Highway Runoff Manual

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Environmental and Engineering Service Center

Foreword

This manual has been prepared as a guide for our engineering and maintenance personnel to provide policies, procedures, and methods for developing and documenting the design and maintenance of improvements to the transportation system in Washington State.

This manual is a guide for the design and operation of transportation facilities that are related to or affect stormwater runoff. This manual is intended to provide uniform procedures for implementing design and maintenance decisions regarding highway runoff facilities to ensure a continuity of quality of these facilities throughout the state. It is recognized that not all conceivable situations will be included in the manual and as a result, sound judgment by knowledgeable personnel will be required for successful implementation. It is also recognized that the practices suggested in this manual may be inappropriate for some projects.

Updating this manual is a continuing process and revisions are issued periodically. Questions or suggestions for modifications are invited and should be directed to the Olympia Service Center Hydraulics Section. Orders for manuals should be addressed to the Publications Support Branch, WSDOT, P.O. Box 47400, Olympia, WA 98504-7400 or telephone (360) 705-7430.

John Conrad Assistant Secretary for Field Operations Support Service Center	E. R. Burch Assistant Secretary for Environmental and Engineering Service Center

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1-1 Basis of Manual Development

The *Highway Runoff Manual* was developed to direct stormwater management for existing and new state highways, rest areas, park and ride lots, and ferry terminals. The manual was written by staff of the Washington State Department of Transportation (WSDOT) with input from an advisory committee made up of representatives of cities, counties, Indian tribes, and other state agencies.

The primary users of this manual will be the following WSDOT personnel: design engineers developing Stormwater Site Plans in design project offices, project inspectors in construction project offices responsible for inspection and maintenance of Temporary Erosion and Sediment Control Plans, and maintenance staff responsible for developing Roadside Management Plans and roadway maintenance practices. The department has developed the *Highway Runoff Manual* to establish minimum requirements and provide technical, uniform guidance for the avoidance and mitigation of water resource impacts of the highway system. The manual will be updated periodically to reflect advances in the management of stormwater, roadside vegetation, and roadway maintenance. The Olympia Service Center Hydraulics Section and Water Quality Unit will jointly be responsible for manual revisions and implementation oversight. The design criteria and procedures presented in this manual shall supersede conflicting information presented in other WSDOT manuals published prior to the date of this manual.

Initially, this manual will be applied in the Puget Sound basin. The Puget Sound basin includes the waters of 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 land draining into these waters. The Puget Sound Water Quality Management Plan and the Puget Sound Highway Runoff Program (Chapter 173-270 WAC) require the development and use of the manual. However, problems associated with stormwater, and the need to manage it properly under such programs as the National Pollutant Discharge Elimination System (NPDES), are not restricted to the Puget Sound basin. Therefore, WSDOT will apply the *Highway Runoff Manual* to certain projects statewide. There are a number of issues that need to be resolved before statewide application can occur, not the least of which is the applicability of certain design elements to the drier climates of eastern Washington. Statewide application of the manual is dependent upon local climatic, geologic, and hydrologic conditions. The Department of Ecology will be expanding its *Stormwater Management Manual for the Puget Sound Basin* (SMMPSB) to be applicable for areas outside of Puget Sound. The *Highway Runoff Manual* will be revised to be consistent with changes to the SMMPSB.

While statewide application of this manual is not currently required, projects outside the Puget Sound basin should follow the guidelines presented whenever there are space and funds available. For projects outside of the Puget Sound basin that are required by local jurisdictions to follow stormwater treatment guidelines, staff can use this manual to design the stormwater facilities. This is done to keep design procedures consistent statewide and should be acceptable to local agencies

since ultimately the result is the same as long as an engineeringly sound design is used. The exception would be in the case of locally adopted basin or watershed plans, NPDES Stormwater Requirements, or sensitive area ordinances, pursuant to Minimum Requirement 8 in Chapter 2. Through interaction with the advisory committee, it has been the intent of WSDOT to develop a set of stormwater design standards that are consistent with state and local jurisdiction requirements such that these standards would be applicable to most WSDOT and local agency roadway department projects.

1-2 Problems Associated With Stormwater

Development can have a dramatic impact on the hydrologic cycle. In western Washington, land cover that once consisted primarily of mature forest has been replaced in many areas with impervious surfaces, such as buildings, parking areas, and roadways. The creation of impervious surfaces has two main impacts on the hydrologic cycle, increased runoff, and prevention of infiltration. Reducing land cover, mainly by tree removal, can also significantly increase runoff even though pervious surfaces remain.

The creation of impervious surfaces increases both the volumes of surface runoff and the peak rate of flow resulting from a storm event. The higher velocity and larger quantity of flow may cause stream bank erosion and general habitat destruction. Sediment from cleared areas and eroded and unstable stream banks is deposited downstream, filling ponds, stream beds, and stormwater facilities. Construction projects that include exposed and nonstabilized soils, especially on slopes, can be a source of such pollution.

