HERRERA
ENVIRONMENTAL
CONSULTANTS

Washington State
Department of Transportation

Spring 2007

Module 4

Washington State Department of Transportation
Highway Runoff Manual
Training

Module 4: Permanent Best Management Practices—Overview and Selection Process

Participant Workbook

Table of Contents

1. Introduction

The Washington State Department of Transportation (WSDOT) Highway Runoff Manual (HRM) was developed to guide WSDOT staff in planning and designing stormwater management facilities for state and federal highways and facilities to protect water quality, its beneficial uses, and environmental health. The HRM reflects WSDOT's current approach to stormwater management.

The HRM training course consists of seven modules that are designed to familiarize WSDOT staff, external designers, engineers, local agencies, and consultants with the content and use of the HRM. The seven modules are described below:

- Module 1 and 2: key terms and minimum requirements
- Module 3: Hydraulics and hydrology
- Module 4: Permanent best management practices (BMP)—overview and selection process
- Module 5: Construction site erosion and sediment control BMP—selection and design process
- Module 6: Permanent stormwater BMP—operation and maintenance
- Module 7: Biological assessments.

Training Module 4

Module 4 is a 1-day course to introduce participants to information and guidelines associated with selecting permanent BMPs, as presented by the WSDOT HRM. This module is the fourth in a series designed to provide participants with a hands-on introduction to the HRM.

Module 4 serves as a general overview of the types and selection process for permanent BMPs. The module includes exercises to demonstrate the appropriate use of the HRM in selecting BMPs for a particular project. An emphasis is also placed on WSDOT's initiative to use low impact development (LID) approaches and its approval process for the use of BMPs that are not included in the HRM, including emerging technologies. The key points included in this module are the following:

- Fundamentals of BMPs
    - Source control
    - Runoff treatment
    - Flow control

- Determining the most appropriate and practical BMPs
    - Pros and cons
    - Where particular BMPs are not appropriate
    - New BMP approaches
    - Cost effectiveness
- Hands-on exercises for participants to apply these concepts to project scenarios, including a discussion of the results.

The content of this module and the supplemental materials are not a substitute for the HRM. It is important that, in practice, the participants use the HRM for each individual project to ensure that the project-specific guidelines and requirements are met.

Workbook Organization

This workbook contains all the information and materials necessary for Module 4. The information is organized as follows:

- Module Goals and Objectives
- Module Agenda
- Course Slides
- Exercises and Example

2. Module Goals and Objectives

Module 4 Goals

The purpose of Module 4 is to guide participants through the selection of permanent BMPs such that the most appropriate and practical BMP is chosen. Although some of the material may not be new to participants, the focus of this module is on the practical implementation of effective BMPs and an introduction to alternative approaches and emerging technologies for consideration. The goals of this module are:

1. Step through the BMP selection process; break old habits of just using favorite BMPs.
2. Inform participants of the new stormwater management techniques and the process for obtaining authorization to use BMPs that not in the HRM.
3. Apply knowledge from Modules 1 and 2.

Module 4 Objectives

At the end of Module 4, participants will be able to:

1. Assess site conditions and step through the BMP selection process.
2. Defend their selected BMPs.
3. Describe the differences between the BMPs in the HRM and the alternative compliance pathways.

3. Module Agenda

Time	**Lesson**	**Length (min)**
8:30-9:05	Introduction and Introductory Exercise	35
9:05-10:05	Lesson 1: Stormwater Planning	60
10:05-10:15	Break	10
10:15-11:00	Lesson 2: General Overview of BMP Selections	45
11:00-11:10	Break	10
11:10-12:10	Lesson 3: BMP Selection and Design Considerations	60
12:10-1:10	Lunch	60
1:10-3:45	Lesson 4: Example Exercises (with breaks)	155
3:45-4:00	Module Evaluation, Wrap-Up, Summary	15

4. Course Slides

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Highway Runoff Manual Training: Module 4

- ✓ Overview of Permanent Best Management Practices (BMPs)
- ✓ BMP Selection Process

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Introductions

- New instructor introductions
- Any new participants?

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Today's Agenda

Please refer to your participant Workbook, page III-3.

- Schedule
  - 4 Lessons and a wrap-up
  - interactive exercises and examples
  - 10- to 15-minute breaks
  - 1-hour lunch

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Organization of Training Notebooks

- Introduction
- Course goal and outcomes
- Agenda
- PowerPoint presentation slides
- BMP selection project examples
- Glossary
- Flow charts and tables

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Encouraging Participation

- Connect with the Module 1 and 2 lessons
  - Module 1 – Project site assessment
  - Module 2 – Minimum requirements and TDAs
- Other HRM classes
  - Module 3 – Hydrologic analysis and modeling
  - Module 5 – Construction BMPs

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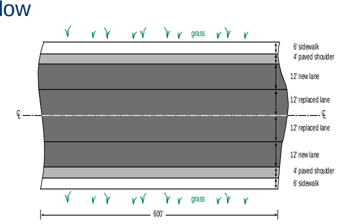
Warm-up exercise

- Use the HRM
- Create a conceptual flow control and runoff treatment design.
- No exemptions apply
- Page V-1 of your participant workbook



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Classroom Objectives

- Complete an overview of permanent stormwater BMPs:
  - source control
  - runoff treatment
  - flow control
- Describe when a BMP is appropriate
- Step through the BMP selection process

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Classroom Objectives

- Complete project examples.
- Describe the procedures for selecting alternative BMP options
- Understand the purpose of and application of the Engineering, Economic, and Feasibility (EEF) Checklist
- Apply knowledge from Modules 1 and 2 and Hydraulics and Highway Drainage

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Learning Outcomes

- Assess site conditions and select appropriate flow control and water quality BMPs
- Defend your BMP selection
- Describe the options for deviating from the BMPs presented in the HRM

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Lesson 1: Stormwater Planning

- Context and background
- Project site assessment
- Project area conditions
- Explain the purpose of the EEF

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Orange County Public Service Announcement

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Learning Objectives

Understand:

- *Importance of stormwater planning*
- *Site considerations that may influence stormwater approach*
- *Why each consideration is important*
- *Purpose of the Engineering and Economic Feasibility (EEF) evaluation*

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Variability

I-90, Kittitas Co.

