shall also be applied for discharges to wetlands.

Standard Requirement

Discharges to wetlands shall maintain the hydrologic conditions, hydrophytic vegetation, and substrate characteristics necessary to support existing and designated uses. The hydrologic analysis shall use the existing land cover condition to determine the existing hydrologic conditions unless directed otherwise by a regulatory agency with jurisdiction. A wetland can be considered for hydrologic modification and/or stormwater treatment in accordance with Guide Sheet 1B in Appendix I-D.

Additional Requirements

The standard requirement does not excuse any discharge from the obligation to apply whatever technology is necessary to comply with state water quality standards, Chapter 173-201A WAC, or state ground water standards, Chapter 173-200 WAC. Additional treatment requirements to meet those standards may be required by federal, state, or local governments.

Stormwater treatment and flow control facilities shall not be built within a natural vegetated buffer, except for:

- **necessary conveyance systems as approved by the local government; or**
- **as allowed in wetlands approved for hydrologic modification and/or treatment in accordance with Guidesheet 1B.**

An adopted and implemented basin plan (Minimum Requirement #9), or a Total Maximum Daily Load (TMDL, also known as a Water

Clean-up Plan) may be used to develop requirements for wetlands that are tailored to a specific basin.

Objective

To ensure that wetlands receive the same level of protection as any other waters of the state. Wetlands are extremely important natural resources which provide multiple stormwater benefits, including ground water recharge, flood control, and stream channel erosion protection. They are easily impacted by development unless careful planning and management are conducted. Wetlands can be severely degraded by stormwater discharges from urban development due to pollutants in the runoff and also due to disruption of natural hydrologic functioning of the wetland system. Changes in water levels and the frequency and duration of inundations are of particular concern.

Supplemental Guidelines

Appendix I-D, "Wetlands and Stormwater Management Guidelines" is an amended version of Chapter 14 of the publication, "Wetlands and Urbanization, Implications for the Future", the final report of the Puget Sound Wetland and Stormwater Management Research Program, 1997. It should be used for discharges to natural wetlands and wetlands constructed as mitigation. The amendments were added to Guidesheets 1A, 2B, and 2C to improve clarity of intent and to make them compatible with the updated manual. While it is always necessary to pre-treat stormwater prior to discharge to a wetland, there are limited circumstances where wetlands may be used for additional treatment and detention of stormwater. These situations are considered in Guide Sheet 1B of the guidelines.

Note that if selective runoff bypass is an alternative being considered to maintain the hydroperiod, the hydrologic analysis must consider the impacts of the bypassed flow. For instance, if the bypassed flow is eventually directed to a stream, the flow duration standard, Minimum Requirement #7, applies to the bypass.

2.5.9 Minimum Requirement #9: Basin/Watershed Planning

Projects may be subject to equivalent or more stringent minimum requirements for erosion control, source control, treatment, and operation and maintenance, and alternative requirements for flow control and wetlands hydrologic control as identified in Basin/Watershed Plans. Basin/Watershed plans shall evaluate and include, as necessary, retrofitting urban stormwater BMPs into existing development and/or redevelopment in order to achieve watershed-wide pollutant reduction and flow control goals that are

consistent with requirements of the federal Clean Water Act. Standards developed from basin plans shall not modify any of the above minimum requirements until the basin plan is formally adopted and implemented by the local governments within the basin, and approved or concurred with by Ecology.

Objective

To promote watershed-based planning as a means to develop and implement comprehensive, water quality protection measures. Primary objectives of basin planning are to reduce pollutant loads and hydrologic impacts to surface and ground waters in order to protect beneficial uses.

Supplemental Guidelines

Though Minimum Requirements #1 through #8 establish general standards for individual sites, they do not evaluate the overall pollution impacts and protection opportunities that could exist at the watershed level. In order for a basin plan to serve as a means of modifying the minimum requirements the following conditions must be met:

- the plan must be formally adopted by all jurisdictions with responsibilities under the plan and
- all ordinances or regulations called for by the plan must be in effect.

This is what is meant by an adopted and implemented basin plan.

Basin planning provides a mechanism by which the minimum requirements and implementing BMP's can be evaluated and refined based on an analysis of an entire watershed. Basin plans are especially well suited to develop control strategies to address impacts from future development and to correct specific problems whose sources are known or suspected. Basin plans can be effective at addressing both long-term cumulative impacts of pollutant loads and short-term acute impacts of pollutant concentrations, as well as hydrologic impacts to streams, wetlands, and ground water resources. The USGS has developed software called "GenScn" (Generation and Analysis of Model Simulation Scenarios) that can facilitate basin planning. The program is a Windows-based use of HSPF that predicts water quality and quantity changes for multiple scenarios of land use and water management within a basin.

Examples of how Basin Planning can alter the minimum requirements of this manual are given in Appendix I-A.

2.5.10 Minimum Requirement #10: Operation and Maintenance

An operation and maintenance manual that is consistent with the provisions in Volume V of this manual shall be provided for all proposed stormwater facilities and BMPs, and the party (or parties) responsible for maintenance and operation shall be identified. At private facilities, a copy of the manual shall be retained onsite or within reasonable access to the site, and shall be transferred with the property to the new owner. For public facilities, a copy of the manual shall be retained in the appropriate department. A log of maintenance activity that indicates what actions were taken shall be kept and be available for inspection by the local government.

Objective

To ensure that stormwater control facilities are adequately maintained and operated properly.

Supplemental Guidelines

Inadequate maintenance is a common cause of failure for stormwater control facilities. The description of each BMP in Volumes II, III, and V includes a section on maintenance. Chapter 4 of Volume V includes a schedule of maintenance standards for drainage facilities. Local governments should consider more detailed requirements for maintenance logs, such as a record of where wastes were disposed.

2.6 Optional Guidance

The following guidance is offered as recommendations to local governments. Ecology considers their use to be in the best interest of the general public and the environment but will not make their implementation a requirement for manual equivalency.

2.6.1 Optional Guidance #1: Financial Liability

Performance bonding or other appropriate financial guarantees shall be required for all projects to ensure construction of drainage facilities in compliance with these standards. In addition, a project applicant shall post a two-year financial guarantee of the satisfactory performance and maintenance of any drainage facilities that are scheduled to be assumed by the local government for operation and maintenance.

Objective

To ensure that development projects have adequate financial resources to fully implement stormwater management plan requirements and that liability is not unduly incurred by local governments.

Supplemental Guidelines

The type of financial instrument required is less important than ensuring that there are adequate funds available in the event that non-compliance occurs.

2.6.2 Optional Guidance #2: Off Site Analysis and Mitigation

Development projects that discharge stormwater offsite shall submit an offsite analysis report that assesses the potential off-site water quality, erosion, slope stability, and drainage impacts associated with the project and that proposes appropriate mitigation of those impacts. An initial qualitative analysis shall extend downstream for the entire flow path from the project site to the receiving water or up to one mile, whichever is less. If a receiving water is within one-quarter mile, the analysis shall extend within the receiving water to one-quarter mile from the project site. The analysis shall extend one-quarter mile beyond any improvements proposed as mitigation. The analysis must extend upstream to a point where any backwater effects created by the project cease. Upon review of the qualitative analysis, the local administrator may require that a quantitative analysis be performed.

The existing or potential impacts to be evaluated and mitigated shall include:

- Conveyance system capacity problems;
- Localized flooding;
- Upland erosion impacts, including landslide hazards;
- Stream channel erosion at the outfall location;
- Violations of surface water quality standards as identified in a Basin Plan or a TMDL (Water Clean-up Plan); or violations of ground water standards in a wellhead protection area.

Objective

To identify and evaluate offsite water quality, erosion, slope stability, and drainage impacts that may be caused or aggravated by a proposed project, and to determine measures for preventing impacts and for not aggravating existing impacts. Aggravated shall mean increasing the frequency of occurrence and/or severity of a problem.

Supplemental Guidelines

Ecology highly recommends that local governments adopt similar offsite analysis requirements. Some of the most common and potentially destructive impacts of land development are erosion of downgradient properties, localized flooding, and slope failures. These are caused by increased surface water volumes and changed runoff patterns. Because these problems frequently do not have a related water quality impact, Ecology is not listing offsite analysis as a minimum requirement. However, taking the precautions of offsite analysis could prevent substantial property damage and public safety risks.

Projects should be required to initially submit, with the permit application, a qualitative analysis of each downstream system leaving a site. The analysis should accomplish four tasks:

Task 1 – Define and map the study area

Submission of a site map showing property lines; a topographic map (at a minimum a USGS 1:24000 Quadrangle Topographic map) showing site boundaries, study area boundaries, downstream flowpath, and potential/existing problems.

Task 2 – Review all available information on the study area

This should include all available basin plans, ground water management area plans, drainage studies, floodplain/floodway FEMA maps, wetlands inventory maps, Critical Areas maps, stream habitat reports, salmon distribution reports, etc.

Task 3 – Field inspect the study area

The design engineer should physically inspect the existing on- and off-site drainage systems of the study area for each discharge location for existing or potential problems and drainage features. An initial inspection and investigation should include:

- Investigate problems reported or observed during the resource review
- Locate existing/potential constrictions or capacity deficiencies in the drainage system
- Identify existing/potential flooding problems
- Identify existing/potential overtopping, scouring, bank sloughing, or sedimentation
- Identify significant destruction of aquatic habitat (e.g., siltation, stream incision)
- Collect qualitative data on features such as land use, impervious surface, topography, soils, presence of streams, wetlands
- Collect information on pipe sizes, channel characteristics, drainage structures
- Verify tributary drainage areas identified in task 1

- Contact the local government office with drainage review authority, neighboring property owners, and residents about drainage problems
- Note date and weather at time of inspection

Task 4 – Describe the drainage system, and its existing and predicted problems

For each drainage system component (e.g., pipe, culvert, bridges, outfalls, ponds, vaults) the following should be covered in the analysis: location, physical description, problems, and field observations.

All existing or potential problems (e.g., ponding water, erosion) identified in tasks 2 and 3 above should be described. The descriptions should be used to determine whether adequate mitigation can be identified, or whether more detailed quantitative analysis is necessary. The following information should be provided for each existing or potential problem:

- Magnitude of or damage caused by the problem
- General frequency and duration
- Return frequency of storm or flow when the problem occurs (may require quantitative analysis)
- Water elevation when the problem occurs
- Names and concerns of parties involved
- Current mitigation of the problem
- Possible cause of the problem
- Whether the project is likely to aggravate the problem or create a new one.

Upon review of this analysis, the local government may require mitigation measures deemed adequate for the problems, or a quantitative analysis, depending upon the presence of existing or predicted flooding, erosion, or water quality problems, and on the proposed design of the onsite drainage facilities. The analysis should repeat tasks 3 and 4 above, using quantitative field data including profiles and cross-sections.

The quantitative analysis should provide information on the severity and frequency of an existing problem or the likelihood of creating a new problem. It should evaluate proposed mitigation intended to avoid aggravation of the existing problem and to avoid creation of a new problem.

2.7 Adjustments

Adjustments to the Minimum Requirements may be granted prior to permit approval and construction. The drainage manual administrator of the local government may grant an adjustment provided that a written finding of fact is prepared, that addresses the following:

- **The adjustment provides substantially equivalent environmental protection.**
- **The objectives of safety, function, environmental protection and facility maintenance, based upon sound engineering, are met.**

2.8 Exceptions/Variances

Exceptions to the Minimum Requirements may be granted prior to permit approval and construction. The drainage manual administrator of the local government may grant an exception following legal public notice of an application for an exception, legal public notice of the administrator's decision on the application, and a written finding of fact that documents the following:

- **There are special physical circumstances or conditions affecting the property such that the strict application of these provisions would deprive the applicant of all reasonable use of the parcel of land in question, and every effort to find creative ways to meet the intent of the Minimum Requirements has been made; and**
- **That the granting of the exception will not be detrimental to the public health and welfare, nor injurious to other properties in the vicinity and/or downstream, and to the quality of waters of the state; and**
- **The exception is the least possible exception that could be granted to comply with the intent of the Minimum Requirements.**

Supplemental Guidelines

The adjustment and exception provisions are an important element of the plan review and enforcement programs. They are intended to maintain a necessary flexible working relationship between local officials and applicants. Plan Approval Authorities should consider these requests judiciously, keeping in mind both the need of the applicant to maximize cost-effectiveness and the need to protect off-site properties and resources from damage.

Chapter 3 - Preparation of Stormwater Site Plans

The Stormwater Site Plan is the comprehensive report containing all of the technical information and analysis necessary for regulatory agencies to evaluate a proposed new development or redevelopment project for compliance with stormwater requirements. Contents of the Stormwater Site Plan will vary with the type and size of the project, and individual site characteristics.

The scope of the Stormwater Site Plan also varies depending on the applicability of Minimum Requirements (see Section 2.4).

This chapter describes the contents of a Stormwater Site Plan and provides a general procedure for how to prepare the plan. The specific BMPs and design methods and standards to be used are contained in Volumes II-V. The content of, and the procedures for preparing a Construction Stormwater Pollution Prevention Plan (Construction SWPPP) are covered in detail in Chapter 3 of Volume II. Guidelines for selecting BMPs are given in Chapter 4 of this Volume.

The goal of this chapter is to provide a framework for uniformity in plan preparation. Such uniformity will promote predictability throughout the region and help secure prompt governmental review and approval. Properly drafted engineering plans and supporting documents will also facilitate the operation and maintenance of the proposed system long after its review and approval.

State law requires that engineering work be performed by or under the direction of a professional engineer licensed to practice in Washington State. Plans involving construction of treatment facilities or flow control facilities (detention ponds or infiltration basins), structural source control BMPs, or drainage conveyance systems generally involve engineering principles and should be prepared by or under the direction of a licensed engineer. Construction Stormwater Pollution Prevention Plans (SWPPPs) that involve engineering calculations must also be prepared by or under the direction of a licensed engineer.

3.1 Stormwater Site Plans: Step-By-Step

The steps involved in developing a Stormwater Site Plan are listed below.

1. Collect and Analyze Information on Existing Conditions
2. Prepare Preliminary Development Layout
3. Perform Off-site Analysis (at local government's option)
4. Determine Applicable Minimum Requirements
5. Prepare a Permanent Stormwater Control Plan
6. Prepare a Construction Stormwater Pollution Prevention Plan

7. Complete the Stormwater Site Plan
8. Check Compliance with All Applicable Minimum Requirements

The level of detail needed for each step depends upon the project size as explained in the individual steps. A narrative description of each of these steps follows.

3.1.1 Step 1 – Collect and Analyze Information on Existing Conditions

Collect and review information on the existing site conditions, including topography, drainage patterns, soils, ground cover, presence of any critical areas, adjacent areas, existing development, existing stormwater facilities, and adjacent on- and off-site utilities. Analyze data to determine site limitations including:

- Areas with high potential for erosion and sediment deposition (based on soil properties, slope, etc.); and
- Locations of sensitive and critical areas (e.g. vegetative buffers, wetlands, steep slopes, floodplains, geologic hazard areas, streams, etc.).

Delineate these areas on the vicinity map and/or a site map that are required as part of Step 7 – Completing a Stormwater Site Plan. Prepare an Existing Conditions Summary that will be submitted as part of the Site Plan. Part of the information collected in this step should be used to help prepare the Construction Stormwater Pollution Prevention Plan.

3.1.2 Step 2 – Prepare Preliminary Development Layout

Based upon the analysis of existing site conditions, locate the buildings, roads, parking lots, and landscaping features for the proposed development. Consider the following points when laying out the site:

- Fit development to the terrain to minimize land disturbance; Confine construction activities to the least area necessary, and away from critical areas;
- Preserve areas with natural vegetation (especially forested areas) as much as possible;
- On sites with a mix of soil types, locate impervious areas over less permeable soil (e.g., till), and try to restrict development over more porous soils (e.g., outwash);
- Cluster buildings together;
- Minimize impervious areas; and
- Maintain and utilize the natural drainage patterns.

The development layout designed here will be used for determining threshold discharge areas, for calculating whether size thresholds under Minimum Requirements #6, #7, and #8 are exceeded (see Chapter 2), and for the drawings and maps required for the Stormwater Site Plan.

3.1.3 Step 3 – Perform an Offsite Analysis

The Department of Ecology (Ecology) recommends that local governments require an offsite analysis for projects that add 5,000 square feet or more of new impervious surface, or that convert ¾ acres of pervious surfaces to lawn or landscaped areas, or convert 2.5 acres of forested area to pasture.

The phased offsite analysis approach outlined in Optional Guidance #2 is recommended. This phased approach relies first on a qualitative analysis. If the qualitative analysis indicates a potential problem, the local government may require mitigation or a quantitative analysis. For more information, see Section 2.6.2.

3.1.4 Step 4 – Determine and Read the Applicable Minimum Requirements

Section 2.5 establishes project size thresholds for the application of Minimum Requirements to new development and redevelopment projects. Figures 2.2 and 2.3 provide the same thresholds in a flow chart format.

3.1.5 Step 5 – Prepare a Permanent Stormwater Control Plan

Select stormwater control BMPs and facilities that will serve the project site in its developed condition. This selection process is presented in detail in Chapter 4 of this Volume.

A preliminary design of the BMPs and facilities is necessary to determine how they will fit within and serve the entire preliminary development layout. After a preliminary design is developed, the designer may want to reconsider the site layout to reduce the need for construction of facilities, or the size of the facilities by reducing the amount of impervious surfaces created and increasing the areas to be left undisturbed. After the designer is satisfied with the BMP and facilities selections, the information must be presented within a Permanent Stormwater Control Plan. The Permanent Stormwater Control Plan should contain the following sections:

Permanent Stormwater Control Plan – Existing Site Hydrology

If flow control facilities are proposed to comply with Minimum Requirement #7, provide a listing of assumptions and site parameters used in analyzing the pre-developed site hydrology. The acreage, soil types, and land covers used to determine the pre-developed flow characteristics, along with basin maps, graphics, and exhibits for each subbasin affected by the project should be included. The pre-developed condition to be matched shall be a forested land cover unless reasonable, historic information is provided that indicates the site was prairie prior to settlement.