Runoff functions as the transport mechanism for nonpoint sources of pollution, those sources being dispersed throughout the watershed resulting from a variety of land uses. The increase in the introduction of these pollutants from human habitation and activity can result in measurable degradation of receiving waters. Runoff from roadways and associated facilities may contain oil and grease (hydrocarbons), heavy metals such as lead and zinc, and in some cases, volatile organic compounds.

Aquatic life can be affected by development in a watershed. Habitats are altered when a stream changes its configuration and deposits its sediment load in response to significant urbanization. Natural structures of the stream channel, riffles, pools, gravel bars, and other areas, are altered and sometimes destroyed. Spawning areas, consisting mainly of clean gravels, can become imbedded with silt and unusable by fish. Urbanization may also cause an increase in water temperature when vegetation, which shades the water, is removed. Increase in water temperature coupled with nutrients from some land uses may cause algal blooms and reduction of dissolved oxygen (DO). Low DO can cause fish and other organisms to die, and allow undesirable species to establish residence.

A more subtle impact of development on the hydrologic cycle is the reduction of infiltration. Infiltration recharges ground water and produces interflow, the sub-surface flow particularly common in the soils of the Puget Sound lowlands. Ground water is the source that produces summer base flows in streams and

sustains water levels in some wetlands. Reduction in infiltration can dry up small streams and wetlands in the summer and in turn render aquatic systems useless during these times.

1-3 Solutions to Stormwater Problems

The best solution to problems created by stormwater runoff is the application of some type of Best Management Practice (BMP). BMPs are defined as physical, structural, and managerial practices that, when used individually or in combination, prevent or reduce pollution of water and attenuate peak flows and volumes. In order to address the types of problems discussed above, BMPs are grouped into three types: source control, water quality, and water quantity BMPs.

Source control BMPs are designed to prevent the introduction of pollutants into runoff. Examples would be mulches and cover over bare soil, and putting roofs over outside storage areas. Water quality BMPs include facilities that remove pollutants from runoff by simple gravity settling of particulate matter, filtration, biological uptake, and soil adsorption. Examples include wet ponds and vegetated swales. Water quantity BMPs protect stream ecosystems from excessive erosion by reducing the peak rate of runoff during a storm event by storing the flow and releasing it at a lower rate. Typical examples are dry ponds and dry vaults.

When BMPs are correctly applied to a project site, the impacts of the change of land use is minimized. There are several types of BMPs that are included within each of the three main groups. The selection of the proper BMP for a project is dependent on characteristics of the project site, and often any one of a number of BMPs could be utilized to accomplish the same result. Some project sites may require a combination of BMPs. When selecting a BMP for the project, the designer should first consider the ability of the BMP to treat highway runoff, then select the most cost effective, safe, and aesthetically pleasing of the available options.

Stormwater problems can be grouped into two separate categories. The first category being problems from existing impervious areas and the other being problems that will occur from new impervious areas if no stormwater controls are used. New projects that must comply with this manual are required to provide stormwater treatment for the new portions of the roadway. The existing highway sections will eventually be retrofitted with stormwater treatment facilities pursuant to the WSDOT retrofit program, which will include a project priority ranking. As a minimum, stormwater treatment facilities must be sized for the flows that they service and overall water quality must not be degraded as a result of the project.

The designers of new projects should keep in mind that the ultimate goal is to provide practicable stormwater treatment for the entire roadway. If it is cost effective to size a BMP for the entire roadway, even though only a lane is being added, then the BMP should treat the entire roadway, thus saving the cost of retrofitting in the future. If runoff from all of the roadway cannot be cost effectively treated then the selected BMPs should be sized to treat just the new roadway and placed in a location that will allow for future expansion when the site is retrofitted. When determining whether or not it is cost effective to provide stormwater treatment for the entire roadway, the design engineer must determine the benefits that will be derived from the additional treatment. Information relating

to benefits derived from water quality improvements can be obtained from the Environmental Section, the Department of Fish and Wildlife, the Department of Ecology, and many local agencies.

When the requirements of this manual can not be met, the designer must contact the Hydraulics and Environmental Sections. The Hydraulics and Environmental Sections will coordinate with the Department of Fish and Wildlife, the Department of Ecology, and any affected local agency to determine the practicable amount of stormwater treatment that can be included in the project.

1-4 Background of Stormwater Management

Water pollution control has been a federal program since the first Water Pollution Control Act was passed by Congress in the 1960s. For many years, the emphasis was on the control of point source pollution, typically outfalls from industrial factories and municipal sewage treatment plants. Since the early 1980s, interest has been shifting to nonpoint source pollution. Nonpoint source pollution is pollution that originates from diffuse, diverse activities and land uses on the watershed, and enters a water body through nondiscernible, unconfined and indistinct conveyances. Stormwater is unique in that it originates as nonpoint source pollution, but it typically is collected, conveyed, and discharged as a point source.