I-90/I-405 Interchange

4

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Stormwater Planning: General Overview

1. Evolving focus
2. Various applicable regulations
3. WSDOT design strategy
4. Broader roles and responsibilities for designers
5. Multi-team approach
6. Every project is unique

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Stormwater Planning: Evolution of Highway SW Management

- Conveyance and safety
- Ecological impacts
- Water quality
- Physical impacts to streams and rivers
- See also HRM 2-2

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Stormwater Planning: What regulations apply to stormwater?

- Clean Water Act (e.g., NPDES and TMDLs)
- Endangered Species Act
- Safe Drinking Water Act (e.g., UIC)
- State Water Quality standards
- Local regulations (e.g., CAO, SMPs, basin plans)

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Stormwater Planning: WSDOT Stormwater Design Strategy

Step 1 – Avoid and minimize impacts on hydrology and water quality

Step 2 – Compensate for altered hydrology and water quality by mimicking natural processes

Step 3 – Compensate for altered hydrology and water quality by using end-of-pipe solutions

- See **HRM 2-5.2**

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Stormwater Planning: Designer's Role

- How does the design relate to other projects and environmental issues?
- Not just a conveyance design role
- Stormwater design requires a multi-team approach
  - Requires input from geotechnical, hydraulic, environmental, permitting, and design engineering experts
  - Communication and coordination is critical
  - Saves project time, effort, and money

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Stormwater Planning: Project Variability

- "Context-sensitive solutions" – i.e., the watershed context of a project
- Know the site conditions and regulatory obligations before BMP selection and design

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Every Project is Unique Example

- Site-specific factors often make constructing stormwater facilities adjacent to the highway or within the right-of-way infeasible

I-90 Floating Bridge

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Stormwater Planning: Project Variability

- Cannot use a "boilerplate" approach working from outdated designs
- Each project requires a detailed Project Site Assessment and unique design approach
- Team approach: Solicit and incorporate input from multiple disciplines

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Stormwater Planning: Project Variability

- Identify pitfalls, streamline permitting, provide flexibility
- Stormwater management cannot be an after thought

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Stormwater Planning: Project Site Assessment

- Consider project variables and plan accordingly
- First, perform detailed project site assessment

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Stormwater Planning: Project Site Assessment

- Extensive project site factors and variables that must be considered (**HRM 2-3.2**)
  - General site data
  - Water resources data
  - Water quality data
  - Soil/groundwater data

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Project Site Assessment:
General Site Data

- Project vicinity map and site map
- Aerial photographs
- Topography – USGS, survey
- Land surveys

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Project Site Assessment:
General Site Data

- Existing utilities
- Old right of way plans
- Land cover types and areas
- Vegetation surveys

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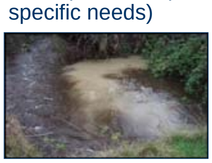
Project Site Assessment:
Water Resource Data - Basin

- Watershed or drainage basin boundaries
- Drainage patterns and drainage areas
- Basin plan data (basin-specific needs)



- Existing stormwater outfalls (outfall inventory and site reconnaissance)
- Floodplains
- Other

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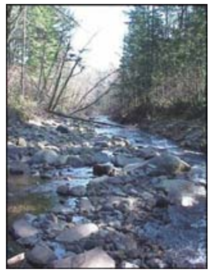
Project Site Assessment: Water Resource Data – Sub-basin

- Receiving water conditions
- Wetlands
- Stream flow data
- Ditch drainage and enclosed drainage
- Existing stormwater facilities
- Other



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Project Site Assessment: Water Quality Data

- Land use types and associated pollutants
- Total maximum daily loads (TMDLs)
- Water cleanup plans
- Clean Water Act Section 303(d) list of impaired waters
- Hazardous materials or wastes
- Other

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Project Site Assessment: Soil and Groundwater Data

- Soil types, depth, and slope - Natural Resources Conservation Service (NRCS) soil surveys
- Groundwater data e.g., depth to water table
- Soil infiltration rates
- Geotechnical evaluation (see also HRM 2-3.2.2)
- Other

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Project Site Assessment:
Project Area Variables

- Onsite and adjacent area conditions
- Proposed project conditions
- Applicable Minimum Requirements and exemptions
- Retrofitting needs and opportunities
- ESA (Appendix 2B)

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Special Design Considerations

- ✓ Bridges
- ✓ Park-and-ride lots & rest areas
- ✓ Ferry terminals
- ✓ Maintenance yards
- ✓ Facilities near airports

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BMP Selection: Group Exercise #1

- What project site assessment conditions (project area and vicinity) can influence BMP selection, and how?
- What project area conditions (the project itself) can influence BMP selection, and how?

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BMP Selection: Planning

- Designers must evaluate a broad range of issues before selecting BMPs
- Contact WSDOT ESO
- Avoid future design changes due to overlooked permitting requirements (saves time and money)

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BMP Selection: Presumptive vs. Demonstrative

- Option #1: HRM & Ecology approved practices = presumptive approach
  - i.e., presumed to meet regulatory requirements
- Option #2: Alternatives to HRM & Ecology approved practices = demonstrative approach
  - Requires technical justification that regulatory requirements will be met
  - EEF checklist

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Engineering and Economic Feasibility (EEF)

- Appendix 2A of the HRM
- Tool to help determine when site-specific factors could make constructing stormwater facilities adjacent to the highway or within the right-of-way infeasible.