Provide a topographic map, of sufficient scale and contour intervals to determine basin boundaries accurately, and showing:

- Delineation and acreage of areas contributing runoff to the site;
- Flow control facility location;
- Outfall;
- Overflow route; and
- All natural streams and drainage features.

The direction of flow, acreage of areas contributing drainage, and the limits of development should be indicated. Each basin within or flowing through the site should be named and model input parameters referenced.

Permanent Stormwater Control Plan – Developed Site Hydrology

All Projects:

Totals of impervious surfaces, pollution-generating impervious surfaces, and pollution generating pervious surfaces must be tabulated for each threshold discharge area for which On-site Stormwater Management BMPs are the sole stormwater management approach. These are needed to verify that the thresholds for application of treatment facilities (Minimum Requirements #6 and #8) and flow control facilities (Minimum Requirement #7 and #8) are not exceeded.

Projects and Threshold Discharge Areas within Projects That Require Treatment and Flow Control Facilities:

Provide narrative, mathematical, and graphic presentations of model input parameters selected for the developed site condition, including acreage, soil types, and land covers, road layout, and all drainage facilities.

Developed basin areas, threshold discharge areas, and flows should be shown on a map and cross-referenced to computer printouts or calculation sheets. Developed basin flows should be listed and tabulated.

Any documents used to determine the developed site hydrology should be included. Whenever possible, maintain the same basin name as used for the pre-developed site hydrology. If the boundaries of a basin have been modified by the project, that should be clearly shown on a map and the name modified to indicate the change.

Final grade topographic maps shall be provided. Ecology recommends local governments also require finished floor elevations.

Permanent Stormwater Control Plan – Performance Standards and Goals

If treatment facilities are proposed, provide a listing of the water quality menus used (Chapter 3, Volume V). If flow control facilities are proposed, provide a confirmation of the flow control standard being achieved (e.g., the Ecology flow duration standard).

Permanent Stormwater Control Plan – Flow Control System

Provide a drawing of the flow control facility and its appurtenances. This drawing must show basic measurements necessary to calculate the storage volumes available from zero to the maximum head, all orifice/restrictor sizes and head relationships, control structure/restrictor placement, and placement on the site.

Include computer printouts, calculations, equations, references, storage/volume tables, graphs as necessary to show results and methodology used to determine the storage facility volumes. Where the Western Washington Hydrology Model (WWHM), or other approved runoff model, is used, its documentation files should be included.

Permanent Stormwater Control Plan – Water Quality System

Provide a drawing of the proposed treatment facilities, and any structural source control BMPs. The drawing must show overall measurements and dimensions, placement on the site, location of inflow, bypass, and discharge systems.

Include WWHM or other approved model printouts, calculations, equations, references, and graphs as necessary to show the facilities are designed consistent with the Volume V requirements and design criteria.

Permanent Stormwater Control Plan – Conveyance System Analysis and Design

Present an analysis of any existing conveyance systems, and the analysis and design of the proposed stormwater conveyance system for the project. This information should be presented in a clear, concise manner that can be easily followed, checked, and verified. All pipes, culverts, catch basins, channels, swales, and other stormwater conveyance appurtenances must be clearly labeled and correspond directly to the engineering plans.

3.1.6 Step 6 – Prepare a Construction Stormwater Pollution Prevention Plan

The Construction SWPPP for projects adding or replacing 2,000 square feet of impervious surface or more, or clearing 7,000 square feet or more, must contain sufficient information to satisfy the local government Plan Approval Authority that the potential pollution problems have been adequately addressed for the proposed project. An adequate Construction SWPPP includes a narrative and drawings. The narrative is a written statement to explain and justify the pollution prevention decisions made for a particular project. The narrative contains concise information concerning existing site conditions, construction schedules, and other pertinent items that are not contained on the drawings. The drawings and notes describe where and when the various BMPs should be installed, the performance the BMPs are expected to achieve, and actions to be taken if the performance goals are not achieved.

The 12 Elements listed below must be considered in the development of the Construction SWPPP unless site conditions render the element unnecessary and the exemption from that element is clearly justified in the narrative of the Construction SWPPP. These elements are described in detail in Section 2.5.2. They cover the general water quality protection strategies of limiting site impacts, preventing erosion and sedimentation, and managing activities and sources.

The 12 Elements are:

- Mark Clearing Limits
- Establish Construction Access
- Control Flow Rates
- Install Sediment Controls
- Stabilize Soils
- Protect Slopes
- Protect Drain Inlets
- Stabilize Channels And Outlets
- Control Pollutants
- Control De-Watering
- Maintain BMPs
- Manage the Project

A complete description and BMPs applicable to each element is given in Volume II, Chapter 3.

On construction sites that discharge to surface water, the primary consideration in the preparation of the Construction SWPPP is compliance with the State Water Quality Standards. The step–by-step procedure outlined in Volume II, Section 3.2 is recommended for the development of these Construction SWPPPs. A checklist is contained in Volume II, Section 3.3 that may be helpful in preparing and reviewing the Construction SWPPP.

On construction sites that infiltrate all stormwater runoff, the primary consideration in the preparation of the Construction SWPPP is the protection of the infiltration facilities from fine sediments during the construction phase and protection of ground water from other pollutants. Several of the other elements are very important at these sites as well, such as marking the clearing limits, establishing the construction access, and managing the project.

3.1.7 Step 7 – Complete the Stormwater Site Plan

The Stormwater Site Plan encompasses the entire submittal to the local government agency with drainage review authority. It includes the following documents

Project Overview

The project overview must provide a general description of the project, predeveloped and developed conditions of the site, site area and size of the improvements, and the pre- and post-developed stormwater runoff conditions. The overview should summarize difficult site parameters, the natural drainage system, and drainage to and from adjacent properties, including bypass flows.

A vicinity map should clearly locate the property, identify all roads bordering the site, show the route of stormwater off-site to the local natural receiving water, and show significant geographic features and sensitive/critical areas (streams, wetlands, lakes, steep slopes, etc.).

A site map should display:

- Acreage and outlines of all drainage basins;
- Existing stormwater drainage to and from the site;
- Routes of existing, construction, and future flows at all discharge points; and
- The length of travel from the farthest upstream end of a proposed storm drainage system to any proposed flow control and treatment facility.

A soils map should show the soils within the project site. Soil Survey maps may be used. However, it is the designer's responsibility to ensure that the soil types of the site are properly identified and correctly used in the hydrologic analysis.

Existing Conditions Summary

This is the summary described in Section 3.1.1 above. If the local government does not require a detailed offsite analysis, this summary should also describe:

- The natural receiving waters that the stormwater runoff either directly or eventually (after flowing through the downstream conveyance system) discharges to, and
- Any area-specific requirements established in local plans, ordinances, or regulations or in Water Clean-up Plans approved by Ecology.

Off-site Analysis Report

This is the report described under Section 3.1.3 above.

Permanent Stormwater Control Plan

This is the plan described in Section 3.1.5 above.

Construction Stormwater Pollution Prevention Plan

This is the plan described in Section 3.1.6 above.

Special Reports and Studies

Include any special reports and studies conducted to prepare the Stormwater Site Plan (e.g., soil testing, wetlands delineation).

Other Permits

Include a list of other necessary permits and approvals as required by other regulatory agencies, if those permits or approvals include conditions that affect the drainage plan, or contain more restrictive drainage-related requirements.

Operation and Maintenance Manual

Submit an operations and maintenance manual for each flow control and treatment facility. The manual should contain a description of the facility, what it does, and how it works. The manual must identify and describe the maintenance tasks, and the frequency of each task. The maintenance tasks and frequencies must meet the standards established in this manual or an equivalent manual adopted by the local government agency with jurisdiction.

Include a recommended format for a maintenance activity log that will indicate what actions will have been taken.

The manual must prominently indicate where it should be kept, and that it must be made available for inspection by the local government.

Bond Quantities Worksheet

If the local government adopts a requirement for a performance bond (or other financial guarantee) for proper construction and operation of construction site BMPs, and proper construction of permanent drainage facilities, the designer shall provide documentation to establish the appropriate bond amount.

3.1.8 Step 8 – Check Compliance with All Applicable Minimum Requirements

A Stormwater Site Plan as designed and implemented should specifically fulfill all Minimum Requirements applicable to the project. The Stormwater Site Plan should be reviewed to check that these requirements are satisfied.

3.2 Plans Required After Stormwater Site Plan Approval

This section includes the specifications and contents required of those plans submitted after the local government agency with jurisdiction has approved the original Stormwater Site Plan.

3.2.1 Stormwater Site Plan Changes

If the designer wishes to make changes or revisions to the originally approved stormwater site plan, the proposed revisions shall be submitted to the local government agency with review authority prior to construction. The submittals should include the following:

1. Substitute pages of the originally approved Stormwater Site Plan that include the proposed changes.
2. Revised drawings showing any structural changes.
3. Any other supporting information that explains and supports the reason for the change.

3.2.2 Final Corrected Plan Submittal

If the project included construction of conveyance systems, treatment facilities, flow control facilities, or structural source control BMPs (i.e., this does not extend to construction of On-site Stormwater Management BMPs), the applicant shall submit a final corrected plan ("as-builts") to the local government agency with jurisdiction when the project is completed. These should be engineering drawings that accurately represent the project as constructed. These corrected drawings must be professionally drafted revisions that are stamped, signed, and dated by a licensed civil engineer registered in the state of Washington.

Chapter 4 - BMP and Facility Selection Process for Permanent Stormwater Control Plans

4.1 Purpose

The purpose of this chapter is to provide guidance for selecting permanent BMPs and facilities for new development and redevelopment sites (including retrofitting of redevelopment sites). The task of selecting BMPs and facilities is necessary to complete the Permanent Stormwater Control Plan - one of the major components of a Stormwater Site Plan. The details for how to complete the other major component - a Construction Stormwater Pollution Prevention Plan - are included in Chapter 3 of Volume II of this manual.

The Department of Ecology's (Ecology) pollution control strategy is to emphasize pollution prevention first, through the application of source control BMPs. Then the application of appropriate treatment and flow control facilities fulfills the statutory obligation to provide "all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the State of Washington." (RCW 90.48.010) This statutory requirement is generally known by an acronym – AKART.

The remainder of this Chapter presents seven steps in selecting BMPs, Treatment Facilities, and Flow Control Facilities.

4.2 BMP and Facility Selection Process

Step I: Determine and Read the Applicable Minimum Requirements

Section 2.5 establishes project size thresholds for the application of Minimum Requirements to new development and redevelopment projects. Figures 2.2 and 2.3 provide the same thresholds in a flow chart format.

Step II: Select Source Control BMPs

Note: If your project is a residential development, you may skip this step.

Refer to Volume IV. If the project involves construction of areas or facilities to conduct any of the activities described in Section 2.2 of Volume IV, the "applicable" structural source control BMPs described in that section must be constructed as part of the project. In addition, if the specific business enterprise that will occupy the site is known, the "applicable" operational source control BMPs must also be described.

The project may have additional source control responsibilities as a result of area-specific pollution control plans (e.g., watershed or basin plans, water clean-up plans, groundwater management plans, lakes management plans), ordinances, and regulations.

Step III: Determine Threshold Discharge Areas and Applicable Requirements for Treatment, Flow Control, and Wetlands Protection

Minimum Requirements #6 (Runoff Treatment) and #7 (Flow Control) have size thresholds that determine their applicability (see Sections 2.5.6 and 2.5.7). Minimum Requirement #8 (wetlands protection) uses the same size thresholds as those used in #6 and #7. Those thresholds determine whether certain areas (called "threshold discharge areas") of a project must use treatment and flow control facilities, designed by a professional engineer, or whether Minimum Requirement #5 (On-Site Stormwater Management BMPs) can be applied instead (see Section 2.5.5).

Step 1: Read the definitions in Section 2.3 for the following terms: effective impervious surface, impervious surface, pollution-generating impervious surface (PGIS), pollution-generating pervious surface (PGPS), and threshold discharge area.

Step 2: ***Outline the threshold discharge areas*** for your project site.

Step 3: Determine the amount of effective pollution-generating impervious surfaces and pollution –generating pervious surfaces in each threshold discharge area. Compare those totals to the categories in Section 2.5.6 (Table 2.1) to determine where treatment facilities are necessary. Note that On-site Stormwater Management BMPs are always applicable.

Step 4: ***Determine the amount of effective impervious surfaces and converted pervious surfaces*** in each threshold discharge area. Using an approved continuous runoff simulation model, estimate the increase in the 100-year flow frequency within each threshold discharge area.

Compare those totals to the categories in Section 2.5.7 (Table 2.2) to determine where flow control facilities are necessary. Note that On-site Stormwater Management BMPs are always applicable.

Step IV: Select Flow Control BMPs and Facilities

A determination should have already been made whether Minimum Requirement #7 or Minimum Requirement #8 applies to the project site. If one or both of them apply, On-site Stormwater Management BMPs from Chapter 5 of Volume V, and Roof Downspout Controls from Chapter 3 of Volume III must be applied in accordance with Minimum Requirement #5. In addition, flow control facilities must be provided for discharges from those threshold discharge areas that exceeded the thresholds outlined in Table 2.2. Use an approved continuous runoff model (e.g. the Western Washington Hydrology Model) and the details in Chapter 3 of Volume III to size and design the facilities.

The following describes a selection process for those facilities.

Step 1: Determine whether you can infiltrate.

There are two possible options for infiltration.

The first option is to infiltrate through rapidly draining soils that do not meet the site characterization and site suitability criteria for providing adequate treatment. See Chapter 3 of Volume III for design criteria for infiltration facilities intended to provide flow control without treatment. In this case, a treatment facility must be provided prior to discharge to the ground for infiltration. The treatment facility could be located off-line with a capacity to treat the water quality design flow rate or volume (See Volume V, Chapter 4) to the applicable performance goal (See Volume V, Chapter 3). Volumes or flow rates in excess of the design volume or flow rate would bypass untreated into the infiltration basin. (Note that wetpool treatment facilities are always designed to be on-line.) The infiltration facility must provide adequate volume such that the flow duration standard of Minimum Requirement #7, or the water surface elevation requirements of Minimum Requirement #8 will be achieved.

The second option is to infiltrate through soils that meet the site characterization and site suitability criteria in Chapter 3 of Volume III. The facility would be designed to meet the requirements for treatment and flow control. 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. Therefore this option will, in most cases, be cost and space prohibitive.

If infiltration facilities for flow control are planned, the flow control requirement has been met. Proceed to Step V. If infiltration facilities are not planned, proceed to Step 2.

Step 2: Use the Western Washington Hydrology Model to size a detention facility.

Refer to Chapter 2, of Volume III for an explanation of the use of the Western Washington Hydrology Model. Note that the more the site is left undisturbed, and the less impervious surfaces are created, the smaller the detention facility. Additional incentives are given within the model for reducing the disruption of the natural hydrology.

Step V: Select Treatment Facilities

Note: This step-by-step process also appears in Volume V, Chapter 2.

Please refer to Figure 4.1. Use the step-by-step process outlined below to determine the type of treatment facilities applicable to the project.

Step 1: Determine the Receiving Waters and Pollutants of Concern Based on Off-Site Analysis.

To obtain a more complete determination of the potential impacts of a stormwater discharge, Ecology encourages local governments to require an Offsite Analysis similar to that in Chapter 2, Volume I. Even without an offsite analysis requirement, the project proponent must determine the natural receiving waters for the stormwater drainage from the project site (ground water, wetland, lake, stream, salt water). This is necessary to determine the applicable treatment menu from which to select treatment facilities. The identification of receiving waters should be verified by the local government agency with review responsibility. If the discharge is to the local municipal storm drainage system, the receiving waters for the drainage system must be determined.

The local government should verify whether any type of water quality management plans and/or local ordinances or regulations have established specific requirements for the receiving waters. Examples of plans to be aware of include:

- Watershed or Basin Plans: These can be developed to cover a wide variety of geographic scales (e.g., Water Resource Inventory Areas, or sub-basins of a few square miles). They can be focused solely on establishing stormwater requirements (e.g., "Stormwater Basin Plans"), or can address a number of pollution and water quantity issues, including urban stormwater (e.g., Puget Sound Non-Point Action Plans).
- Water Clean-up Plans: These plans are written to establish a Total Maximum Daily Load (TMDL) of a pollutant or pollutants in a specific receiving water or basin, and to identify actions necessary to remain below that maximum loading. The plans may identify discharge limitations or management limitations (e.g., use of specific treatment facilities) for stormwater discharges from new and redevelopment projects.
- Groundwater Management Plans (Wellhead Protection Plans): To protect groundwater quality and/or quantity, these plans may identify actions required of stormwater discharges.
- Lake Management Plans: These plans are developed to protect lakes from eutrophication due to inputs of phosphorus from the drainage basin. Control of phosphorus from new development is a likely requirement in any such plans.

An analysis of the proposed land use(s) of the project should also be used to determine the stormwater pollutants of concern. Table 4.1 lists the pollutants of concern from various land uses. Refer to this table for example treatment options after determining whether "basic," "enhanced," or "phosphorus" treatment requirements apply to the project. Those decisions are made in the steps below.

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.

The Oil Control Menu (Volume V, Section 3.2) 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. 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.

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

Please refer to the Oil Control Menu for a listing of oil control facility options. Then see Chapter 11 of Volume V for guidance on the proper selection of options and design details.