Major amendments to the Federal Water Pollution Control Act (which has become known as the Clean Water Act) in 1987 addressed stormwater, by extending the NPDES permit program to include stormwater. Also in 1987, the Puget Sound Water Quality Management Plan was issued. This plan called for a Highway Runoff Program, which was subsequently developed in detail by the Department of Ecology and codified in Chapter 173-270 of the Washington Administrative Code. As a result of these federal and state initiatives, new requirements have been placed on the construction of highway projects.

Activities for both federal and state stormwater regulations are progressing concurrently. It is the intent of WSDOT to develop a highway runoff program that utilizes sound engineering principles and satisfies all federal and state requirements. This manual is based on the best engineering practices currently available and will satisfy all existing federal and state requirements.

1-5 Manual Organization

This manual is divided into eight different sections, each corresponding to a chapter. The first chapter is used as an overview to the stormwater problems associated with highways. It is intended to inform the designer which areas will require stormwater treatment and why stormwater treatment is required.

Chapter 2 lists the minimum requirements for stormwater treatment. There are nine minimum requirements listed that shall be checked for every project that is required to follow this manual. Each minimum requirement describes its function and when it should be applied.

Chapter 3 is a description of the methodology that must be used to design the BMPs for the project. The methodology is slightly different than the methodology previously used for WSDOT projects. Because of this, it is explained in detail using examples to show how it would be applied to a project.

Chapter 4 guides the project designer through the BMP selection process. It includes an easy to follow process for BMP selection. The result of this process are the recommended BMPs for both temporary (construction phase) use and permanent use.

Chapter 5 describes what should be included in a Stormwater Site Plan (SSP). The SSP is a required document for all projects that must follow the guidelines of this manual. The SSP will be the document used to review the selection and design process for the BMPs to be used in the project.

Chapter 6 deals with vegetation management. Different methods for managing vegetation along roadways are described. Using this chapter design engineers and maintenance personnel will be able to develop a plan for managing vegetation at the BMPs installed with the project and along the remaining right of way included in the project.

Chapter 7 contains information for design and maintenance personnel on the impact and mitigation of various roadway maintenance practices, including waste disposal, use of traction materials and deicers, and the maintenance of certain BMPs. A special section on bridge painting water quality impacts is included in this chapter for staff involved in these projects.

Chapter 8 is a complete listing of all WSDOT preferred BMPs. Each BMP is in a complete and stand-alone format. After reading Chapters 2 and 3 and following the process in Chapter 4 to select a BMP, this chapter will show the designer the complete set of design steps that must be used for the specific BMP.

1-6 Additional Information

Most projects lend themselves to easily installing one or more of the different BMPs. However, there are times when the site does not provide for easy installation of any of the BMPs or when the available BMPs in Chapter 8 are not well suited for the site. When these types of problems arise, the following staff should be contacted for assistance:

- BMP Selection: regional hydraulics staff, then Olympia Service Center Hydraulics Section.
- Outfall Inventory/Field Screening Results, Retrofit Priorities, NPDES Municipal Stormwater Permit, and Sampling: Olympia Service Center Water Quality Unit.
- Temporary Erosion and Sediment Control Plans and control of pollutants other sediment: regional environmental staff, then Olympia Service Center Water Quality Unit.
- Vegetation Management: regional and Olympia Service Center landscape architects, then Olympia Service Center Maintenance Office.
- Roadway Maintenance Practices: regional maintenance staff, then Olympia Service Center Operations Division Environmental Compliance Branch.

For some projects, it may be necessary to use BMPs that are considered experimental in nature. They must be approved by the Olympia Service Center Hydraulics Section in advance, prior to submittal to the Department of Ecology for review and approval.

The designer should contact the regional Hydraulics Section or the Olympia Service Center Hydraulics Section when selecting BMPs for projects outside of the Puget Sound basin that will implement stormwater treatment. For western Washington, this is mainly to verify the usefulness of the treatment. For eastern Washington, this is also necessary to select a suitable BMP, due to the climate specific requirements of some of the BMPs.

The Stormwater Management Manual for the Puget Sound Basin (SMMPSB) contains in-depth explanations of many of the parameters used to develop the *Highway Runoff Manual*. The SMMPSB should be used as the main reference whenever a designer seeks additional information about treatment of stormwater runoff. When using the SMMPSB as a reference, the designer must realize that it deals with many different type of projects, unlike the *Highway Runoff Manual* which primarily deals with roadway projects. As a result, some of the BMPs presented in the SMMPSB would not be applicable to a highway project.

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