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Engineering and Economic Feasibility (EEF)

- The EEF documents the critical site-specific limiting factors
- A series of yes/no questions
- Evaluation checklist criteria
  1) Collect project site data
  2) Infrastructure limitations
  3) Geographic and geotechnical limitations
  4) Hydraulic limitations
  5) Environmental & health limitations
  6) Cost limitations

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Review Learning Outcomes

- Identify site considerations that may influence the approach to stormwater management
- Explain why each consideration is important
- Explain the purpose of the EEF

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Lesson 2 – Types of Permanent Stormwater BMPs and Their Functions

- BMP suitability
- BMP identification
- Category I, II, and III BMPs

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Learning Objectives

Understand:

- *Suitability of BMP types with respect to site conditions*
- *O&M considerations for BMPs*
- *Difference between the BMPs in the HRM, and Categories I, II, and III*
- *Category I, II, and III approval processes*

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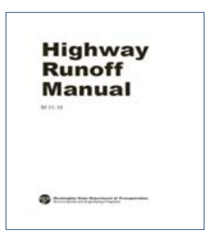
BMPs in the HRM

- Approved by Ecology and considered appropriate for highway application by WSDOT
- Check WSDOT HRM website for updates



List serve:
subscribe-stormwater_list@lists.wsdot.wa.gov

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Recall - BMP Families

- Stormwater Source Control
- Stormwater Runoff Treatment
- Stormwater Flow Control

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What BMP information is in the HRM?

- General description
- Applications and limitations
- Design method
- Siting and structural criteria
- Operations and maintenance considerations

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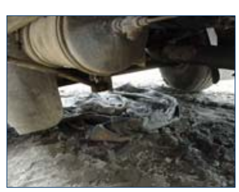
Stormwater Source Control

- First consideration – eliminate the source
- Subset of Ecology Source Control BMPs applies to roadways, ferry terminals, rest areas, park-and-ride lots:
  - Street sweeping
  - Dust control
  - Deicing/anti-icing
  - Spill control
- Section 5-2.1



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Runoff Treatment and Flow Control

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Stormwater Runoff Treatment

- Remove pollutants from roadway runoff
- Pollutant removal mechanisms
  - Sedimentation
  - Filtration
  - Plant uptake
  - Ion exchange
  - Adsorption
  - Precipitation
  - Bacterial decomposition

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Stormwater Flow Control

- Control the rate, volume, and duration of flows in order to prevent erosion in receiving waters
- Examples
  - Detention
  - Infiltration to ground

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Dual Function BMPs

- Several BMPs can provide both Runoff Treatment and Flow Control
  - Dispersion
  - Infiltration
  - Combined treatment/detention ponds
- Preferred approaches

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Stormwater Runoff Treatment and Flow Control - Dispersion BMPs

- Natural dispersion
- Engineered dispersion

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Dispersion BMPs

- Recharges groundwater
- Low O&M cost
- Consider local groundwater requirements
- May require purchase of right-of-way or easement
- Must be protected from future development

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Stormwater Runoff Treatment and Flow Control - Infiltration BMPs

- Bioinfiltration pond
- Infiltration pond
- Infiltration trench
- Infiltration vault
- Drywell

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Infiltration BMPs - Benefits

- Recharges groundwater
- Decreases infrastructure costs
- Trenches or vaults require minimal space

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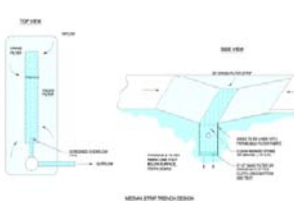
Infiltration BMPs - Drawbacks



- May require pretreatment to prevent siltation
- May not be suitable in areas with high groundwater
- Consider local groundwater quality protection requirements
- See Chapter 4 for infiltration rate requirements

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Stormwater Runoff Treatment and Flow Control - Combined

- Combined wet/detention pond (basic treatment)
- Stormwater treatment wetland/detention pond (enhanced treatment)

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Stormwater Runoff Treatment

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Stormwater Runoff Treatment BMP Types

- Dispersion
- Infiltration
- Biofiltration
- Wet pool
- Special - oil control or phosphorus control

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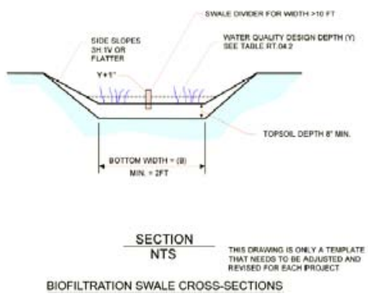
Stormwater Runoff Treatment
Biofiltration BMPs



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Stormwater Runoff Treatment
Biofiltration BMPs

- Biofiltration swale
- Wet biofiltration swale
- Continuous inflow biofiltration swale
- Ecology embankment
- Compost-amended vegetated filter strip (CAVFS)
- Vegetated filter strip

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Stormwater Runoff Treatment
Biofiltration BMPs - Advantages

- VFS and CAVFS have low capital and O&M costs
- Provide some flow control
- Good options for limited right-of-way
- Wet biofiltration swale can be used in areas with high groundwater.