Note that some land use types require the use of a spill control (SC-type) oil/water separator. Those situations are described in Volume IV and are separate from this treatment requirement. While a number of activities may be required to use spill control (SC-type) separators, only a few will necessitate American Petroleum Institute (API) or coalescing plate (CP)-type separators for treatment. The following urban land uses are likely to have areas that fall within the definition of "high-use sites" or have sufficient quantities of free oil present that can be treated by an API or CP-type oil/water separator.

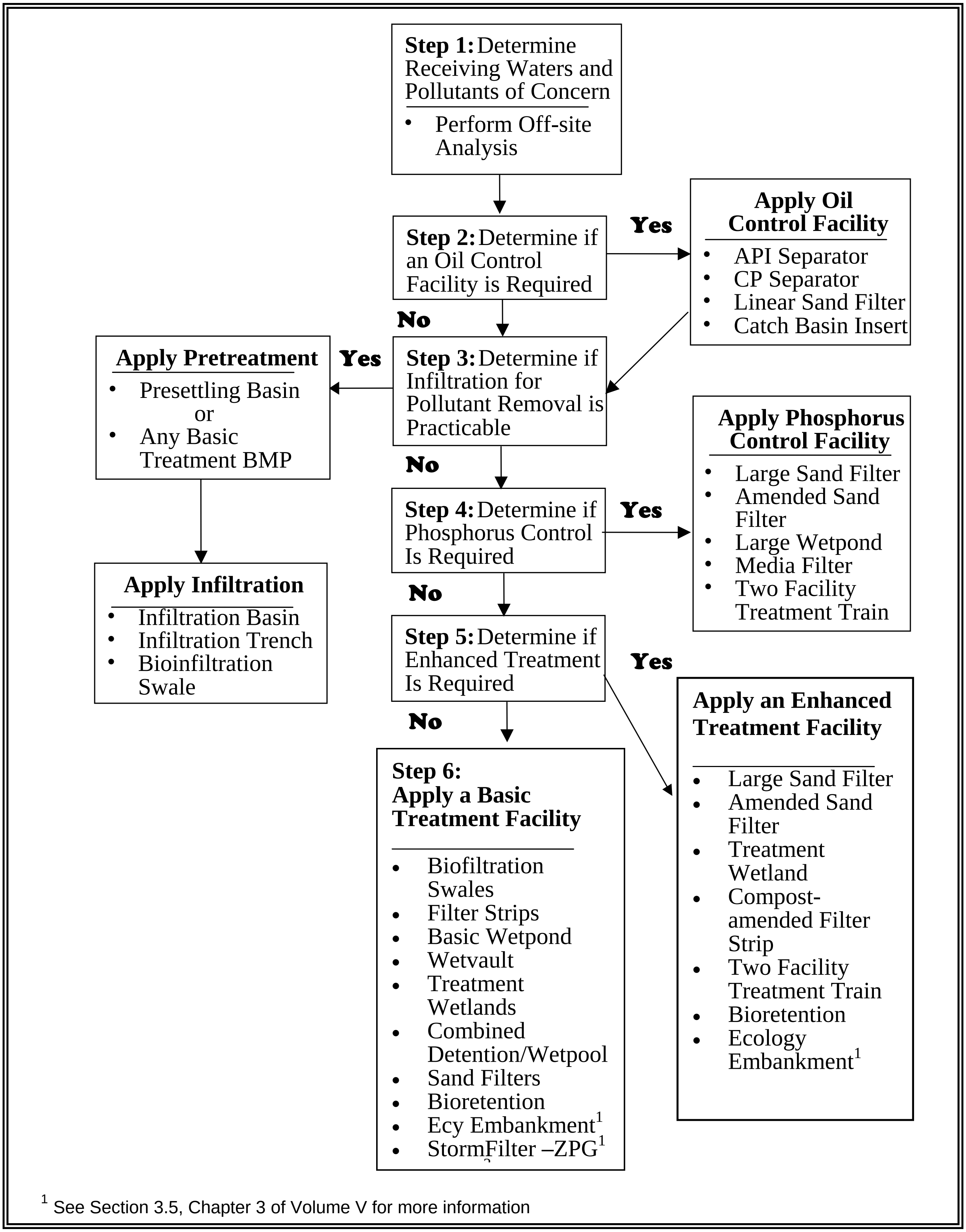

Figure 4.1 Treatment Facility Selection Flow Chart

- Industrial Machinery and Equipment, and Railroad Equipment Maintenance
- Log Storage and Sorting Yards
- Aircraft Maintenance Areas
- Railroad Yards
- Fueling Stations
- Vehicle Maintenance and Repair
- Construction Businesses (paving, heavy equipment storage and maintenance, storage of petroleum products)

If oil control is required for the site, please refer to the General Requirements in Chapter 4, Volume V. These requirements may affect the design and placement of facilities on the site (e.g., flow splitting).

If an Oil Control Facility is required, select and apply an Oil Control Facility. Please refer to the Oil Control Menu in Volume V. 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. Please check the infiltration treatment design criteria in Chapter 3 of Volume III. Infiltration can be effective at treating stormwater runoff, but soil properties must be appropriate to achieve effective treatment while not adversely impacting ground water resources. The location and depth to bedrock, the water table, or impermeable layers (such as glacial till), and the proximity to wells, foundations, septic tank drainfields, and 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. An oil/water separator may serve for pre-settling if it is also necessary for oil control. More frequent maintenance would be necessary to remove solids. Any of the basic treatment facilities, and detention ponds designed to meet flow control requirements, can also be used for pre-treatment.

If infiltration is planned, please refer to the General Requirements in Chapter 4 of Volume V. They can affect the design and placement of facilities on your site. For non-residential developments, if the infiltration site is within ¼ mile of a fish-bearing stream, a tributary to a fish-bearing stream, or a lake, please refer to the Enhanced Treatment Menu (Volume V, Section 3.4). Read the "Where Applied" paragraph in that section to determine if the Enhanced Treatment Menu applies to part of the site or the entire site. If it applies, read the "Note" under "Infiltration with appropriate pretreatment" to identify special pretreatment needs. If the infiltration site is within ¼ mile of phosphorus-sensitive receiving water, please refer to the Phosphorus Treatment Menu (Volume V, Section 3.3) for special pretreatment needs.

Note: Infiltration through soils that do not meet the site suitability criteria in Chapter 3 of Volume III is allowable as a flow control BMP (see Chapter 3 of Volume III). However, the infiltration must be preceded by at least a basic treatment facility. Following a basic treatment facility (or an enhanced treatment or phosphorus treatment facility in accordance with the previous paragraph) infiltration through the bottom of a detention/retention facility for flow control can also be acceptable as a way to reduce direct discharge volumes to streams and to reduce the size of the facility.

If infiltration is practicable, select and apply pretreatment and an infiltration facility.

If infiltration is not practicable, proceed to Step 4.

Step 4: Determine if Control of Phosphorous is Required.

Please refer to the plans, ordinances and regulations referred to in Step 1 as sources of information.

The requirement to provide phosphorous control is determined by the local government with jurisdiction, the Department of Ecology or the USEPA. The local government may have developed a management plan and implementing ordinances or regulations for control of phosphorus from new/redevelopment for the receiving water(s) of the stormwater drainage. The local government can use the following sources of information for pursuing plans and implementing ordinances and/or regulations:

- Those waterbodies reported under section 305(b) of the Clean Water Act, and designated as not supporting beneficial uses due to phosphorous;
- Those listed in Washington State's Nonpoint Source Assessment required under section 319(a) of the Clean Water Act due to nutrients.

If phosphorus control is required, select and apply a phosphorus treatment facility. Please refer to the Phosphorus Treatment Menu in Volume V, Section 3.3. Select an option from the menu after reviewing the applicability and limitations, site suitability, and design criteria of each for compatibility with the site. You may also use Tables 4.1 through 4.3 in this chapter as an initial screening of options.

If you have selected a phosphorus treatment facility, please refer to the General Requirements in Chapter 4 of Volume V. They may affect the design and placement of the facility on the site.

Note: Project sites subject to the Phosphorus Treatment requirement could also be subject to the Enhanced Treatment removal 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 not required for the site, proceed to Step 5.

Step 5: Determine if Enhanced Treatment is Required.

Enhanced treatment is required for the following project sites that discharge to fish-bearing streams, lakes, or to waters or conveyance systems tributary to fish-bearing streams or lakes:

Industrial project sites,
Commercial project sites,
Multi-family project sites, and
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 4^{th} Strahler order stream or larger (as determined using 1:24,000 scale maps to delineate stream order).

However, such sites listed above that discharge directly (or, indirectly through a municipal storm sewer system) to Basic Treatment Receiving Waters (Appendix I-C), and areas of the above-listed project sites that are identified as subject to Basic Treatment requirements (see Step 6) are also not 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 comprise 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 Volume V, Section 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. You may also use Tables 4.1 through 4.3 in this chapter for an initial screening of options.

Note: Project sites subject to the Enhanced Treatment requirement could also be subject to a phosphorus removal requirement if located in an area designated for phosphorus control. 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 you have selected an Enhanced Treatment facility, please refer to the General Requirements in Chapter 4 of Volume V. They may affect the design and placement of the facility on the site.

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 generally applied to:

- Project sites that discharge to the ground (see Step 3), UNLESS:

  The soil suitability criteria for infiltration treatment are met (use infiltration treatment; see Chapter 3 of Volume III), 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 within ¼ mile of a fish-bearing stream, or a lake (use the Enhanced Treatment Menu).
- Residential projects not otherwise needing phosphorus control in Step 4 as designated by USEPA, the Department of Ecology, or a local government; and
- Project sites discharging directly to salt waters, river segments, and lakes listed in Appendix I-C; and
- Project sites that drain to streams that are not fish-bearing, or to waters not tributary to fish-bearing streams;
- Landscaped areas of industrial, commercial, and multi-family project sites, and parking lots of industrial and commercial project sites that do not involve pollution-generating sources (e.g., industrial activities, customer parking, storage of erodible or leachable material, wastes or chemicals) other than parking of employees' private vehicles. 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 comprise 50% or more of the total runoff within a threshold discharge area.

Please refer to the Basic Treatment Menu in Volume V, Section 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. You may also use Tables 4.1 through 4.3 in this chapter as an initial screening of options.

After selecting a Basic Treatment Facility, please refer to the General Requirements in Chapter 4 of Volume V. They may affect the design and placement of the facility on the site.

Note: For guidance on additional factors that can affect treatment facility selection, please refer to Section 2.2 of Volume V.

You have completed the treatment facility selection process.

Step VI: Review Selection of BMPs and Facilities

The list of treatment and flow control facilities, and the list of source control BMPs should be reviewed. The site designer may want to re-evaluate site layout to reduce the need for construction of facilities, or the size of the facilities by reducing the amount of impervious surfaces created and increasing the areas to be left undisturbed.

Step VII: Complete Development of Permanent Stormwater Control Plan

The design and location of the BMPs and facilities on the site must be determined using the detailed guidance in Volumes III, IV, and V. Operation and Maintenance manuals for each treatment and flow control facility are necessary. Please refer to Chapter 3 for guidance on the contents of the Stormwater Site Plan which includes the Permanent Stormwater Control Plan and the Erosion and Sediment Control Plan.

Table 4.1 Suggested Stormwater Treatment Options for New Development and Redevelopment Projects

Pollutant Sources	Pollutants of Concern			Phosphorus Treatment[1]
ROOFS:				
Com/Ind				
Metal	Zn	STW/INF	LSF/ASF/STW/INF	
Vents & Emissions[2]	O & G, TSS, Organics	OWS/CBI + BF/WP/STW	OWS/CBI + INF/ASF/STW/LSF	OWS/CBI + INF/LWP/LSF
PARKING LOT/DRIVEWAY:				
>High-use Site	High O & G, TSS, Cu, Zn, PAH	OWS/CBI/LinSF + BF/WP/STW	OWS/CBI + BF/WP/WV + SF	OWS/CBI + LSF/LWP, or OWS/CBI + BF/WP/WV+ SF
<High-use	O & G, TSS	BF/WP/STW	BF/WP/STW/WV + SF	LSF/LWP, or BF/WP/WV+SF
STREETS/HIGHWAYS:				
Arterials/H'ways	O & G, TSS, Cu, Zn, PAH	BF/WP/WV/STW	INF/LSF/ASF/STW, or BF/WV/WP + SF	INF/LSF/LWP, or BF/WV + SF
Residential Collectors	Low O & G, TSS, Cu, Zn	BF/WP/STW/INF	Not Applicable	INF/LSF/LWP, or BF/WV + SF
High Use Site Intersections	High O & G, TSS, Cu, Zn, PAH	OWS + BF/WP/WV/LinSF	OWS + BF/WV+SF, or OWS + LinSF+BF	OWS + ASF, or OWS + LinSF + Filter Strip
OTHER SOURCES:				
Industrial/ Commercial Development	O & G, TSS, Cu, Zn	WP/WV/SF/STW	LSF/ASF/STW, or BF/WP/WV + SF	LSF/ASF/LWP, or BF/WP/STW + SF
Residential Development	TSS, Pest/ Herbicides Nutrients	INF/BF/WP/SF/STW	Not Applicable	INF/LSF/LWP, or BF/WP/STW + SF
Large PGPS	TSS, Nutrients, Pest/Herbicides	WP/STW/SF	Not Applicable	LSF/LWP, or WP/STW + SF
Uncovered Fueling Stations:	High conc. O & G	OWS + BF/WP	OWS + LSF/ASF, or OWS+LinSF+Filter strip	OWS + LSF/ASF, or OWS+LinSF+ Filter strip
Industrial Yards	High O & G, TSS, Metals, PAH	OWS/CBI + BF/WP, or PSB/WV + OWS/CBI + BF/WP	OWS/CBI + LSF/ASF/STW, or OWS/CBI + BF/WP/WV + SF	OWS/CBI + LSF/ASF/LWP, or OWS/CBI + BF/WP/STW + SF
	Metals, TSS, PAH	BF/WP/STW , or PSB +BF/WP/STW	LSF/ASF/STW, or BF/WP/WV + SF	LSF/ASF/LWP, or BF/WP/STW + SF

Notes:

1. Though phosphorus is not typically listed as a pollutant of concern, it is present in most urban runoff situations. It becomes a pollutant of concern when identified by USEPA, the Department of Ecology, or a local government in a local management plan and when requirements are established in local ordinance or rules. If phosphorus is identified as a pollutant of concern, consider the treatment options listed here.
2. Application of effective source control measures per BMP S2.70 in Volume IV is the preferred approach for pollutant reduction. Where source control measures are not used, or where they are ineffective, stormwater treatment is necessary.

Legend:

ASF = Amended Sand Filter
BF = Biofilter (includes swales and strips)
Cu = Copper
LSF = Large Sand Filter
LWP = Large Wet Pond
OWS = Oil & Water Separator
PSB = Presettling Basin
SF = Sand Filter
TSS = Total Suspended Solids
WV = Wetvault
INF = Infiltration
CBI = Catch Basin Insert, if applicable (See Chapter 12, Volume V)
Com/Ind = Commercial or industrial
LinSF = Linear Sand Filter
O & G = Oil and Grease
PAH = Polycyclic Aromatic Hydrocarbons
PGPS = Pollution-generating pervious surface
STW = Stormwater Treatment Wetland
WP = Wet Pond
Zn = Zinc

/ = or : The slashes between the abbreviations for treatment types are intended to indicate equivalent treatment options

Additional Notes: - If a detention facility is needed for flow control to meet Min. Requirement #7 or #8, a combined detention and Wetpool (Basic or Large depending upon the discharge circumstance) facility should be considered.

Table 4.2 Ability of Treatment Facilities to Remove Key Pollutants[(1),(3)]						
	TSS	**Dissolved Metals**	**Soap**	**Total Phosphorus**	**Pesticides/ Fungicides**	**Hydro-carbons**
Wet Pond	Ω	+		+	+	+
Wet Vault	Ω			+	+	+
Biofiltration	Ω	+		+	+	+
Sand Filter	Ω	+		+	+	Ω
Constructed Wetland	Ω	Ω	Ω		Ω	Ω
Compost Filters	Ω	+			Ω	Ω
Infiltration(2)	Ω			Ω	+	Ω
Oil/Water Separator	+			+	+	Ω

Notes:
Ω Major Process
\+ Minor Process
(1) Adapted from Kulzer; King Co.
(2) Assumes Loamy sand, Sandy loam, or Loam soils
(3) If neither a Major or Minor Process is shown, the Treatment Facility is not particularly effective at treating the identified pollutant

Table 4.3 Screening Treatment Facilities Based on Soil Type			
Soil Type	**Infiltration**	**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.

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Appendix I-A
Guidance for Altering the Minimum Requirements Through Basin Planning

Basin Planning Applied to Source Control

(Minimum Requirement #3)

Basin plans can identify potential sources of pollution and develop strategies to eliminate or control these sources to protect beneficial uses. A basin plan can include the following source control strategies:

1. Detection and correction of illicit discharges to storm sewer systems, including the use of dry weather sampling and dye-tracing techniques;
2. Identification of existing businesses, industries, utilities, and other activities that may store materials susceptible to spillage or leakage of pollutants into the storm sewer system or to the ground via wells, drains, or sumps;
3. Elimination or control of pollutant sources identified in (2);
4. Identification and control of future businesses, industries, utilities, and other activities which may store materials susceptible to spillage or leakage of pollutants into the storm sewer system; and
5. Training and public education

Basin Planning Applied to Runoff Treatment

(Minimum Requirement #6)

Basin plans can develop different runoff treatment requirements and performance standards to reduce pollutant concentrations or loads based on an evaluation of the beneficial uses to be protected within or downstream of a watershed. Consideration must be given to the antidegradation provisions of the Clean Water Act and implementing state water quality standards. The evaluation should include an analysis of existing and future conditions. Basin specific requirements and performance standards can be developed based on an evaluation of pollutant loads and modeling of receiving water conditions.

The Basic Treatment Level is viewed as a minimum technology-based requirement that must be applied regardless of the quality of the receiving waters. Additional levels of control beyond the Basic Treatment Level of Minimum Requirement #6 may be justified in order to control the impacts of future development.

Runoff treatment requirements and performance standards developed from a basin plan should apply to individual development sites. Regional treatment facilities can be considered an acceptable substitute for on-site treatment facilities if they can meet the identified treatment requirements and performance standards. A limitation to the use of regional treatment systems is that the conveyances used to transport the stormwater to the facility must not include waters of the state that have existing or attainable beneficial uses other than drainage.

Basin Planning Applied to Flow Control

(Minimum Requirement #7)

Basin planning is well-suited to control stream channel erosion for both existing and future conditions. Flow control standards developed from a basin plan may include a combination of on-site, regional, and stream protection and rehabilitation measures. On-site standards are usually the primary mechanism to protect streams from the impacts of increased high flows in future conditions. Regional flow control facilities are used primarily to correct existing stream erosion problems. Basin plans can evaluate retrofitting opportunities, such as modified outlets for existing stormwater detention facilities.

Stream protection and rehabilitation measures may be applied where stream channel erosion problems exist that will not be corrected by on-site or regional facilities. However, caution is urged in the application of such measures. If the causes of the stream channel erosion problems still exist, repairs to the physical expression of those problems may be short-lived. In some instances, it may be prudent to apply in-stream measures to reduce impacts until the basin hydrology is improved.

Another potential outcome of basin planning is the identification of a different flow control standard. Ecology's flow duration standard is based upon a generalization that the threshold of significant bedload movement in Western Washington streams occurs at 50% of the 2-year return stream flow. Through field observations and measurements, a local government may estimate a more appropriate threshold – higher or lower- for a specific stream. The alternative threshold can become the lower limit for the range of flows over which the duration standard applies. For instance, if the threshold is established at 70% of a 2-year return flow, the alternative standard would be to match the discharge durations of flows from the developed site to the range of pre-developed discharge rates from 70% of the 2-year peak flow up to the full 50-year peak flow.

Basin Planning Applied to Wetlands and other Sensitive Areas

(Minimum Requirement #8)

Basin planning can be used to develop alternative protection standards for wetlands and other sensitive areas, such as landslide hazard areas, wellhead protection areas, and ground water quality management areas. These standards can include source control, runoff treatment, flow control, stage levels, and frequency and duration of inundations.

Appendix I-B
Water Quality Treatment Design Storm, Volume, and Flow Rate

Water Quality Design Storm: A 24-hour storm with a 6-month return frequency(a.k.a., 6-month, 24-hour storm). The 6-month, 24-hour storm can be estimated as 72% of the 2-year, 24-hour rainfall amount for areas in western Washington.

Water Quality Design Storm Volume: The volume of runoff predicted from a 6-month, 24-hour storm. **Alternatively, the 91st percentile, 24-hour runoff volume indicated by an approved continuous runoff model.**

Facilities such as wetpools are sized based upon either: 1) the volume of runoff produced by the water quality design storm, or 2) the 91st percentile, 24-hour runoff volume indicated by an approved continuous runoff model. They are the same size whether they precede, follow, or are incorporated (i.e., combined detention and wetpool facilities) into detention facilities for flow control. The water quality design storm volume can be computed using the SCS (NRCS) curve number equations in Volume III, Chapter 2.

Unless amended to reflect local precipitation statistics, the 6-month, 24-hour precipitation amount may be assumed to be 72 percent of the 2-year, 24-hour amount. Precipitation estimates of the 6-month and 2-year, 24-hour storms for certain towns and cities are listed in this appendix. For other areas, interpolating between isopluvials for the 2-year, 24-hour precipitation and multiplying by 72% yields the appropriate storm size. Isopluvials for 2-year, 24-hour amounts for Western Washington are reprinted in Volume III.

Background for the Water Quality Design Storm and Volume:

The 6-month, 24-hour storm was the water quality design storm in the 1992 Stormwater Management Manual for the Puget Sound Basin. It was originally chosen when developing the Puget Sound manual based upon a judgement of when the incremental costs of additional treatment capacity exceed the incremental benefits. In particular, the cost of providing the increased detention volume for a wet pond was not seen as cost-effective when compared with the incremental amount of annual stormwater volume that would be effectively treated. Rainfall data from Sea-Tac was used in the original analysis.

Estimation of the 6-month, 24-hour rainfall amount for rain gauge sites: There are at least two ways to estimate the rainfall amount of a 6-month, 24-hour storm. One way is to analyze the 24-hour rainfall records for each rainfall station. The more extensive the record is, the more confidence there is in the estimate. The rainfall amount which has a probability of being equaled or exceeded twice a year is the 6-month, 24-hour storm. The 6-month, 24-hour rainfall amounts shown for 58 stations in Table B.1 have been estimated by analyzing the daily rain gauge data obtained from CD-ROM Hydrodata, USGS Daily and Peak Values, published by Hydrosphere Data Products, Inc. [(11)]

The way in which the 6-month, 24-hour estimates in Table B.2 are calculated is as follows. A data set containing the annual maxima series for 24-hour durations for rainfall stations throughout the state was used to determine the 2-year, 24-hour return frequency in the first column of Table B.2. The data set was collected by Dr. Schaefer of the Washington State Department of Ecology and is more fully described in "Regional Analyses of Precipitation Annual Maxima in Washington State"[(12)]. An algorithm was applied to convert the series to a partial duration series. Dr. Schaefer describes the conversion as follows: "A return period of 1.16 years (annual exceedance probability of 0.862) in the annual maxima data series is equivalent to a 6-month return period in the partial duration data series. The 6-month values were computed using at-site 24-hour station mean values, regional coefficients of variation (Cv) and L-skewness (tau3), and a frequency factor (K) of –0.94 which corresponds to a return period of 1.16 years. This K value of –0.94 yields 6-month estimates that are correct within 3% +/- for various Kappa distribution parameter sets for climates from arid to rainforest in Washington State." (The reader is referred to Volume I References #13 and #14.) Note that the 2-year storm values in Table B.2 differ slightly from those in Table B.1 because they are a different data set and have undergone additional statistical analysis. Where a single site is listed in both tables, the value listed in Table B.2 should be used.

Estimation of 6-month, 24-hour amounts for any project site:

A disadvantage to using the 6-month, 24-hour storm as the design storm is that all isopluvials identifying 6-month, 24-hour storms statewide do not exist. A map would need to be produced, or a method developed to estimate the volume for projects at sites not listed in a reference table of 6-month, 24-hour storms. One method to do the latter is described below.

The first step is to look for a consistent relationship between the 6-month, 24-hour rainfall amount and a rainfall amount for which we have isopluvials. Based upon an analysis of the rainfall record of 58 stations across the state, the 6-month, and 2-year, 24-hour rainfall amounts were calculated and compared. Those results are shown in Table B.1. The arithmetic average of the ratio of the 6-month to the 2-year totals for 35 stations in western Washington (expressed as a percentage) was 71%. The median was 72%. With the exception of a few stations, the percentages vary within a range of 67% to 76%.

Updated statewide isopluvial maps for the 2-year, 24-hour rainfall amounts are expected to be available soon. By interpolation, the 2-year rainfall amount for a project site can be easily identified. Multiplying the 2-year amount by 72% yields an estimate of the 6-month, 24-hour rainfall amount.

Justification for use of the 6-month, 24-hour storm:

In the manual update, it is consistently proposed to retain the 6-month, 24-hour storm (hereafter referred to as the 6/24 storm) as the "Water Quality Design Storm." The 1992 manual noted that 24-hour storms up through the 6/24 storm produced 91% of the historic runoff volume (Sea-Tac Airport rain data). That is probably an overestimate because many smaller storms do not produce measurable runoff and the statement ignores the fact of variability in soil absorption capacity preceding each event. However, it is the presumption made in 1992, and it is not fatally incorrect.

The original basis for the 6-month, 24-hour rainfall amount was a cost-effectiveness analysis referred to in Appendix AI-2.1 of the '92 manual. The assumption in these comparisons is that storm sizes crudely track relative runoff quantities. The cost analysis simply compared the incremental cost increase in wet ponds sized to treat the 91st percentile storm versus the 95th percentile storm. For a 4% increase in annual treated volume, the pond had to be increased by 34% in volume. That was seen as being not cost-effective and therefore not cost reasonable. (The costs to treat the runoff from the 91st percentile storm were further supported by an analysis for three example developments (Herrera, 1993)).

The percentage of the 24-hour rainfall volumes that the 6-month, 24-hour storm and smaller 24-hour rainfall amounts represent changes across the state. For the 34 western Washington stations computed, the 6-month storm and smaller storms represent from 88.4% to 93.4% of the total rainfall volume. See Table B.1, column entitled, "6 month, % Rainfall Volume." Therefore, the cost-effectiveness analysis is not exactly the same for other areas. However, because the 91% value for Sea-Tac is a mid-range figure for a data set with small variation, the cost analysis is a reasonable basis for setting the 6-month, 24-hour storm as the water quality design storm.

Citing a particular percentage of the 2-year, 24-hour rainfall amount (or a 6-month, 24-hour event) means that different areas of the state will be effectively sizing treatment facilities for the runoff from storms of different sizes. However, those size differences are based upon actual differences in rainfall amounts among the sites.

Water Quality Design Flow Rate:

Preceding detention facilities or when detention facilities are not required: The flow rate at or below which 91% of the runoff volume, as estimated by an approved continuous runoff model, will be treated. Design criteria for treatment facilities are assigned to achieve the applicable performance goal at the water quality design flow rate (e.g., 80% TSS removal).

Downstream of detention facilities: The full 2-year release rate from the detention facility.

Background for the Water Quality Design Flow Rate:

Basis for Water Quality Design Flow Rate in 1992 Manual:

The cost effectiveness analysis performed for the 1992 manual seems to assumed that BMPs sized by flow rate (bioswales, filter strips, oil/water separators), using the 10-minute peak flow predicted by SBUH for a 6/24 storm, and a Type 1A storm distribution would result in treating roughly 91 percent of the annual runoff volume. That appears to be an incorrect assumption. The error is caused by the size of the 10-minute peak increment of the 6/24 storm when compared to the actual rainfall intensities experienced in western Washington. The Olympia, Lacey, Tumwater, Thurston Co. stormwater managers provided some actual 2-hour rainfall intensity statistics for Olympia, and compared these to the intensity predicted by a 6/24, type 1A storm for Olympia. The statistics seem to confirm the conservativeness of the original assumption.

Basis for a new Water Quality Design Flow Rate:

The use of continuous runoff modeling techniques provides another perspective on flow rates. Continuous runoff modeling takes a long, uninterrupted record of observed rainfall data and transforms it into a record (a.k.a., time series) of runoff data. This is done by use of a set of mathematical algorithms that represent the rainfall-runoff processes. The model's algorithms are adjusted to simulate the rainfall/runoff relationships of a particular watershed. HSPF, Hydrological Simulation Program – Fortran, is one type of continuous runoff model. The Department of Ecology has funded the development of an HSPF-based continuous runoff model for Western Washington using the best available precipitation and mathematical algorithms. It is referred to as the Western Washington Hydrology Model (WWHM). King County has already employed an HSPF-based model (King County Runoff Time Series, KCRTS) to estimate runoff flow rates and volumes in their jurisdiction.

Runoff flow rates for a number of different development scenarios have been estimated and compared using KCRTS and the Santa Barbara Urban Hydrograph Method (SBUH). KCRTS was used for this comparison because it provides flow rates in 15-minute time increments. At the time of this analysis the WWHM only provided 1-hour increments. A 15-minute increment data set is more comparable to the 10-minute time step of the SBUH analysis. It is expected that a comparison between the WWHM and SBUH would provide similar results as the KCRTS vs. SBUH comparison.

A spreadsheet can be used to statistically analyze the long time series of runoff predicted by KCRTS. That analysis shows that only 2.5 to 3% of the annual runoff volume is discharged at a rate that equals or exceeds the peak 10 minute runoff predicted by SBUH for the water quality design storm. This is a second indicator that the 1992 manual water quality design flow rate is too conservative if the intent is to provide effective treatment for 91% of the runoff volume.

Using the same spreadsheet, a flow rate can be identified above which only 9% of the annual runoff volume is discharged. However, that flow rate is still too conservative if the intent is to provide effective treatment for 91% of the annual runoff volume. An off-line facility that is designed to receive and effectively treat a flow rate at or below which 91% of the annual volume is discharged, will actually treat 97 to 98% of the annual runoff volume. This occurs because a flow splitter continues to send a portion (in this instance, the flow rate above which only 9% of the runoff volume is discharged) of the higher flow rates to the treatment facility. To treat 91% of the annual runoff volume, a flow splitter should start to bypass incremental portions of flow rates above a rate at which 72 to 80% of the runoff volume is discharged. The above percentage changes with project characteristics, most notably the percent imperviousness of a project.

This flow rate, which a flow splitter must route to the treatment facility in an off-line mode, becomes the water quality design flow rate. This rate is sometimes referred to as the 91% flow rate in the manual. At the time of publication of the 2001manual, the WWHM did not identify this water quality design flow rate directly for the user. The user would have to take the output of the WWHM and perform a statistical analysis of the data set to determine the flow rate associated with treating 91% of the runoff volume. However, the WWHM only provides flow rates in 1-hour time increments. Further, it is more appropriate to use 15-minute time increments for facilities that perform their treatment function with short hydraulic residence times. Therefore, that flow rate would have to be increased by a factor to convert the hourly flow rate to an equivalent 15-minute flow rate.

WWHM2 now provides an estimate of the water quality design flow rate in 1-hour and 15-minute time steps, and for off-line and on-line facilities.

Water Quality Design Flow Rate Downstream of Detention Facilities:

The 91% flow rate downstream of detention will be significantly smaller than upstream of detention. The detention facilities, which are fitted with flow-restricting orifices, significantly change the distribution of flow rates. The flow duration standard requires that the total amount of time that flows are discharged above ½ of the 2-year flow not increase. There is a much greater volume of surface runoff post-development than pre-development. Therefore, an extra volume of water must be discharged at rates below ½ the 2-year rate for extended periods of time.

The result of this redistribution is that downstream treatment facilities will operate for extended periods of time at flow rates at or near their design flow rate. For downstream facilities sized for the 91% flow rate this will achieve less annual treatment removal efficiency than that achieved by facilities located upstream. Upstream treatment facilities see more variable flow rates, and presumably, operate more efficiently at lower flow rates than the design flow rate. In addition, downstream detention facilities would have a hard time meeting the annual TSS removal performance goal of 80% removal. They also would need intensive maintenance as they are treating the same volume of water through substantially less treatment area and volume.

In order to compensate for this, the water quality design flow rate, downstream of detention facilities is the 2-year return frequency flow from a detention facility that is designed to meet the flow duration standard. The 2-year frequency flow rate represents a flow rate that will effectively treat a greater percentage of the annual runoff volume than 91%. In addition, flow rate-based treatment facilities downstream of detention should only be designed to be on-line facilities. These downstream water quality design flow rates are 3.5 times smaller than upstream, off-line flow rates, and 6.5 times smaller than upstream, on-line flow rates.

This requirement applies to treatment facilities that are sized based upon a short hydraulic residence time or velocity. This would include biofiltration swales, oil/water separators, and sand/media filters that are not preceded by a significant storage reservoir (i.e., above the filtration unit). Where a sand/media filter is preceded by a significant equalization/storage reservoir, it may be sized using a continuous runoff model and a volume-based approach to achieve the 91% or 95% volume targets (whichever is applicable).

Impact on Design Criteria:

The 1992 design criteria for some public domain treatment facilities had been intended to apply to the water quality design flow rate in the 1992 manual. The new water quality design flow rate is a fraction of that old rate. If the 1992 design criteria were retained and applied at the new water quality design flow rate, new treatment facilities would be that same fraction of the size of existing treatment facilities. This would not be a prudent action since it is not known whether existing treatment facilities can meet the proposed performance goals. Until more reliable monitoring information to judge the performance of existing treatment facilities exist, the prudent action is to adjust their design criteria such that they continue to be built to approximately the same size as they should have been built using the 1992 design criteria and design flow rates.