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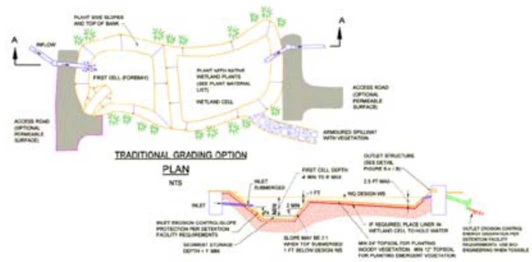
Stormwater Runoff Treatment
Wet Pool BMPs



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Stormwater Runoff Treatment
Wet Pool BMPs

- Combined wet/detention pond
- Combined stormwater treatment wetland/ detention pond
- Wet pond
- Constructed stormwater treatment wetland

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Stormwater Runoff Treatment
Wet Pool BMPs

- Not recommended for arid or semi-arid climates
- Normally can't use native wetlands
- Constructed wetland systems have higher capital and O&M costs than ponds

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Stormwater Runoff Treatment
Oil Control BMPs

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Stormwater Runoff Treatment
Oil or Phosphorus Control BMPs

- Oil containment boom
  - Boom can be placed on top of water in other sediment control BMPs
- Bioinfiltration pond (oil control)
  - Eastern Washington only
- Large wet pond (phosphorus control)

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Stormwater Runoff Treatment
Phosphorus Control BMPs

- Large wet pond

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Stormwater Flow Control

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Stormwater Flow Control BMP Types

- Dispersion
- Infiltration
- Detention

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Stormwater Flow Control Detention BMPs

- Detention pond
  - Only detention BMP listed in HRM

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Category 1: Ecology-Approved BMPs Not in HRM

- Listed in SMMWW/SMMEW
- Not for general highway use
- Require WSDOT Region Hydraulics and Maintenance Superintendent approval
- Listed on WSDOT HRM website
- Examples:
  - Sand filters
  - Proprietary filters (Ecology approved)
  - Oil/water separators
  - Vaults

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Category 2: Emerging Technologies

- Preliminary data promising
- Have not yet received a general use designation from Ecology
- Require Ecology, region Hydraulics, ESO, and Maintenance Superintendent approval
- Examples listed on WSDOT HRM website

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Category 3: Demonstrative Approach

- Encourage innovation
- Must prove that alternative provides equivalent protection
- Requires submittal and approval of proposal to Ecology prior to use
- Examples?

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BMP Authorizations

	Approval given	Approval required
Listed in the HRM	Approved by WSDOT and Ecology	None
Category 1	Approved by Ecology	Region Hydraulics and Maintenance
Category 2	A) Ecology pilot or conditional use approval	HQ ESO, Region Hydraulics, Maintenance
	B) No prior approval (designer must prepare a design thesis)	Ecology—either TAPE or QAPP
Category 3	Purely demonstrative	Ecology and WSDOT

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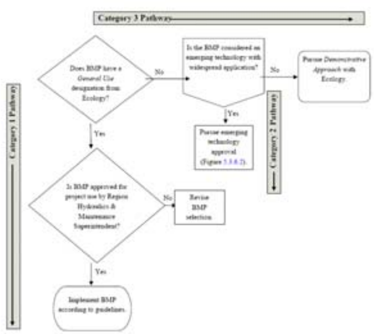
Alternative BMPs

- Follow flow chart in Figure 5.3.6.1



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Category 2 Authorization

- Follow flow chart in Figure 5.3.6.2

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Review Learning Outcomes

- Explain the suitability of the BMP types with respect to site conditions, O&M considerations
- Identify the difference between the BMPs in the HRM and the Category I, II, and III BMPs and explain their approval processes

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Lesson 3 – BMP Selection Process

• Choose appropriate BMPs
• Justify stormwater management decisions

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Learning Objectives

Understand:

- *How to locate the BMP selection flow charts in the HRM*
- *How to choose appropriate BMPs for a given set of site conditions*
- *How to justify stormwater management decisions*

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BMP Selection – Getting Started

- Review available project and area information
  - Proposed project conditions
  - Project site/area assessment
  - Applicable regulations
- Understand available BMPs and applications
- Go to HRM **Section 5-3** – begin BMP selection process

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BMP Selection

The BMP selection process is the same for eastern and western Washington

-but-

Appropriate BMPs will vary by region

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Summary – BMP Selection Process

- Part I – Determine:
  - Applicable minimum requirements
  - Project-specific conditions
- Part II – Select source control BMPs
- Part III – Determine TDA requirements for:
  - Runoff treatment
  - Flow control
- Part IV – Select flow control
- Part V – Select runoff treatment

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Part I – Determine: Applicable Minimum Requirements Project-Specific Conditions

- Chapter 3, minimum requirements
  - Project level (Tier 1)
- Other jurisdictional requirements?
- Outfall inventory, retrofitting required?

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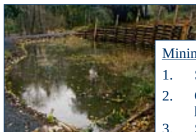
Part I – Determine: Applicable Minimum Requirements Project-Specific Conditions



Minimum Requirements

1. Stormwater planning
2. Construction stormwater pollution prevention
3. Source control
4. Preservation of natural drainage
5. Runoff treatment
6. Flow control
7. Wetland protection
8. Basin/Watershed planning
9. Operations and maintenance

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Part II – Select Source Control BMPs

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Part II – Select Source Control BMPs

- Pollution-generating activities
- Ecology's SMMWW/ SMMEW

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Part III – Determine TDA Requirements

Step A - Recall Terminology

- New impervious surface
- PGIS and PGPS
- Converted pervious surface
- Non-effective impervious surface / PGIS
- Effective impervious surface / PGIS
- Replaced impervious surface
- Equivalent area
- Threshold Discharge Area (TDA)

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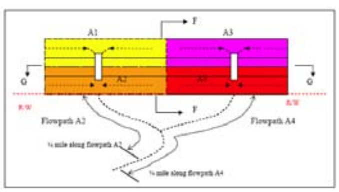
Part III – Determine TDA Requirements

For Runoff Treatment and Flow Control

Step B:
Review project thresholds; are Minimum Requirements 5 and 6 required?