Table B.1 24-Hour Rainfall Amounts and Comparisons for Selected USGS Stations								
	Station Name	**6 Month Storm Inches**	**6 Month % Rainfall Volume**	**2 Year Storm Inches**	**6 Month/ 2 year %**	**90% Rainfall Inches**	**95% Rainfall Inches**	**Mean Annual Precip. Inches**
1	Aberdeen	2.47	92.58%	3.43	72.0%	2.25	2.81	83.12
2	Anacortes	0.93	90.45%	1.37	67.9%	0.91	1.22	25.92
3	Appleton	1.39	89.04%	1.96	70.9%	1.45	1.80	32.71
4	Arlington	1.28	93.42%	1.74	73.6%	1.11	1.40	46.46
5	Bellingham	1.27	90.78%	1.79	70.9%	1.23	1.63	35.82
6	Bremerton	1.87	90.75%	2.61	71.6%	1.83	2.22	49.97
7	Cathlamet	2.13	92.52%	3.47	61.4%	1.89	2.59	78.97
8	Centralia	1.49	91.81%	2.09	71.3%	1.40	1.78	45.94
9	Chelan	0.62	84.50%	0.96	64.6%	0.76	1.00	10.44
10	Chimacum	1.20	89.63%	1.73	69.4%	1.22	1.52	29.45
11	Clearwater	3.46	92.88%	4.75	72.8%	3.04	3.94	125.25
12	CleElum	1.06	86.85%	1.66	63.9%	1.20	1.64	22.17
13	Colfax	0.80	90.52%	1.07	74.8%	0.80	0.99	19.78
14	Colville	0.71	90.46%	0.97	73.2%	0.69	0.86	18.31
15	Cushman Dam	3.31	91.26%	5.29	62.6%	3.18	4.25	100.82
16	Cushman PwrH	3.17	90.81%	4.42	71.7%	3.08	4.00	85.71
17	Darrington	2.90	91.19%	4.01	72.3%	2.73	3.42	82.90
18	Ellensburg	0.50	84.63%	0.79	63.3%	0.62	0.81	8.75
19	Elwha RS	2.14	90.49%	2.80	76.4%	2.11	2.53	55.87
20	Everett	1.10	93.14%	1.46	75.3%	1.00	1.22	36.80
21	Forks	3.47	92.50%	5.07	68.4%	3.13	4.00	117.83
22	Goldendale	0.84	86.92%	1.29	65.1%	0.98	1.25	17.57
23	Hartline	0.61	84.85%	0.96	63.5%	0.77	0.97	10.67
24	Kennewick	0.46	84.10%	0.71	64.8%	0.55	0.72	7.57
25	Lk. Wenatchee	2.20	85.87%	3.16	69.6%	2.58	3.16	42.72
26	Long Beach	2.32	93.09%	3.08	75.3%	2.04	2.55	80.89
27	Longview	1.41	92.02%	1.97	71.6%	1.29	1.67	45.62
28	Mc Millin	1.31	92.24%	1.82	72.0%	1.21	1.49	40.66
29	Monroe	1.38	92.90%	1.86	74.2%	1.26	1.53	48.16
30	Moses Lake	0.47	85.32%	0.70	67.1%	0.54	0.68	7.89
31	Oakville	1.81	92.86%	2.28	79.4%	1.62	1.98	57.35
32	Odessa	0.52	87.23%	0.76	68.4%	0.56	0.72	10.09
33	Olga	1.02	90.82%	1.52	67.1%	0.99	1.30	28.96
34	Olympia	1.74	91.13%	2.51	69.3%	1.65	2.19	50.68
35	Omak	0.66	85.89%	0.98	67.3%	0.79	0.98	11.97
36	Packwood	2.41	88.70%	3.52	68.5%	2.51	3.20	55.20

Table B.1 24-Hour Rainfall Amounts and Comparisons for Selected USGS Stations								
	Station Name	**6 Month Storm Inches**	**6 Month % Rainfall Volume**	**2 Year Storm Inches**	**6 Month/ 2 year %**	**90% Rainfall Inches**	**95% Rainfall Inches**	**Mean Annual Precip. Inches**
37	Pomeroy	0.75	89.29%	1.02	73.5%	0.78	0.98	16.04
38	Port Angeles	1.12	88.39%	1.66	67.5%	1.19	1.56	25.46
39	Port Townsend	0.77	90.56%	1.14	67.5%	0.76	0.95	19.13
40	Prosser	0.48	83.82%	0.74	64.9%	0.61	0.78	7.90
41	Quilcene	2.53	88.81%	3.40	74.4%	2.61	3.15	54.88
42	Quincy	0.53	82.12%	0.81	65.4%	0.68	0.90	8.07
43	Sea-Tac	1.32	91.13%	1.83	72.1%	1.27	1.63	38.10
44	Seattle JP	1.30	92.05%	1.74	74.7%	1.20	1.49	38.60
45	Sedro Woolley	1.50	92.07%	2.01	74.6%	1.41	1.80	46.97
46	Shelton	2.15	91.49%	3.13	68.7%	2.05	2.55	64.63
47	Smyrna	0.52	83.16%	0.76	68.4%	0.63	0.75	7.96
48	Spokane	0.68	89.54%	0.96	70.8%	0.70	0.88	16.04
49	Sunnyside	0.45	82.22%	0.73	61.6%	0.63	0.76	6.80
50	Tacoma	1.21	92.18%	1.61	75.2%	1.12	1.37	36.92
51	Toledo	1.36	92.73%	2.10	64.8%	1.25	1.68	50.18
52	Vancouver	1.35	91.32%	1.93	69.9%	1.28	1.62	38.87
53	Walla Walla	0.90	88.60%	1.23	73.2%	0.94	1.18	19.50
54	Waterville	0.67	84.43%	1.04	64.4%	0.81	1.05	11.47
55	Wauna	1.82	91.37%	2.50	72.8%	1.72	2.18	51.61
56	Wenatchee	0.58	81.97%	0.92	63.0%	0.80	1.04	8.93
57	Winthrop	0.75	85.36%	1.13	66.4%	0.94	1.13	14.28
58	Yakima	0.53	81.44%	0.85	62.4%	0.72	1.03	8.16

Table B.2 24-Hour Rainfall Amounts and Statistics					
Station Name	**Return** **2-yr.**	**Freq** **6-month**	**Knee-of-curve 24 hr. (in)**	**Mean Annual Storm (in)**	**Mean Annual Precip (in)**
Aberdeen	3.32	2.53	2.81		83.1
Anacortes	1.33	0.99	1.20		25.9
Appleton	1.97	1.47	1.80		32.7
Arlington	1.79	1.35	1.40		46.5
Auburn	2.00	1.51		0.54	44.9
Battle Ground	2.12	1.60			52.0
Bellingham 3SSW -- F	1.70	1.27			35.0
Bellingham CAA AP	1.56	1.17	1.63		35.8
Benton City 2NW	0.79	0.53			8.0
Blaine 1ENE	1.89	1.42		0.46	39.9
Bremerton	2.31	1.74	2.22		50.0
Buckley 1NE	2.09	1.58			49.0
Burlington	1.75	1.31		0.40	35.0
Carnation 4NW	1.91	1.44		0.49	47.5
Cathlamet 6NE	3.84	2.93	2.59		79.0
Centralia 1W	2.10	1.59	1.78	0.44	47.6
Chelan	0.94	0.65	1.00		10.4
Colfax 1NW	1.18	0.86	0.99		19.8
Colville	1.02	0.74	0.86		18.3
Colville WB AP	1.01	0.73		0.35	17.4
Coupville 1S	1.08	0.79			21.0
Cushman Dam	4.61	3.52	4.25	1.23	99.7
Darrington RS	3.32	2.53	3.42	0.84	79.8
Duvall 3NE	1.99	1.50			50.0
Ellensburg	0.70	0.48	0.80	0.25	9.2
Ellensburg WB AP	0.72	0.51			12.0
Elwha RS	2.74	2.07	2.53		55.9
Everett Jr. Col.	1.48	1.11	1.22	0.41	34.4
Forks 1E	4.90	3.76	3.99		117.8
Goldendale	1.12	0.81	1.25		17.6
Goldendale 2E	1.31	0.95			18.0
Hartline	0.89	0.62	0.98		10.7
Hoquiam AP	2.85	2.17			71.0
Kennewick	0.71	0.48	0.71		7.6
Kent	1.87	1.40			36.0

Table B.2 24-Hour Rainfall Amounts and Statistics					
	Return	Freq	Knee-of-		
Station Name	**2-yr.**	**6-month**	**curve 24 hr. (in)**	**Mean Annual Storm (in)**	**Mean Annual Precip (in)**
Leavenworth	1.64	1.21			26.0
Long Beach Exp	2.99	2.28	2.54		80.0
Longview	2.20	1.66	1.67	0.48	48.1
Mazama 2W	1.59	1.17		0.41	22.7
Mc Millin Reservoir	1.81	1.36	1.49	0.46	40.0
Mill Creek	2.04	1.53			35.0
Monroe	1.91	1.44	1.52		48.2
Montesano 3NW	3.30	2.52		0.81	81.5
Moses Lake Devil Far	0.74	0.50	0.68		7.9
Mount Vernon 3WNW	1.60	1.20			32.0
Newport	1.41	1.05			29.0
Oakville	2.46	1.86	1.99		57.4
Odessa	0.80	0.55	0.72		10.1
Okanogan	0.90	0.63			12.0
Olga 2se	1.52	1.13	1.29		29.0
Olympia WB AP	2.62	1.98	2.18	0.62	51.1
Omak 2nw	0.99	0.70	0.98		12.0
Othello 5e	0.70	0.47			8.0
Packwood	2.92	2.21	3.16		55.2
Pomeroy	1.10	0.79	0.97		16.0
Port Angeles	1.69	1.26	1.56	0.42	24.2
Port Townsend	1.11	0.81	0.95	0.35	17.6
Prosser	0.74	0.49	0.78		7.9
Prosser 4NE	0.72	0.48			8.0
Pullman 2NW	1.17	0.86		0.41	22.3
Puyallup 2w Exp Stn	1.85	1.40			41.0
Quilcene 2SW	3.42	2.59	3.14		54.9
Quilcene Dam 5SW	3.84	2.92		0.77	69.4
Quincy 1S	0.77	0.52	0.90		8.1
Republic	1.04	0.76			17.0
Seattle Jackson Park	1.49	1.12	1.49		38.6
Seattle Tac WB AP	1.90	1.42	1.62	0.49	37.4
Seattle U. of W.	1.72	1.29			36.0
Sedro Wolley 1E	2.05	1.55	1.80		47.0
Sequim	1.11	0.80			16.0
Shelton	3.15	2.39	2.54		64.6

Table B.2 24-Hour Rainfall Amounts and Statistics					
Station Name	Return 2-yr.	Freq 6-month	Knee-of-curve 24 hr. (in)	Mean Annual Storm (in)	Mean Annual Precip (in)
Smyrna	0.79	0.53	0.75		8.0
Spokane	1.11	0.80	0.88		16.0
Spokane WB AP	0.97	0.70		0.35	17.0
Sunnyside	0.76	0.50	0.76	0.30	7.4
Tacoma City Hall	1.70	1.28	1.37		36.9
Toledo	1.99	1.51	1.68		50.2
Vancouver 4NNE	2.01	1.51	1.62		38.9
Walla Walla CAA AP	1.19	0.87	1.17		19.5
Waterville	1.00	0.70	1.05		11.5
Wauna	2.15	1.63	2.18		51.6
Wenatchee	0.95	0.65	1.04		8.9
Winthrop 1WSW	1.19	0.85	1.13		14.3
Yakima WB AP	0.81	0.54	1.03	0.33	8.2

Appendix I-C
Basic Treatment Receiving Waters

1. **<u>All Salt Waterbodies</u>**

2. **<u>Rivers</u>** **Basic Treatment Applies Below This Location**

Rivers	Basic Treatment Applies Below This Location
Baker	Anderson Creek
Bogachiel	Bear Creek
Cascade	Marblemount
Chehalis	Bunker Creek
Clearwater	Town of Clearwater
Columbia	Canadian Border
Cowlitz	Skate Creek
Elwha	Lake Mills
Green	Howard Hanson Dam
Hoh	South Fork Hoh River
Humptulips	West and East Fork Confluence
Kalama	Italian Creek
Lewis	Swift Reservoir
Muddy	Clear Creek
Nisqually	Alder Lake
Nooksack	Glacier Creek
South Fork Nooksack	Hutchinson Creek
North River	Raymond
Puyallup	Carbon River
Queets	Clearwater River
Quillayute	Bogachiel River
Quinault	Lake Quinault
Sauk	Clear Creek
Satsop	Middle and East Fork Confluence
Skagit	Cascade River
Skokomish	Vance Creek
Skykomish	Beckler River
Snohomish	Snoqualmie River
Snoqualmie	Middle and North Fork Confluence
Sol Duc	Beaver Creek
Stillaguamish	North and South Fork Confluence
North Fork Stillaguamish	Boulder River
South Fork Stillaguamish	Canyon Creek
Suiattle	Darrington
Tilton	Bear Canyon Creek
Toutle	North and South Fork Confluence
North Fork Toutle	Green River
Washougal	Washougal
White	Greenwater River
Wind	Carson
Wynoochee	Wishkah River Road Bridge

3. Lakes

Lakes	**County**
Washington	King
Sammamish	King
Union	King
Whatcom	Whatcom
Silver	Cowlitz

Note: Local governments may petition for the addition of more waters to this list. The initial criteria for this list are rivers whose mean annual flow exceeds 1,000 cfs, and lakes whose surface area exceeds 300 acres. Additional waters do not have to meet these criteria, but should have sufficient background dilution capacity to accommodate dissolved metals additions from build-out conditions in the watershed under the latest Comprehensive Land Use Plan and zoning regulations.

Appendix I-D
Wetlands and Stormwater Management Guidelines

As Amended from Chapter 14 of "Wetlands and Urbanization, Implications for the Future," by Richard R. Horner, Amanda A. Azous, Klaus O. Richter, Sarah S. Cooke, Lorin E. Reinelt and Kern Ewing

If you are unfamiliar with these guidelines, read the description of the approach and organization that follows. If you are familiar, proceed directly to the appropriate guide sheet(s) for guidelines covering your issue(s) or objective(s):

Approach and Organization of the Management Guidelines

Introduction

The Puget Sound Wetlands and Stormwater Management Research Program performed comprehensive research with the goal of deriving strategies that protect wetland resources in urban and urbanizing areas, while also benefiting the management of urban stormwater runoff that can affect those resources. The research primarily involved long-term comparisons of wetland ecosystem characteristics before and after their watersheds urbanized, and between a set of wetlands that became affected by urbanization (treatment sites) and a set whose watersheds did not change (control sites). This work was supplemented by shorter term and more intensive studies of pollutant transport and fate in wetlands, several laboratory experiments, and ongoing review of relevant work being performed elsewhere. These research efforts were aimed at defining the types of impacts that urbanization can cause and the degree to which they develop under different conditions, in order to identify means of avoiding or minimizing impacts that impair wetland structure and functioning. The program's scope embraced both situations where urban drainage incidentally affects wetlands in its path, as well as those in which direct stormwater management actions change wetlands' hydrology, water quality or both.

This document presents preliminary management guidelines for urban wetlands and their stormwater discharges based on the research results. The set of guidelines is the principal vehicle to implement the research findings in environmental planning and management practice.

Guidelines Scope and Underlying Principles. Note: For terms in **boldface** type see item 1 under Support Materials below.

1. These provisions currently have the status of guidelines rather than requirements. Application of these guidelines does not fulfill assessment and permitting requirements that may be associated with a project. It is, in general, necessary to follow the stipulations of the State Environmental Policy Act and to contact such agencies as the local planning agency; the Washington Departments of Ecology, Fisheries, and Wildlife; the U. S. Environmental Protection Agency; and the U. S. Army Corps of Engineers.

2. Using the guidelines should be approached from a problem-solving viewpoint. The "problem" is regarded to be accomplishing one or more particular planning or management objectives involving a **wetland** potentially or presently affected by stormwater drainage from an urban or urbanizing area. The objectives can be broad, specific, or both. Broad objectives involve comprehensive planning and subsequent management of a drainage catchment or other **landscape unit** containing one or more wetlands. Specific objectives pertain to managing a wetland having particular attributes to be sustained. Of course, the prospect for success is greater with ability to manage the whole landscape influencing the wetland, rather than just the wetland itself.

3. The guidelines are framed from the standpoint that some change in the landscape has the potential to modify the physical and chemical **structure** of the wetland environment, which in turn could alter biological communities and the wetland's ecological **functions**. The general objective in this framework would be to avoid or minimize negative ecological change. This view is in contrast to one in which a wetland has at some time in the past experienced negative change, and consequent ecological degradation, and where the general objective would be to recover some or all of the lost structure and functioning through **enhancement** or **restoration** actions. Direct attention to this problem was outside the scope of the Puget Sound Wetlands and Stormwater Management Research Program. However, the guidelines do give information that applies to enhancement and restoration. For example, attempted restoration of a diverse amphibian community would not be successful if the water level fluctuation limits consistent with high amphibian species richness are not observed.

4. The guidelines can be applied with whatever information concerning the problem is available. Of course, the comprehensiveness and certainty of the outcome will vary with the amount and quality of information employed. The guidelines can be applied in an iterative fashion to improve management understanding as the information

improves. Wetlands Guidance Appendix 1 lists the information needed to perform basic analyses, followed by other information that can improve the understanding and analysis.

5. These guidelines emphasize avoiding structural, hydrologic, and water quality **modifications** of existing wetlands to the extent possible in the process of urbanization and the management of urban stormwater runoff.

6. In pursuit of this goal, the guidelines take a systematic approach to management problems that potentially involve both urban stormwater (quantity, quality, or both) and wetlands. The consideration of wetlands involves their areal extent, **values**, and functions. This approach emphasizes a comprehensive analysis of alternatives to solve the identified problem. The guidelines encourage conducting the analysis on a landscape scale and considering all of the possible stormwater management alternatives, which may or may not involve a wetland. They favor **source control best management practices** (BMPs) and **pre-treatment** of stormwater runoff prior to release to wetlands.

7. Furthermore, the guidelines take a holistic view of managing wetland resources in an urban setting. Thus, they recognize that urban wetlands have the potential to be affected structurally and functionally whether or not they are formally designated for stormwater management purposes. Even if an urban wetland is not structurally or hydrologically engineered for such purposes, it may experience altered hydrology (more or less water), reduced water quality, and a host of other impacts related to urban conditions. It is the objective of the guidelines to avoid or reduce the negative effects on wetland resources from both specific stormwater management actions and incidental urban impacts.

Support Material

1. The guidelines use certain terms that require definition to ensure that the intended meaning is conveyed to all users. Such terms are printed in **boldface** the first time that they appear in each guide sheet, and are defined in Wetlands Guidance Appendix B.

2. The guideline provisions were drawn principally from the available results of the Puget Sound Wetlands and Stormwater Management Research Program, as set forth in Sections 2 and 3 of the program's summary publication, Wetlands and Urbanization, Implications for the Future (Horner et al. 1996). Where the results in this publication are the basis for a numerical provision, a separate reference is not given.

Numerical provisions based on other sources are referenced. See Wetlands Guidance References at the end of this appendix.

3. Appendix 3 presents a list of plant species native to wetlands in the Puget Sound Region. This appendix is intended for reference by guideline users who are not specialists in wetland botany. However, non-specialists should obtain expert advice when making decisions involving vegetation.

4. Appendix 4 compares the water chemistry characteristics of *Sphagnum* bog and fen wetlands (termed **priority peat wetlands** in these guidelines) with more common wetland communities. These bogs and fens appear to be the most sensitive among the Puget Sound lowland wetlands to alteration of water chemistry, and require special water quality management to avoid losses of their relatively rare communities.

Guide Sheet 1: Comprehensive Landscape Planning for Wetlands and Stormwater Management

Wetlands in newly developing areas will receive urban effects even if not specifically "used" in stormwater management. Therefore, the task is proper overall management of the resources and protection of their general **functioning**, including their role in storm drainage systems. Stormwater management in newly developing areas is distinguished from management in already developed locations by the existence of many more feasible stormwater control options prior to development. The guidelines emphasize appropriate selection among the options to achieve optimum overall resource protection benefits, extending to downstream receiving waters and ground water aquifers, as well as to wetlands.

The comprehensive planning guidelines are based on two principles that are recognized to create the most effective environmental management: (1) the best management policies for the protection of wetlands and other natural resources are those that prevent or minimize the development of impacts at potential sources; and (2) the best management strategies are self-perpetuating, that is they do not require periodic infusions of capital and labor. To apply these principles in managing wetlands in a newly developing area, carry out the following steps.

Guide Sheet 1A: Comprehensive Planning Steps

1. Define the **landscape unit** subject to comprehensive planning. Refer to the definition of landscape unit in Appendix 2 for assistance in defining it.

2. Begin the development of a plan for the landscape unit with attention to the following general principles:

   - Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.

   - Map and assess land suitability for urban uses. Include the following landscape features in the assessment: forested land, open unforested land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e. g., a fish run, scenic area, recreational area, threatened species habitat, farmland). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

3. Maximize natural water storage and infiltration opportunities within the landscape unit and outside of existing wetlands, especially:

   - Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.

   - Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

   - In evaluating infiltration opportunities refer to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination and poor soils and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas. Relatively dense developments on glacial outwash soils may require additional runoff treatment to protect groundwater quality.

4. Establish and maintain **buffers** surrounding wetlands and in riparian zones as required by local regulations or recommended by the Puget Sound Water Quality Authority's wetland guidelines. Also, maintain interconnections among wetlands and other natural habitats to allow for wildlife movements.

5. Determine whether the wetland has a breeding, native amphibian population. A survey should be conducted in the spring.

6. Take specific management measures to avoid general urban impacts on wetlands and other water bodies (e. g., littering, vegetation destruction, human and pet intrusion harmful to wildlife).

7. To support management of runoff water quantity, perform a hydrologic analysis of the contributing drainage catchment to define the type and extent of flooding and stream channel erosion problems associated with existing development, redevelopment, or new development that require control to protect the beneficial uses of receiving waters, including wetlands. This analysis should include assembly of existing flow data and hydrologic modeling as necessary to establish conditions limiting to attainment of beneficial uses. Modeling should be performed as directed by the stormwater management manual in effect in the jurisdiction.

8. In wetlands previously relatively unaffected by human activities, manage stormwater quantity to attempt to match the **pre-development hydroperiod** and **hydrodynamics**. In wetlands whose hydrology has been disturbed, consider ways of reducing hydrologic impacts. This provision involves not only management of high runoff volumes and rates of flow during the wet season, but also prevention of water supply depletion during the dry season. The latter guideline may require flow augmentation if urbanization reduces existing surface or groundwater inflows. Refer to Guide Sheet 2, Wetland Protection Guidelines, for detail on implementing these guidelines.

9. Assess alternatives for the control of runoff water quantities as follows:

    a. Define the runoff quantity problem subject to management by analyzing the proposed land development action.

    b. For existing development or **redevelopment**, assess possible alternative solutions that are applicable at the site of the problem occurrence, including:

- Protect health, safety, and property from flooding by removing habitation from the flood plain.

- Prevent stream channel erosion by stabilizing the eroding bed and/or bank area with **bioengineering** techniques, preferably, or by structurally reinforcing it, if this solution would be consistent with the protection of aquatic habitats and beneficial uses of the stream (refer to Chapter 173-201A of the Washington Administrative Code (WAC) for the definition of beneficial uses).

c. For new development or redevelopment, assess possible regulatory and incentive land use control alternatives, such as density controls, clearing limits, impervious surface limits, transfer of development rights, purchase of conservation areas, etc.

d. If the alternatives considered in Steps 9a or 9b cannot solve an existing or potential problem, perform an analysis of the contributing drainage catchment to assess possible alternative solutions that can be applied **on-site** or on a **regional** scale. The most appropriate solution or combination of alternatives should be selected with regard to the specific opportunities and constraints existing in the drainage catchment. For new development or redevelopment, on-site facilities that should be assessed include, in approximate order of preference:

- Infiltration basins or trenches;
- Retention/detention ponds;
- Below-ground vault or tank storage;
- Parking lot detention.

Regional facilities that should be assessed for solving problems associated with new development, redevelopment, or existing development include:

- Infiltration basins or trenches;
- Detention ponds;
- **Constructed wetlands;**
- Bypassing a portion of the flow to an acceptable receiving water body, with treatment as required to protect water quality and other special precautions as necessary to prevent downstream impacts.

e. Consider structurally or hydrologically engineering an existing wetland for water quantity control only if upland alternatives are inadequate to solve the existing or potential problem. To evaluate the possibility, refer to the Storm-water Wetland Assessment Criteria in Guide Sheet 1B.

10. Place strong emphasis on water resource protection during construction of new development. Establish effective erosion control programs to reduce the sediment loadings to receiving waters to the maximum extent possible. No preexisting wetland or other water body should ever be used for the sedimentation of solids in construction-phase runoff.

11. In wetlands previously relatively unaffected by human activities, manage stormwater quality to attempt to match pre-development water quality conditions. To support management of runoff water quality, perform an analysis of the contributing drainage catchment to define the type and extent of runoff water quality problems associated with existing development, redevelopment, or new development that require control to protect the beneficial uses of receiving waters, including wetlands. This analysis should incorporate the hydrologic assessment performed under step 7 and include identification of key water pollutants, which may include solids, oxygen-demanding substances, nutrients, metals, oils, trace organics, and bacteria, and evaluation of the potential effects of water pollutants throughout the drainage system.

12. Assess alternatives for the control of runoff water quality as follows:

    a. Perform an analysis of the contributing drainage catchment to assess possible alternative solutions that can be applied on-site or on a regional scale. The most appropriate solution or combination of alternatives should be selected with regard to the specific opportunities and constraints existing in the drainage catchment. Consider both **source control BMPs** and **treatment BMPs** as alternative solutions before considering use of existing wetlands for quality improvement according to the following considerations:

        – Implementation of source control BMPs prevent the generation or release of water pollutants at potential sources. These alternatives are generally both more effective and less expensive than treatment controls. They should be applied to the maximum extent possible to new development, redevelopment, and existing development.

        – Treatment BMPs capture water pollutants after their release. This alternative often has limited application in existing developments because of space limitations, although it can be employed in new development and when redevelopment occurs in already developed areas. Refer to Minimum Requirement #6 in Volume 1 of the Stormwater Management Manual for Western Washington to determine whether a treatment facility is necessary for your site. If a facility is required, refer to Chapter 4 of Volume 1, or Chapter 2 of Volume 5 to determine which treatment requirement – basic, enhanced, phosphorus, or oil control - applies to your site. Then refer to the corresponding BMP menu for that requirement in Chapter 3 of Volume V. From the menu select a BMP that fits with your project site.

b. Consider structurally or hydrologically engineering an existing wetland for water quality control only if upland alternatives are inadequate to solve the existing or potential problem. Use of Waters of the State and Waters of the United States, including wetlands, for the treatment or conveyance of wastewater, including stormwater, is prohibited under state and federal law. Discussions with federal and state regulators during the research program led to development of a statement concerning the use of existing wetlands for improving stormwater quality (**polishing**), as follows. Such use is subject to analysis on a case-by-case basis and may be allowed only if the following conditions are met:

   – If **restoration** or **enhancement** of a previously **degraded** wetland is required, and if the upgrading of other wetland functions can be accomplished along with benefiting runoff quality control, and

   – If appropriate source control and treatment BMPs are applied in the contributing catchment on the basis of the analysis in Step 12a, and any legally adopted water quality standards for wetlands are observed.

   If these circumstances apply, refer to the Stormwater Wetland Assessment Criteria in Guide Sheet 1B to evaluate further.

13. Stimulate public awareness of and interest in wetlands and other water resources in order to establish protective attitudes in the community. This program should include:

   - Education regarding the use of fertilizers and pesticides, automobile maintenance, the care of animals to prevent water pollution, and the importance of retaining buffers;

   - Descriptive signboards adjacent to wetlands informing residents of the wetland type, its functions, the protective measures being taken, etc.

- If beavers are present in a wetland, educate residents about their ecological role and value and take steps to avoid human interference with beavers.

Guide Sheet 1B: Stormwater Wetland Assessment Criteria

This guide sheet gives criteria that disqualify a natural wetland from being structurally or hydrologically engineered for control of stormwater quantity, quality, or both. These criteria should be applied only after performing the alternatives analysis outlined in Guide Sheet 1A.

1. A wetland <u>should not</u> be structurally or hydrologically engineered for runoff quantity or quality control and should be given maximum protection from overall urban impacts (see Guide Sheet 2, Wetland Protection Guidelines) under any of the following circumstances:

   - In its present state it is primarily an **estuarine** or **forested wetland** or a **priority peat system**.

   - It is a rare or irreplaceable wetland type, as identified by the Washington Natural Heritage Program, the Puget Sound Water Quality Preservation Program, or local government.

   - It provides **rare, threatened, or endangered species** habitat that could be impaired by the proposed action. Determining whether or not the conserved species will be affected by the proposed project requires a careful analysis of its requirements in relation to the anticipated habitat changes.

   - It provides a high level of many functions

   In general, the wetlands in these groups are classified in Categories I and II in the "Washington State Wetland Rating System of Western Washington." That publication is available on-line at http://www.ecy.wa.gov/biblio/sea.htmles.

2. A wetland <u>can be considered</u> for structural or hydrological modification for runoff quantity or quality control if most of the following circumstances exist:

   - It is classified in Category IV in the "Washington State Wetland Rating System of Western Washington". In general, Category IV wetlands have monotypic vegetation of similar age and class, lack special habitat features, and are isolated from other aquatic systems. Any functions lost through hydrologic or structural modification in a Category IV wetland would have to be compensated/replaced.

- The wetland has been previously **disturbed** by human activity, as evidenced by agriculture, fill, ditching, and/or introduced or **invasive weedy plant species**.
- The wetland has been deprived of a significant amount of its water supply by draining or previous urbanization (e. g., by loss of groundwater supply), and stormwater runoff is sufficient to augment the water supply. A particular candidate is a wetland that has experienced an increased summer dry period, especially if the drought has been extended by more than two weeks.
- Construction for structural or hydrologic modification in order to provide runoff quantity or quality control will disturb relatively little of the wetland.
- The wetland can provide the required storage capacity for quantity or quality control through an outlet orifice modification to increase storage of water, rather than through raising the existing overflow. Orifice modification is likely to require less construction activity and consequent negative impacts.
- Under existing conditions the wetland's experiences a relatively high degree of water level fluctuation and a range of velocities (i. e., a wetland associated with substantially flowing water, rather than one in the headwaters or entirely isolated from flowing water).
- The wetland does not exhibit any of the following features:
  - Significant priority peat system or forested zones that will experience substantially altered hydroperiod as a result of the proposed action;
  - Regionally **unusual biological community types**;
  - Animal habitat features of relatively high value in the region (e. g., a protected, undisturbed area connected through undisturbed corridors to other valuable habitats, an important breeding site for protected species);
  - The presence of protected commercial or sport fish;
  - Configuration and topography that will require significant modification that may threaten fish stranding;
  - A relatively high degree of public interest as a result of, for example, offering valued local open space or educational, scientific, or recreational opportunities, unless the proposed action would enhance these opportunities;
- The wetland is threatened by potential impacts exclusive of stormwater management, and could receive greater protection if

acquired for a stormwater management project rather than left in existing ownership.

- There is good evidence that the wetland actually can be restored or enhanced to perform other functions in addition to runoff quantity or quality control.
- There is good evidence that the wetland lends itself to the effective application of the Wetland Protection Guidelines in Guide Sheet 2.
- The wetland lies in the natural routing of the runoff. Local regulations often prohibit drainage diversion from one basin to another.
- The wetland allows runoff discharge at the natural location.

Guide Sheet 2: Wetland Protection Guidelines

This guide sheet provides information about likely changes to the ecological **structure** and **functioning** of **wetlands** that are incidentally subject to the effects of an urban or urbanizing watershed or are **modified** to supply runoff water quantity or quality control benefits. The guide sheet also recommends management actions that can avoid or minimize deleterious changes in these wetlands.

Guide Sheet 2A: General Wetland Protection Guidelines

1. Consult regulations issued under federal and state laws that govern the discharge of pollutants. Wetlands are classified as "Waters of the United States" and "Waters of the State" in Washington.

2. Maintain the wetland **buffer** required by local regulations or recommended by the Puget Sound Water Quality Authority's draft wetland guidelines.

3. Retain areas of native vegetation connecting the wetland and its buffer with nearby wetlands and other contiguous areas of native vegetation.

4. Avoid compaction of soil and introduction of exotic plant species during any work in a wetland.

5. Take specific site design and maintenance measures to avoid general urban impacts (e. g., littering and vegetation destruction). Examples are protecting existing buffer zones; discouraging access, especially by vehicles, by plantings outside the wetland; and encouragement of stewardship by a homeowners' association. Fences can be useful to restrict dogs and pedestrian access, but they also interfere with wildlife movements. Their use should be very carefully evaluated on the basis of the relative importance of intrusive impacts versus wildlife presence. Fences should generally not be installed when wildlife

would be restricted and intrusion is relatively minor. They generally should be used when wildlife passage is not a major issue and the potential for intrusive impacts is high. When wildlife movements and intrusion are both issues, the circumstances will have to be weighed to make a decision about fencing.

6. If the wetland inlet will be modified for the stormwater management project, use a diffuse flow method, such as a spreader swale, to discharge water into the wetland in order to prevent flow channelization.

Guide Sheet 2B: Guidelines for Protection from Adverse Impacts of Modified Runoff Quantity Discharged to Wetlands

1. Protection of wetland plant and animal communities depends on controlling the wetland's **hydroperiod**, meaning the pattern of fluctuation of water depth and the frequency and duration of exceeding certain levels, including the length and onset of drying in the summer. A <u>hydrologic assessment</u> is useful to measure or estimate elements of the hydroperiod under existing **pre-development** and anticipated **post-development** conditions. This assessment should be performed with the aid of a qualified hydrologist. Post-development estimates of watershed hydrology and wetland hydroperiod must include the cumulative effect of all anticipated watershed and wetland modifications. Provisions in these guidelines pertain to the full anticipated build-out of the wetland's watershed.

   This analysis hypothesizes a fluctuating water stage over time before development that could fluctuate more, both higher and lower after development; these greater fluctuations are termed **stage excursions**. The guidelines set limits on the frequency and duration of excursions, as well as on overall water level fluctuation, after development.

   To determine <u>existing hydroperiod</u> use one of the following methods, listed in order of preference:

   - Estimation by a continuous simulation computer model--The model should be calibrated with at least one year of data taken using a continuously recording level gage under existing conditions and should be run for the historical rainfall period. The resulting data can be used to express the magnitudes of depth fluctuation, as well as the frequencies and durations of surpassing given depths. [Note: Modeling that yields high quality information of the type needed for wetland hydroperiod analysis is a complex subject. Providing guidance on selecting and applying modeling options is beyond the scope of these guidelines but is being developed by King County Surface Water Management

Division and other local jurisdictions. An alternative possibility to modeling depths, frequencies, and durations within the wetland is to model durations above given discharge levels entering the wetland over various time periods (e. g., seasonal, monthly, weekly). This option requires further development.]

- Measurement during a series of time intervals (no longer than one month in length) over a period of at least one year of the maximum water stage, using a crest stage gage, and instantaneous water stage, using a staff gage--The resulting data can be used to express water level fluctuation (WLF) during the interval as follows:

  Average base stage = (Instantaneous stage at beginning of interval + Instantaneous stage at end of interval)/2

  WLF = Crest stage - Average base stage

  Compute mean annual and mean monthly WLF as the arithmetic averages for each year and month for which data are available.

To forecast future hydroperiod use one of the following methods, listed in order of preference:

- Estimation by the continuous simulation computer model calibrated during pre-development analysis and run for the historical rainfall period--The resulting data can be used to express the magnitudes of depth fluctuation, as well as the frequencies and durations of surpassing given depths. [Note: Post-development modeling results should generally be compared with pre-development modeling results, rather than directly with field measurements, because different sets of assumptions underlie modeling and monitoring. Making pre- and post-development comparisons on the basis of common assumptions allows cancellation of errors inherent in the assumptions.]

- Estimation according to general relationships developed from the Puget Sound Wetlands and Stormwater Management Program Research Program, as follows (in part adapted from Chin 1996):

  – Mean annual WLF is very likely (100% of cases measured) to be < 20 cm (8 inches or 0.7 ft) if total impervious area (TIA) cover in the watershed is < 6% (roughly corresponding to no more than 15% of the watershed converted to urban land use).

  – Mean annual WLF is very likely (89% of cases measured) to be > 20 cm if TIA in the watershed is > 21% (roughly corresponding to more than 30% of the watershed converted to urban land use).