Step C:
Outline the TDAs for the project site.



See **Figure 4-2a,b**

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Part III – Determine TDA Requirements

Step D:
If flow control for the project is required, determine for each TDA:

- Effective impervious surface area
- Converted pervious surface area
- Which TDAs require flow control BMPs

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Part III – Determine TDA Requirements

Step E:

If runoff treatment for the project is required, determine for each TDA:

- PGIS
- PGPS
- Which TDAs require runoff treatment BMPs

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Part IV – Select Flow Control BMPs

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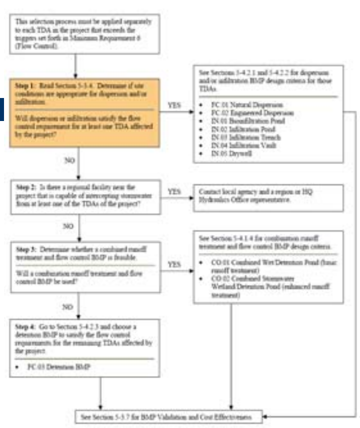
Part IV: Flow Control

Step 1 – Mitigation and management by the natural landscape or infiltration?

If yes, select

- **Dispersion**
- **Bioinfiltration**
- **Infiltration**
- **Drywells**

If no, continue to step 2



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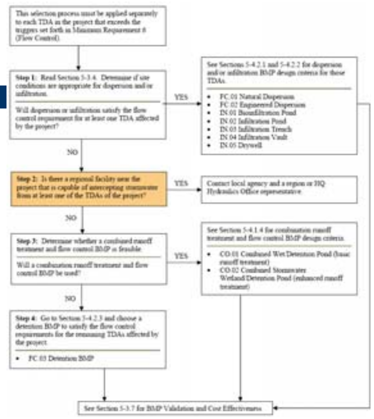
Part IV: Flow Control

Step 2 – Regional Facility

If yes, contact HQ Hydraulics

If no, continue to step 3



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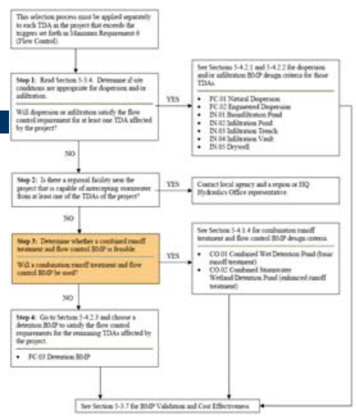
Part IV: Flow Control

Step 3 – Combined Facility

If yes, select
- Combined Wet/Detention Pond
- Combined Wetland/Detention Pond

If no, continue to step 4



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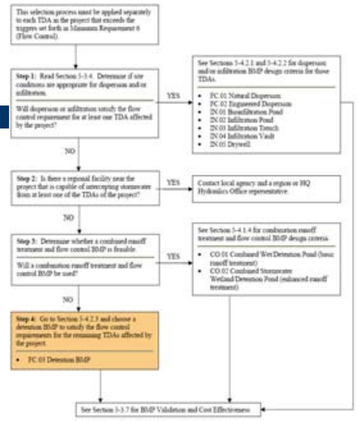
BMP Selection Part IV Flow Control

Step 4 – Choose detention pond



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Part V – Select Runoff Treatment BMPs

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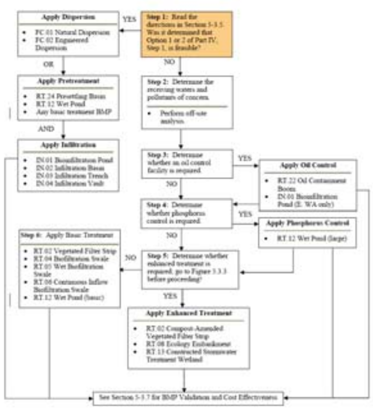
Washington State Department of Transportation

Part V: Runoff Treatment



- **Step 1:**

Was Option 1 or 2 selected in Part IV?

If yes, no further action is necessary

If no, continue on to Step 2.

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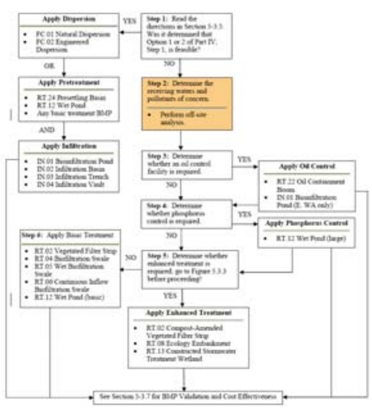
Washington State Department of Transportation

Part V: Runoff Treatment



- **Step 2:**

Determine receiving waters, possible pollutants of concern, and additional local jurisdictional requirements.

Continue on to Step 3.