- Mean annual WLF is somewhat likely (50% of cases measured) to be > 30 cm (1.0 ft) if TIA in the watershed is > 21% (roughly corresponding to more than 30% of the watershed converted to urban land use).
- Mean annual WLF is likely (75% of cases measured) to be > 30 cm, and somewhat likely (50% of cases measured) to be 50 cm (20 inches or 1.6 ft) or higher, if TIA in the watershed is > 40% (roughly corresponding to more than 70% of the watershed converted to urban land use).
- The frequency of stage excursions greater than 15 cm (6 inches or 0.5 ft) above or below pre-development levels is somewhat likely (54% of cases measured) to be more than six per year if the mean annual WLF increases to > 24 cm (9.5 inches or 0.8 ft).
- The average duration of stage excursions greater than 15 cm above or below pre-development levels is likely (69% of cases measured) to be more than 72 hours if the mean annual WLF increases to > 20 cm.

2. The following hydroperiod limits characterize wetlands with relatively high vegetation species richness and apply to <u>all zones</u> within <u>all wetlands</u> over the <u>entire year</u>. If these limits are exceeded, then species richness is likely to decline. If the analysis described above forecasts exceedences, one or more of the management strategies listed in step 5 should be employed to attempt to stay within the limits.

    - <u>Mean annual WLF</u> (and <u>mean monthly WLF</u> for every month of the year) does not exceed 20 cm. Vegetation species richness decrease is likely with: (1) a mean annual (and mean monthly) WLF increase of more than 5 cm (2 inches or 0.16 ft) if pre-development mean annual (and mean monthly) WLF is greater than 15 cm, or (2) a mean annual (and mean monthly) WLF increase to 20 cm or more if pre-development mean annual (and mean monthly) WLF is 15 cm or less.
    - The <u>frequency of stage excursions</u> of 15 cm above or below pre-development stage does not exceed an annual average of six. Note: A short-term lagging or advancement of the continuous record of water levels is acceptable. The 15 cm limit applies to the temporary increase in maximum water surface elevations (hydrograph peaks) after storm events and the maximum decrease in water surface elevations (hydrograph valley bottoms) between events and during the dry season.

- The duration of stage excursions of 15 cm above or below pre-development stage does not exceed 72 hours per excursion. Note: A short-term lagging or advancement of the continuous record of water levels is acceptable. However, the 15 cm limit applies throughout the entire hydrograph, not just the peaks and valleys.

- The total dry period (when pools dry down to the soil surface everywhere in the wetland) does not increase or decrease by more than two weeks in any year.

- Alterations to watershed and wetland hydrology that may cause perennial wetlands to become **vernal** are avoided.

3. The following hydroperiod limit characterizes **priority peat wetlands** (bogs and fens as more specifically defined by the Washington Department of Ecology) and applies to all zones over the entire year. If this limit is exceeded, then characteristic bog or fen wetland vegetation is likely to decline. If the analysis described above forecasts exceedence, one or more of the management strategies listed in step 5 should be employed to attempt to stay within the limit.

   - The duration of stage excursions above the pre-development stage does not exceed 24 hours in any year.

   - Note: This guideline is in addition to the guidelines in #2 directly above. To apply this guideline a continuous simulation computer model needs to be employed. The model should be calibrated with data taken under existing conditions at the wetland being analyzed and then used to forecast post-development duration of excursions.

4. The following hydroperiod limits characterize wetlands inhabited by breeding native amphibians and apply to breeding zones during the period 1 February through 31 May. If these limits are exceeded, then amphibian breeding success is likely to decline. If the analysis described above forecasts exceedences, one or more of the management strategies listed in step 5 should be employed to attempt to stay within the limits.

   - The magnitude of stage excursions above or below the pre-development stage should not exceed 8 cm for more than 24 hours in any 30-day period.

   - Note: To apply this guideline a continuous simulation computer model needs to be employed. The model should be calibrated with data taken under existing conditions at the wetland being analyzed and then used to forecast post-development magnitude and duration of excursions.

5. If it is expected that the hydroperiod limits stated above could be exceeded, consider strategies such as:
   - Reduction of the level of development;
   - Increasing runoff infiltration [Note: Infiltration is prone to failure in many Puget Sound Basin locations with glacial till soils and generally requires **pretreatment** to avoid clogging. In other situations infiltrating urban runoff may contaminate groundwater. Consult the stormwater management manual adopted by the jurisdiction and carefully analyze infiltration according to its prescriptions.];
   - Increasing runoff storage capacity; and
   - Selective runoff bypass.

6. After development, monitor hydroperiod with a continuously recording level gauge or staff and crest stage gauges. If the applicable limits are exceeded, consider additional applications of the strategies in step 5 that may still be available. It is also recommended that goals be established to maintain key vegetation species, amphibians, or both, and that these species be monitored to determine if the goals are being met.

Guide Sheet 2C: Guidelines for Protection from Adverse Impacts of Modified Runoff Quality Discharged to Wetlands

1. Require effective erosion control at any construction sites in the wetland's drainage catchment.

2. Institute a program of **source control BMPs** to minimize the generation of pollutants that will enter storm runoff that drains to the wetland.

3. Provide a water quality control facility consisting of one or more **treatment BMPs** to treat all urban runoff entering the wetland. Refer to Chapter 4 of Volume 1 or Chapter 2 of Volume V of the <u>Stormwater Management Manual for Western Washington</u> to determine treatment requirements. Then refer to the corresponding BMP menu for that requirement in Chapter 3 of Volume V. From the menu select a BMP that fits with the project site.

   - If the wetland is a **priority peat wetland** (bogs and fens as more specifically defined by the Washington Department of Ecology), the facility should include a BMP with the most advanced ability to control nutrients (e. g., an infiltration device, a wet pond or constructed wetland with residence time in the pooled storage of at least two weeks). [Note: Infiltration is prone to failure in many Puget Sound Basin locations with glacial till soils and generally requires **pretreatment** to avoid clogging. In other situations infiltrating urban runoff may contaminate groundwater. Consult the stormwater management manual adopted by the jurisdiction and carefully analyze infiltration according to its prescriptions.] Refer to Appendix 4 for a comparison of water chemistry conditions in priority peat versus more typical wetlands.

Refer to the stormwater management manual to select and design the facility. Generally, the facility should be located outside and upstream of the wetland and its buffer.

4. Design and perform a water quality monitoring program for priority peat wetlands and for other wetlands subject to relatively high water pollutant loadings. The research results (Horner 1989) identified such wetlands as having contributing catchments exhibiting either of the following characteristics:

    - More than 20 percent of the catchment area is committed to commercial, industrial, and/or multiple family residential land uses; or

    - The combination of all urban land uses (including single family residential) exceeds 30 percent of the catchment area.

    A recommended monitoring program, consistent with monitoring during the research program, is:

    - Perform pre-development **baseline sampling** by collecting water quality grab samples in an open water pool of the wetland for at least one year, allocated through the year as follows: November 1-March 31--4 samples, April 1-May 31--1 sample, June 1-August 31--2 samples, and September 1-October 31--1 sample (if the wetland is dry during any period, reallocate the sample(s) scheduled then to another time). Analyze samples for pH; dissolved oxygen (DO); conductivity (Cond); total suspended solids (TSS); total phosphorus (TP); nitrate + nitrite-nitrogen (N); fecal coliforms (FC); and total copper (Cu), lead (Pb), and zinc (Zn). Find the median and range of each water quality variable.

    - Considering the baseline results, set water quality goals to be maintained in the post-development period. Example goals are: (1) pH--no more than “x” percent (e. g., 10%) increase (relative to baseline) in annual median and maximum or decrease in annual minimum; (2) DO--no more than “x” percent decrease in annual median and minimum concentrations; (3) other variables --no more than “x” percent increase in annual median and maximum concentrations; (4) no increase in violations of the Washington Administrative Code (WAC) water quality criteria.

- Repeat the sampling on the same schedule for at least one year after all development is complete. Compare the results to the set goals.

If the water quality goals are not met, consider additional applications of the source and treatment controls described in steps 2 and 3. Continue monitoring until the goals are met at least two years in succession.

Note: Wetland water quality was found to be highly variable during the research, a fact that should be reflected in goals. Using the maximum (or minimum), as well as a measure of central tendency like the median, and allowing some change from pre-development levels are ways of incorporating an allowance for variability. Table D.1 presents data from the wetlands studied during the research program to give an approximate idea of magnitudes and degree of variability to be expected. Nonurbanized watersheds (N) are those that have both < 15% urbanization and < 6% impervious cover. Highly urbanized watersheds (H) are those that have both lost all forest cover and have > 20% impervious cover. Moderately urbanized watersheds (M) are those that fit neither the N nor H category.

Table D.1 Water Quality Ranges Found in Study Wetlands

	N			M			H		
Metric	Median	Mean	Std.Dev./n[a]	Median	Mean	Std.Dev./n[a]	Median	Mean	Dev./n[a]
pH[b]	6.4	6.4	0.5/162	6.7	6.5	0.8/132	6.9	6.7	0.6/52
DO (mg/L)	5.9	5.7	2.6/205	5.1	5.53.6/173	6.3	5.4	2.9/67	
Cond. (µS/cm)	46	73	64/190	160	142	73/161	132	151	86/61
TSS (µg/L)	2.0	4.6	8.5/204	2.8	9.2	22/175	4.0	9.2	15/66
TP (µg/L)	29	52	87/206	70	93	92/177	69	110	234/67
N (µg/L)	112	368	485/206	304	598	847/177	376	395	239/67
FC (no./100mL)	9.0	271	1000/206	46	2665	27342/173	61	969	4753/66
Cu (µg/L)	<5.0	<3.3	>2.7/93	<5.0	<3.7	>1.9/78	<5.0	<4.1	<2.5/29
Pb (µg/L)	1.0	<2.7	>2.8/136	3.0	<3.4	>2.7/122	5.0	<4.5	>4.0/44
Zn (µg/L)	5.0	8.4	8.3/136	8.0	9.8	7.2/122	20	20	17/44

[a] Std. Dev.--standard deviation; n--number of observations.
[b] Values do not apply to priority peat wetlands. The program did not specifically study these wetlands but measured pH in three wetlands with “bog-like” characteristics. The minimum value measured in these wetlands was 4.5, and the lowest median was 4.8; but pH can be approximately 1 unit lower in wetlands of this type.

Guide Sheet 2D: Guidelines for the Protection of Specific Biological Communities

1. For wetlands inhabited by breeding native amphibians:
   - Refer to step 4 of Guide Sheet 2B for hydroperiod limit.
   - Avoid decreasing the sizes of the open water and aquatic bed zones.
   - Avoid increasing the channelization of flow. Do not form channels where none exist, and take care that inflows to the wetland do not become more concentrated and do not enter at higher velocities than accustomed. If necessary, concentrated flows can be uniformly distributed with a flow-spreading device such as a shallow weir, stilling basin, or perforated pipe. Velocity dissipation can be accomplished with a stilling basin or rip-rap pad.
   - Limit the post-development flow velocity to < 5 cm/s (0.16 ft/second) in any location that had a velocity in the range 0-5 cm/s in the pre-development condition.
   - Avoid increasing the gradient of wetland side slopes.

2. For wetlands inhabited by forest bird species:
   - Retain areas of coniferous forest in and around the wetland as habitat for forest species.
   - Retain shrub or woody debris as nesting sites for ground-nesting birds and downed logs and stumps for winter wren habitat.
   - Retain snags as habitat for cavity-nesting species, such as woodpeckers.
   - Retain shrubs in and around the wetland for protective cover. If cover is insufficient to protect against domestic pet predation, consider planting native bushes such as rose species in the buffer.

3. For wetlands inhabited by **wetland obligate** bird species:
   - Retain **forested zones**, sedge and rush meadows, and deep open water zones, both without vegetation and with submerged and floating plants.
   - Retain shrubs in and around the wetland for protective cover. If cover is insufficient to protect against domestic pet predation, consider planting native bushes such as rose species in the buffer.
   - Avoid introducing **invasive weedy plant species**, such as purple loosestrife and reed canary grass.
   - Retain the buffer zone. If it has lost width or forest cover, consider re-establishing forested buffer area at least 30 meters (100 ft) wide.

- If human entry is desired, establish paths that permit people to observe the wetland with minimum disturbance to the birds.

4. For wetlands inhabited by fish:

   - Protect fish habitats by avoiding water velocities above tolerated levels (selected with the aid of a qualified fishery biologist to protect fish in each life stage when they are present), siltation of spawning beds, etc. Habitat requirements vary substantially among fish species. If the wetland is associated with a larger water body, contact the Department of Fisheries and Wildlife to determine the species of concern and the acceptable ranges of habitat variables.
   - If stranding of protected commercial or sport fish could result from a structural or hydrologic modification for runoff quantity or quality control, develop a strategy to avoid stranding that minimizes disturbance in the wetland (e. g., by making provisions for fish return to the stream as the wetland drains, or avoiding use of the facility for quantity or quality control during fish presence).

Wetlands Guidance Appendix 1: Information Needed to Apply Guidelines

The following information listed for each guide sheet is most essential for applying the Wetlands and Stormwater Management Guidelines. As a start, obtain the relevant soil survey; the National Wetland Inventory, topographic and land use maps, and the results of any local wetland inventory.

Guide Sheet 1

1. Boundary and area of the contributing watershed of the wetland or other landscape unit
2. A complete definition of goals for the wetland and landscape unit subject to planning and management
3. Existing management and monitoring plans
4. Existing and projected land use in the landscape unit in the categories commercial, industrial, multi-family residential, single-family residential, agricultural, various categories of undeveloped, and areas subject to active logging or construction (expressed as percentages of the total watershed area)
5. Drainage network throughout the landscape unit
6. Soil conditions, including soil types, infiltration rates, and positions of seasonal water table (seasonally) and restrictive layers
7. Groundwater recharge and discharge points

8. Wetland category (I - IV in the Dept. of Ecology's "Washington State Wetland Rating System for Western Washington," available on-line at http://www.ecy.wa.gov/biblio/sea.html); designation as rare or irreplaceable. Refer to the Washington Natural Heritage Program database. If the needed information is not available, a biological assessment will be necessary.
9. Watershed hydrologic assessment
10. Watershed water quality assessment
11. Wetland type and zones present, with special note of estuarine, priority peat system, forested, sensitive scrub-shrub zone, sensitive emergent zone and other sensitive or critical areas designated by state or local government (with dominant plant species)
12. Rare, threatened, or endangered species inhabiting the wetland
13. History of wetland changes
14. Relationship of wetland to other water bodies in the landscape unit and the drainage network
15. Flow pattern through the wetland
16. Fish and wildlife inhabiting the wetland
17. Relationship of wetland to other wildlife habitats in the landscape unit and the corridors between them

Guide Sheet 2

1. Existing and potential stormwater pollution sources
2. Existing and projected landscape unit land use (see number 4 under Guide Sheet 1)
3. Existing and projected wetland hydroperiod characteristics
4. Wetland bathymetry
5. Inlet and outlet locations and hydraulics
6. Landscape unit soils, geologic and hydrogeologic conditions
7. Wetland type and zones present (see number 11 under Guide Sheet 1)
8. Presence of breeding populations of native amphibian species
9. Presence of forest and wetland obligate bird species
10. Presence of fish species

Wetlands Guidance Appendix 2: Definitions

Baseline sampling	Sampling performed to define an existing state before any modification occurs that could change the state.
Bioengineering	Restoration or reinforcement of slopes and stream banks with living plant materials.
Buffer	The area 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 for the sole purpose of wastewater or stormwater treatment. These wetlands are not normally considered Waters of the United States or Waters of the State.
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
Enhancement	Actions performed to improve the condition of an existing degraded wetland, so that functions it provides are of a higher quality.
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 partly obstructed or sporadic access to the open ocean).
Forested communities (wetlands)	In general terms, communities (wetlands) characterized by woody vegetation that is greater than or equal to 6 meters in height; in these guidelines 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.

Functions	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, flood flow alteration, groundwater recharge and discharge, water quality improvement, and soil stabilization.
Hydrodynamics:	The science involving the energy and forces acting on water and its resulting motion.
Hydroperiod	The seasonal occurrence of flooding and/or soil saturation; encompasses the depth, frequency, duration, and seasonal pattern of inundation.
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 these guidelines.
Landscape unit	An area of land that has a specified boundary and is the locus of interrelated physical, chemical, and biological processes.
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.
On-site	An action (here, for stormwater management purposes) taken within the property boundaries of the site to which the action applies.
Polishing	Advanced treatment of a waste stream that has already received one or more stages of treatment by other means.
Pre-development, post-development	Respectively, the situation before and after a specific stormwater management project (e. g., raising the outlet, building an outlet control structure) will be placed in the wetland or a land use change occurs in the landscape unit that will potentially affect the wetland.
Pre-treatment	An action taken to remove pollutants from runoff before it is discharged into another system for additional treatment.
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, *Rhododendron 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.
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.
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.
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.
Source control best management practices (BMPs)	Actions that are taken to prevent the development of a problem (e. g., increase in runoff quantity, release of pollutants) at the point of origin.
Stage excursion	A post-development departure, either higher or lower, from the water depth existing under a given set of conditions in the pre-development state.
Structure	The components of an ecosystem, both the abiotic (physical and chemical) and biotic (living).
Treatment best management practices (BMPs)	Actions that remove pollutants from runoff through one or more physical, chemical, biological mechanisms.
Unusual biological community types	Assemblages of interacting organisms that are relatively uncommon regionally.
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.

Vernal wetland A wetland that has water above the soil surface for a period of time during and/or after the wettest season but always dries to or below the soil surface in warmer, drier weather.

Wetland obligate A biological organism that absolutely requires a wetland habitat for at least some stage of its life cycle.

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.)

Wetlands Guidance Appendix 3: Native and Recommended Noninvasive Plant Species for Wetlands in the Puget Sound Basin

Caution: Extracting plants from an existing wetland donor site can cause a significant negative effect on that site. It is recommended that plants be obtained from native plant nursery stocks whenever possible. Collections from existing wetlands should be limited in scale and undertaken with care to avoid disturbing the wetland outside of the actual point of collection. Plant selection is a complex task, involving matching plant requirements with environmental conditions. It should be performed by a qualified wetlands botanist. Refer to Restoring Wetlands in Washington by the Washington Department of Ecology for more information.

Plants preferred in Puget Sound Basin freshwater wetlands

Open water zone

Potamogeton species (pondweeds)

Nymphaea odorata (pond lily)

Brasenia schreberi (watershield)

Nuphar luteum (yellow pond lily)

Polygonum hydropiper (smartweed)

Alisma plantago-*aquatica* (broadleaf water plantain)

Ludwigia palustris (water purslane)

Menyanthes trifoliata (bogbean)

Utricularia minor, U. vulgaris (bladderwort)

Emergent zone:

Carex obnupta, C. utriculata, C. arcta, C. stipata, C. vesicaria C. aquatilis, C. comosa, C. lenticularis (sedge)

Scirpus atricinctus (woolly bulrush)

Scirpus microcarpus (small-fruited bulrush)

Eleocharis palustris, E. ovata (spike rush)

Epilobium watsonii (Watson's willow herb)

Typha latifolia (common cattail) (Note: This native plant can be aggressive but has been found to offer certain wildlife habitat and water quality improvement benefits; use with care.)

Veronica americana, V. scutellata (American brookline, marsh speedwell)

Mentha arvensis (field mint)

Lycopus americanus, L. uniflora (bugleweed or horehound)

Angelica species (angelica)

Oenanthe sarmentosa (water parsley)

Heracleum lanatum (cow parsnip)

Glyceria grandis, G. elata (manna grass)

Juncus acuminatus (tapertip rush)

Juncus ensifolius (daggerleaf rush)

Juncus bufonius (toad rush)

Mimulus guttatus (common monkey flower)

Scrub-shrub zone

Salix lucida, S. rigida, S. sitchensis, S. scouleriana, S. pedicellaris (willow)

Lysichiton americanus (skunk cabbage)

Athyrium filix-femina (lady fern)

Cornus sericea (redstem dogwood)

Rubus spectabilis (salmonberry)

Physocarpus capitatus (ninebark)

Ribes species (gooseberry)

Rhamnus purshiana (cascara)

Sambucus racemosa (red elderberry) (occurs in wetland-upland transition)

Loniceria involucrata (black twinberry)

Oemleria cerasiformis (Indian plum)

Stachys cooleyae (Stachy's horsemint)

Prunus emarginata (bitter cherry)

Forested zone:

Populus balsamifera, ssp. trichocarpa (black cottonwood)

Fraxinus latifolia (Oregon ash)

Thuja plicata (western red cedar)

Picea sitchensis (Sitka spruce)

Alnus rubra (red alder)

Tsuga heterophylla (hemlock)

Acer circinatum (vine maple)

Maianthemum dilatatum (wild lily-of-the-valley)

Ivzula parviflora (small-flower wood rush)

Torreyochloa pauciflora (weak alkaligrass)

Ribes species (currants)

Bog:

Sphagnum species (sphagnum mosses)

Rhododendron groenlandicum (Labrador tea)

Vaccinium oxycoccos (bog cranberry)

Kalmia microphylla, ssp. *occidentalis* (bog laurel)

Exotic plants that should not be introduced to existing, created, or constructed Puget Sound Basin freshwater wetlands

Hedera helix (English ivy)

Phalaris arundinacea (reed canarygrass)

Lythrum salicaria (purple loosestrife)

Iris pseudacorus (yellow iris)

Ilex aquifolia (holly)

Impatiens glandulifera (policeman's helmet)

Lotus corniculatus (birdsfoot trefoil)

Lysimachia thyrsiflora (tufted loosestrife)

Myriophyllum species (water milfoil, parrot's feather)

Polygonum cuspidatum (Japanese knotweed)

Polygonum sachalinense (giant knotweed)

Rubus discolor (Himalayan blackberry)

Tanacetum vulgare (common tansy)

Native plants that should not be introduced to existing, created, or constructed Puget Sound Basin freshwater wetlands

Potentilla palustris (Pacific silverweed)

Solarum dulcimara (bittersweet nightshade)

Juncus effusus (soft rush)

Conium maculatum (poison hemlock)

Ranunculus repens (creeping buttercup)

Wetlands Guidance Appendix 4: Comparison of Water Chemistry Characteristics In *Sphagnum* Bog And Fen Versus More Typical Wetlands

Water Quality Variable	Typical Wetlands	*Sphagnum* Bogs and Fens
PH	6 - 7	3.5 - 4.5
Dissolved oxygen (mg/L)	4 - 8	Shallow surface layer oxygenated, anoxic below
Cations	Divalent Ca, Mg common	Divalent Ca, Mg uncommon; Univalent Na, K predominant
Anions	HCO_3^-, CO_3^{2-} predominant	Cl^-, SO_4^{2-} predominant; almost no HCO_3^-, CO_3^{2-} (organic acids form buffering system)
Hardness	Moderate	Very low
Total phosphorus (µg/L)	50 - 500	5 - 50
Total Kjeldahl nitrogen (µg/L)	500 - 1000	~ 50

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Appendix I-E
Flow Control-Exempt Surface Waters

Stormwater discharges, that are otherwise subject to Minimum Requirement #7 – Flow Control, to waters on this list must meet the following restrictions to be exempt from Minimum Requirement #7.

- 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 BMP’s are applied to route natural runoff volumes from the project site to any downstream Type 5 stream or category IV wetland:
    - Design of flow splitting devices or drainage BMP’s 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, durations ranging from 50% of the 2-year to the 50-year peak flow.
    - Flow splitting devices or drainage BMP’s 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 a hydraulic capacity sufficient 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.

Exempt Surface Waters List.

Water Body	**Upstream Point/Reach for Exemption** (if applicable)
Alder Lake	
Aston Creek	Downstream of confluence with George Creek
Baker Lake	
Baker River	Baker River/Baker Lake downstream of the confluence with Noisy Creek
Bogachiel River	0.4 miles downstream of Dowans Creek
Calawah River	Downstream of confluence with South Fork Calawah River
Carbon River	Downstream of confluence with South Prairie Creek
Cascade River	Downstream of Found Creek
Cedar River	Downstream of confluence with Taylor Creek
Chehalis River	1,500 feet downstream of confluence with Stowe Creek
Chehalis River, South Fork	1,000 feet upstream of confluence with Lake Creek
Cispus River	Downstream of confluence with Cat Creek
Clearwater River	Downstream of confluence with Christmas Creek
Columbia River	Downstream of Canadian border
Coweman River	Downstream of confluence with Gobble Creek
Cowlitz River	Downstream of confluence of Ohanapecosh River and Clear Fork Cowlitz River
Crescent Lake	
Dickey River	Downstream of confluence with Coal Creek
Dosewallips River	Downstream of confluence with Rocky Brook
Dungeness River	Downstream of confluence with Gray Wolf River
Elwha River	Downstream of confluence with Goldie River
Grays River	Downstream of confluence with Hull Creek
Green River (WRIA 26 – Cowlitz)	3.5 miles upstream of Devils Creek
Hoh River	1.2 miles downstream of Jackson Creek
Humptulips River	Downstream of confluence with West and East Forks
Kalama River	2.0 miles downstream of Jacks Creek
Lake Cushman	
Lake Quinault	
Lake Shannon	
Lake Sammamish	
Lake Union & Union Bay	King County
Lake Washington, Ship Canal, & Salmon Bay	
Lake Whatcom	
Lewis River	Downstream of confluence with Quartz Creek
Lewis River, East Fork	Downstream of confluence with Big Tree Creek
Lightning Creek	Downstream of confluence with Three Fools Creek
Little White Salmon River	Downstream of confluence with Lava Creek
Mayfield Lake	
Muddy River	Downstream of confluence with Clear Creek
Naselle River	Downstream of confluence with Johnson Creek
Newaukum River	Downstream of confluence with South Fork Newaukum River
Nisqually River	Downstram of confluence with Big Creek
Nooksack River	Downstream of confluence of North Fork and Middle Forks
Nooksack River, North Fork	Downstream of confluence with Glacier Creek, at USGS gauge

Water Body	**Upstream Point/Reach for Exemption** (if applicable)
	12205000
Nooksack River, South Fork	0.1 miles upstream of confluence with Skookum Creek
North River	Downstream of confluence with Vesta Creek
Ohanapecosh River	Downstream of confluence with Summit Creek
Puyallup River	Half-mile downstream of confluence with Kellog Creek
Queets River	Downstream of confluence with Tshletshy Creek
Quillayute River	Downstream of Bogachiel River
Quinault River	Downstream of confluence with North Fork Quinault River
Riffe Lake	
Ruby Creek	Ruby Creek at SR-20 crossing downstream of Granite and Canyon Creeks
Satsop River	Downstream of confluence of Middle and East Forks
Satsop River, East Fork	Downstream of confluence with Decker Creek
Sauk River	Downstream of confluence of South Fork and North Fork
Sauk River, North Fork	North Fork Sauk River at Bedal Campground
Silver Lake	Cowlitz County
Skagit River	Downstream of Canadian border
Skokomish River	Downstream of confluence of North and South Fork
Skokomish River, South Fork	Downstream of confluence with Vance Creek
Skokomish River, North Fork	Downstream of confluence with McTaggert Creek
Skookumchuck River	1 mile upstream of Bucoda at SR 507 mile post 11.0
Skykomish River	Downstream of South Fork
Skykomish River, South Fork	Downstream of confluence of Tye and Foss Rivers
Snohomish River	Down stream of confluence of Snoqualmie and Skykomish Rivers
Snoqualmie River	Downstream of confluence of the Middle Fork
Snoqualmie River, Middle Fork	Downstream of confluence with Rainy Creek
Sol Duc River	Downstream of confluence of North and South Fork Soleduck River
Stillaguamish River	Downstream of confluence of North and South Fork
Stillaguamish River, North Fork	7.7 highway miles west of Darrington on SR530, downstream of confluence with French Creek.
Stillaguamish River, South Fork	Downstream of confluence of Cranberry Creek and South Fork
Suiattle River	Downstream of confluence with Milk Creek
Sultan River	0.4 miles upstream of SR2
Swift Creek Reservoir	
Thunder Creek	Downstream of the confluence with Neve Creek
Tilton River	Downstream of confluence with North Fork Tilton River
Toutle River	North and South Fork Confluence
Toutle River, North Fork	Downstream of confluence with Hoffstadt Creek
Toutle River, South Fork	Downstream of confluence with Thirteen Creek
White River	Downstream of confluence with Huckleberry Creek
Willapa River	Downstream of confluence with Mill Creek
Wind River	Downstream of confluence with Cold Creek
Wynochee Lake	
Wynoochee River	Downstream of confluence with Schafer Creek

Glossary and Notations

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 Volume IV, applicable BMPs are those source control BMPs that are expected to be required by local governments at new development and redevelopment sites. Applicable BMPs will also be required if they are incorporated into NPDES permits, or they are included by local governments in a stormwater program for existing facilities.

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. A major arterial connects an Interstate Highway to cities and counties. A minor arterial connects major arterials to collectors. A collector connects an arterial to a neighborhood. A collector is not an arterial. A local access road connects individual homes to a collector.

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 are 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.

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 at pH 7.0.

CESCL — See Certified Erosion and Sediment Control Lead

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 which is low-lying and either has no, or such a limited, surface water outlet that during storm events the area acts as a retention basin.

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.

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 residue or a mixture of organic residues and soil, that has undergone biological decomposition until it has become relatively stable humus.

Reference note: The Department of Ecology Interim Guidelines for Compost Quality (1994) defines compost as “the product of composting; it has undergone an initial, rapid stage of decomposition and is in the process of humification (curing).” Compost used should meet specifications for grade A or AA compost in Ecology publication 94-038.

Composted Mulch
Mulch prepared from decomposed organic materials that have undergone a controlled process to minimize weed seeds. Acceptable feedstocks include, but are not limited to, yard debris, wood waste, land clearing debris, brush, and branches.

Composting
A controlled process of degrading organic matter by microorganisms. Present day composting is the aerobic, thermophilic decomposing of organic waste to relatively stable humus. Composting is the process of making usable, organic matter that is beneficial to plants and has converted nutrients into slow-release forms (versus mineralized water-soluble forms found in fertilizer).

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.

Certified Erosion and Sediment Control Lead (CESCL) The project proponent designates at least one person as the responsible representative in charge of erosion and sediment control (ESC), and water quality protection. The designated person shall be the Certified Erosion and Sediment Control Lead (CESCL) who is responsible for ensuring compliance with all local, state, and federal erosion and sediment control and water quality requirements.

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	The written decision by the responsible official of the lead agency that a proposal is not likely to have a significant adverse

(DNS)	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 p7er 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 from a drainage facility system 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 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 groundwater 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 owners 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 on residential development sites are considered ineffective if the runoff is dispersed through at least one hundred feet of native vegetation in accordance with BMP T5.30 - "Full Dispersion," as described in Chapter 5 of Volume V.
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 dissipator	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.

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.

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.
Floodway	The channel of the river or stream and those portions of the adjoining floodplains that are reasonably required to carry and discharge the base flood flow. The portions of the adjoining floodplains which are considered to be "reasonably required" is defined by flood hazard regulations.
Flow control 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 design water surface elevation and the elevation of the barrier that contains the water.

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.

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)

Functions 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.

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.

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 See 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 algotrithms 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 permeability coefficient

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.

Type A: 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.

Type B: 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.

Type C: 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.

Type D: 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.

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 hard surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A hard 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.
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 texture 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 movement of earth or 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. Compaction that is associated with stabilization of structures and road construction shall also be considered a land disturbing activity. Vegetation maintenance practices are not considered land-disturbing activity.
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.

Local government Any county, city, town, or special purpose district having its own incorporated government for local affairs.

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 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 resulting 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 and includes replacement of disfunctioning 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. For example, replacing a collapsed, fish blocking, round culvert with a new box culvert under the same span, or width, of roadway. For further details on the application of this manual to various road management functions, please see Section 2.2 in chapter 2 of Volume I.

Manning's equation An equation used to predict the velocity of water flow in an open channel or pipelines:

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

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 are 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 impervious 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.
NRCS Method	See SCS 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	Site development techniques that serve to infiltrate, disperse, and retain stormwater runoff on-site.

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 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.
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 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. Erodible or leachable materials, wastes, or chemicals are those substances which, when exposed to rainfall, measurably alter the physical or chemical characteristics of the rainfall runoff. Examples include erodible soils that are stockpiled, uncovered process wastes, manure, fertilizers, oily substances, ashes, kiln dust, and garbage dumpster leakage. Metal roofs are also considered to be PGIS unless they are coated with an inert, non-leachable material (e.g., baked-on enamel coating).

A surface, whether paved or not, shall be considered subject to vehicular use if it is regularly used by motor vehicles. The following are considered regularly-used surfaces: roads, unvegetated road shoulders, bike lanes within the traveled lane of a roadway, driveways, parking lots, unfenced fire lanes, vehicular equipment storage yards, and airport runways.

The following are not considered regularly-used surfaces: paved bicycle pathways separated from and not subject to drainage from roads for motor vehicles, fenced fire lanes, and infrequently used maintenance access roads.

Pollution-generating pervious surface (PGPS) — Any non-impervious surface subject to use of pesticides and fertilizers or loss of soil. Typical PGPS include lawns, landscaped areas, golf courses, parks, cemeteries, and sports fields.

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 modelling 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 impervious surfaces, or replaced impervious 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.
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.

Recharge The addition of water to the zone of saturation (i.e., an aquifer).

Recommended BMPs As used in Volume IV, recommended BMPs are those BMPs that are not expected to be mandatory by local governments at new development and redevelopment sites. However, they may improve pollutant control efficiency, and may provide a more comprehensive and environmentally effective stormwater management program.

Redevelopment On a site that is already substantially developed (i.e., has 35% or more of existing impervious surface coverage), the creation or addition of impervious 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 impervious 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 impervious surface For structures, the removal and replacement of any exterior impervious surfaces or foundation. For other impervious surfaces, the removal down to bare soil or base course and replacement.

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.

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.
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	A single-event hydrologic analysis technique for estimating runoff based on the Curve Number method. The Curve Numbers are

published by NRCS *in Urban Hydrology for Small Watersheds, 55 TR, June 1976*. With the change in name to the Natural Resource Conservation Service, the method may be referred to as the NRCS Method.

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 vegetation communities Assemblages of woody vegetation less than 6 meters in height, 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 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 within 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 Volume IV 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.

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 system

Constructed and natural features which function together as a system to collect, convey, channel, hold, inhibit, retain, detain, infiltrate, 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 (Stormwater Manual) This manual, as prepared by Ecology, 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 regulatory agencies to evaluate a proposed new development or redevelopment project for compliance with stormwater requirements. Contents of the Stormwater Site Plan will vary with the type and size of the project, and individual site characteristics. It includes a Construction Stormwater Pollution Prevention Plan (Construction SWPPP) and a Permanent Stormwater Control Plan (PSC Plan). Guidance on preparing a Stormwater Site Plan is contained in Chapter 3 of Volume I.

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 of stone or 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."

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 An onsite 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 flowpath). The examples in Figure 2.1 of Volume I 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.

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 Topsoil shall be per ASTM D5268 standard specification, and water permeability shall be 0.6 inches per hour or greater. Organic matter shall have not more than 10 percent of nutrients in mineralized water-soluble forms. Topsoil shall not have phytotoxic characteristics.

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 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 groundwater 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.
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 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.)

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.

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.