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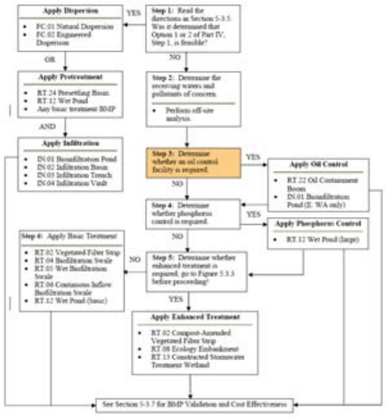
Washington State Department of Transportation

Part V: Runoff Treatment

- **Steps 3 through 5:**

Determine if additional treatment is required for:

Step 3
Oil control



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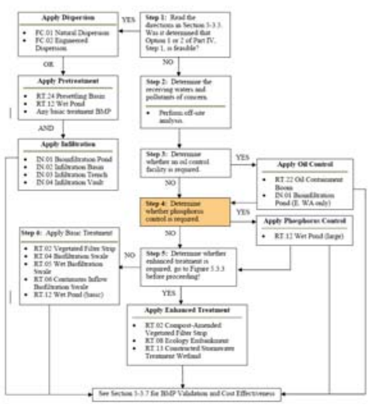
Part V: Runoff Treatment

Step 4:

Phosphorus control



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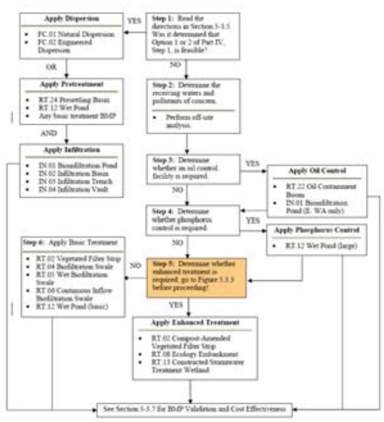
Washington State Department of Transportation

Part V: Runoff Treatment

Step 5:

Enhanced treatment



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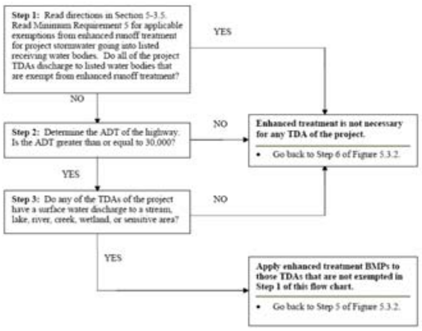
Washington State Department of Transportation

Part V: Runoff Treatment

- Is enhanced treatment required?



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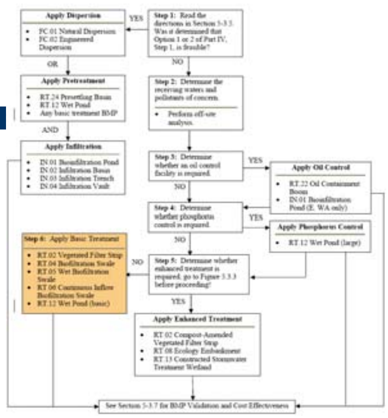
Washington State Department of Transportation

Part V: Runoff Treatment

- **Step 6:** Apply basic treatment



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Washington State Department of Transportation

Validation and Cost-Effectiveness

- General maintenance requirements
  - Design
  - Performance
  - Cost
  - Access
  - Vaults/tanks/catch basins/manholes
  - Ponds

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Washington State Department of Transportation

Group Exercise #2

- Break into groups of 3 to 4.
- Using the BMP selection process in the HRM, select flow control and runoff treatment BMPs.
- No exemptions apply.
- See page V-1 in your workbook.

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Review Learning Outcomes

- Choose appropriate BMPs using the HRM flow charts
- Justify stormwater management decisions

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Washington State Department of Transportation

Wrap-up

1

Washington State Department of Transportation

Thank You for Attending Module 4

- Summary of what we covered
- Information sources, FAQ sheets
- Important contacts
- Course evaluation

2

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Review Learning Outcomes

- List site considerations that may influence the approach to stormwater management
- Explain why each consideration is important
- Explain the purpose of the EEF
- Explain the suitability of the BMP types with respect to site conditions, O&M considerations

3

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Review Learning Outcomes

- Assess site conditions and select appropriate flow control and water quality BMPs.
- Be able to defend a BMP selection.
- Describe the difference between the BMPs in the HRM and the three alternative compliance pathways.

4

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Participant's Workbook

- Information sources
- Important contacts

5

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Thank you!

6

5. Examples

Introductory Exercise

Existing Conditions

- Linear stretch of two-lane concrete, 600 feet in length.
- Two 12-foot lanes (14,400 square feet impervious surface)
- Two 6-foot asphalt shoulders (7,200 square feet impervious surface)
- Grass adjacent to the shoulders.

Proposed Conditions

- Add 12-foot concrete lane in each direction (14,400 square feet impervious surface)
- Add two 4-foot shoulders (4,800 square feet impervious surface)
- Add curb, gutter, and 6-foot sidewalks on each side (7,200 square feet)
- Proposed average daily traffic (ADT) is 35,000 vehicles per day.

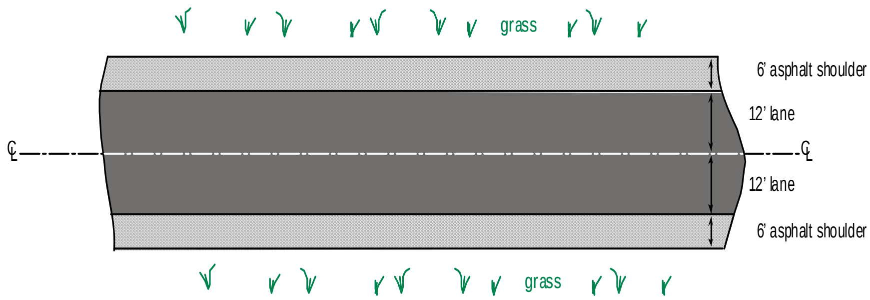
Project Assumptions

- Roadway gradient less than 4 percent
- Project has one threshold discharge area (TDA)
- After runoff leaves the WSDOT right-of-way, it enters an unnamed tributary that flows 3 miles before its confluence with an upper reach of the Yakima River
- Type A soils
- Depth to groundwater is greater than 100-feet
- Vegetation within the 150-foot right-of-way is shrub and grass.

Assume both flow control and enhanced runoff treatment is necessary for this project. What are the most appropriate BMP choices?

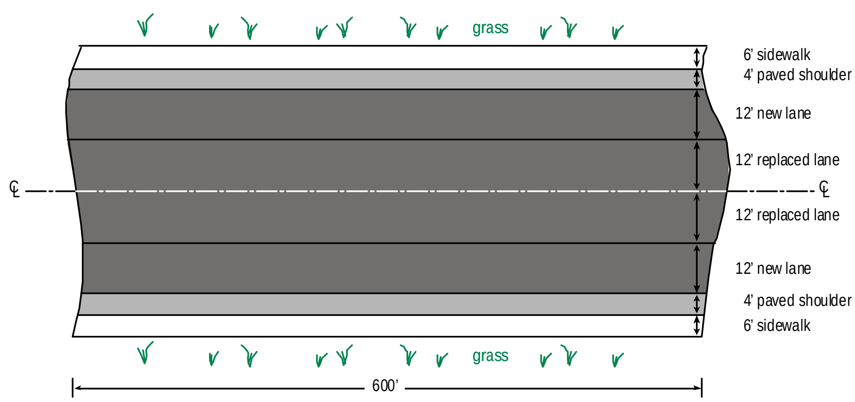
Existing Conditions

Figure V.1



Proposed Conditions

Figure V.2



Example A: US Route (US) 195 Road Widening

The primary purposes of this example project are:

- To illustrate how site conditions can warrant more complex BMP design
- To educate through hands-on examples how to use the Section 5.3 flow charts and tables to choose the most appropriate BMP for a project
- To instill an understanding of the benefits and importance of thoughtful BMP selection.

This example will summarize the steps that should be taken in approaching BMP selection for a project, the information and variables that should be considered, and the impact this has on the stormwater design. This example also intends to underscore the point that stormwater design cannot be limited to providing conveyance to route runoff away from the roadway; there are many other variables that must be considered and doing so at the proper stage in the design effort will save the project time and money.

Note: these examples are for instructional use only and do not provide design-level guidance, nor should they be used as a reference for future work.

<u>Introduction and Background Information</u>: This section outlines the information necessary to complete the example.

Project Description – US 195 Road Widening

The Washington State Department of Transportation (WSDOT) is progressing on plans for construction to widen 0.9 miles of northbound US 195 from West Thorpe Road to the I-90 interchange near Spokane.

- The existing US 195 roadway is a divided highway with two 12-foot travel lanes in each direction and paved shoulders, covering a total roadway length of 0.9 miles.
- This project will widen US 195 in the northbound direction near the I-90 interchange to three 12-foot travel lanes and a 10-foot paved shoulder.
- Traffic volumes in this area approach 35,000 vehicles per day.

The WSDOT right-of-way extends outward approximately 100 feet on either side of US 195. The right-of-way is primarily shrub and grass on both sides of the highway, and the land within the right-of-way will be protected from future development.

A vicinity map is shown in Handout Figure A-1. The US 195 project corridor is shown in Handout Figure A-2 and the roadway profile is shown in Handout Figure A-3.

Water Resource Overview

The entire project is within the Latah Creek drainage basin (Handout Figure A-4). All runoff from the project site area ultimately flows east into Latah Creek via a ditch system that runs along both sides of the highway. Latah Creek drains into the Spokane River approximately 1 mile downstream of the project site.

- An unnamed tributary of Latah Creek passes under US 195 near Station 44+60. This stream flows year-round.
- There are no wetlands in the project area.
- Due to the hydrology and climate of the area, it may be difficult to design a successful wet pond; there is not a constant supply of water through the year and evaporation is a concern.

  There is a detention pond that was constructed as a part of the I-90 interchange project. If necessary, this pond has the capacity to detain flows from TDA 1.
- Latah Creek has been identified by the Department of Ecology as not achieving state water quality standards for:

-fecal coliform bacteria	-ammonia
-dissolved oxygen	-pH
-turbidity	-temperature

- In 2005, the Latah Creek Water Resources Management Plan was finished, adopted by both Spokane and Whitman Counties, and approved by Ecology. The plan also identifies phosphorus as a pollutant of concern.

Receiving Waters Characterization

The project area was divided into one threshold discharge area (TDA).

The project's TDA is delineated in Handout Figure A-5. Latah Creek's 100-year floodplain is shown in Handout Figure A-6.

Environmental Considerations

- Rainbow trout were found both upstream and downstream of the US 195 project area in Latah Creek. Few anadromous salmon or salmonid species aside from rainbow trout can be found within the project vicinity.

- The project biologist has determined that Latah Creek is fish bearing and per Spokane Critical Areas regulations will require a 75-foot vegetated buffer. The unnamed tributary is not fish bearing and will require a 25-foot buffer.

- The project is within 10,000 feet of Spokane International Airport. The airport's hazardous wildlife biologist stated that no special action would be necessary for this project so long as no facility had standing surface water for more than 48 hours.

Slopes, Soils, and Infiltration

Information collected by the geotechnical team indicates:

- There are no steep slopes (greater than 40 percent) adjacent to or near the US 195 project area.
- The predominant soils in the project corridor are classified as Anders-Kuhl complex and Kuhl cobbly silt loam (hydrologic group A).
- Assume slopes within the right-of-way are no greater than 12 percent.
- The soils do not have characteristics which allow infiltration to be used for runoff treatment.
- Handout Figure A-7 is a map of all soil types in the project vicinity.

Groundwater Conditions

The Spokane Valley-Rathdrum Prairie Aquifer is in the project vicinity and is the sole-source of drinking water for more than 500,000 people in Idaho and Washington (Handout Figure A-8).

Drinking water withdrawals from the aquifer occur less than 1 mile downstream of the project site. Consultation with the local groundwater authority is recommended for any BMP design that will have direct or incidental infiltration.

The local contact for U.S. Environmental Protection Agency (U.S. EPA) Region 10 and a Spokane County representative for sole-source aquifer issues stated that infiltration of runoff would be acceptable in areas within the groundwater protection area as long as enhanced runoff treatment is accomplished prior to infiltration.

The water table is approximately 100 to 500 feet below the ground surface.

Cultural Resources

There are no identified cultural or historic resources in the project area.

Project Conditions and BMP Selection Process (HRM Section 5-3)

The US 195 project corridor is divided into a single TDA. BMPs will be selected for this TDA.

- TDA 1 extends from Station 0+00 to the end of project at Station 47+10.
- Runoff from the south half of the project sheet flows from each lane and is collected in roadside ditches to the east and to the west of the highway. At the intersection of US 195 and West Thorpe Road, the west roadside ditch enters a culvert passing under the interchange, and combines with flows from the east roadside ditch. The combined flows are conveyed to Latah Creek via an unnamed drainage ditch.
- Similarly, runoff from the north half of the project sheet flows from each lane and is collected in roadside ditches to the east and to the west of the highway. Flow from the west roadside ditch enters an unnamed tributary near the I-90 interchange before it crosses under US 195. Flow from the east roadside ditch enters the unnamed tributary just after it crosses under US 195.
- Via the shortest flowpath, runoff from the north half and south half combine at a distance less than ¼ mile. Therefore, this project has a single TDA.

Workbook Table A-1 was developed for determining the applicable minimum requirements. These values are also necessary for BMP selection.

Workbook Table A-1. Surface areas within the US 195 project corridor.

	Existing Impervious Surface/ PGIS (acres)	New Impervious Surface (acres)	Replaced Impervious Surface (acres)	Effective Impervious Surface (acres)	New PGIS (acres)	Converted Pervious Surface (acres)	PGPS (acres)
TDA 1	8.90	2.15	0.52		2.15	0	0
Totals for Project	8.90	2.15	0.52		2.15	0	0

1 acre = 43,560 square feet. 5,000 square feet = 0.11 acres.

Part I: Determination of Applicable Minimum Requirements and Project-Specific Considerations

BMP Selection: This section outlines the BMP selection process as described in Section 5-3 in the HRM.

Using HRM Figures 3.1 determine what minimum requirements are required for the project.

Circle the correct assumptions below:

- Do minimum requirements 1-4 apply to the new and replaced impervious surfaces and disturbed land? Yes/No
- Do minimum requirements 5-9 apply to the new impervious surfaces and converted pervious surfaces? Yes/No
- Do minimum requirements 5-9 apply to the replaced impervious surfaces? Yes/No

Part II: Selection of Source Control BMPs

List activities and/or facilities that may require source control BMPs (see Section 8.3 of the Stormwater Management Manual for Eastern Washington included in Workbook Section 6):

Part III: Determine Runoff Treatment and Flow Control Requirements for the Two TDAs

Step A: Review definitions (write a summary of the terms):

- Effective impervious surface:
- Non-effective impervious surface:
- Replaced impervious surface:
- Pollution-generating impervious surface (PGIS):
- Pollution-generating pervious surface (PGPS):
- Converted pervious surface:
- Threshold discharge area (TDA):

Part III: Determine Runoff Treatment and Flow Control Requirements for the Two TDAs (continued)

Step B: Check Step 1 in HRM Section 3-3.6.3 and Step 1 in HRM Section 3-3.5.3

These are the project-level thresholds defined in Chapter 3 of the HRM. If the threshold is exceeded, proceed to Step C.

Minimum Requirement 6: Project level

The US 195 project **does/does not** add over 5,000 square feet of new impervious surfaces➔Minimum Requirement 6 **does/does not** apply to the new impervious surfaces in the Latah Creek basin.

and

The US 195 project **does/does not** add greater than 50 percent to the existing impervious surface area➔Minimum Requirement 6 **does/does not** apply to the replaced impervious surfaces in the Latah Creek basin.

Minimum Requirement 5: Project level

The US 195 project **does/does not** add over 5,000 square feet of new PGIS➔Minimum Requirement 5 **does/does not** apply to the new impervious surfaces in the Latah Creek basin.

and

The US 195 project **does/does not** add greater than 50 percent of the existing PGIS area➔Minimum Requirement 5 **does/does not** apply to the replaced PGIS in the Latah Creek basin.

Step C: Outline TDAs

TDAs for the US 195 Phase II widening have already been delineated. TDA limits are shown in Handout Figure A-5. BMPs will be selected and designed for this TDA.

***Part III:* Determine Runoff Treatment and Flow Control Requirements for the Two TDAs (continued)**

Step D: For flow control, determine the area of effective impervious surfaces and converted impervious surfaces in TDA 1. Refer to and complete Workbook Table A-1.

- Effective impervious surface TDA 1=

  ____

- Converted pervious surface TDA 1=

  ____

Compare the above values to Minimum Requirement 6 for flow control (fill in your answers or circle the correct answer below):

- Does TDA 1 discharge to a flow control exempt surface water? Refer to HRM Table 3-5.

  ____

<u>Minimum Requirement 6: TDA level for **TDA 1**</u>

The project **does/does not** add over 10,000 square feet of effective impervious surface to TDA 1

Therefore,

Minimum Requirement 6 **does/does not** apply to the effective impervious surfaces and converted pervious surfaces in TDA 1.

Step E: For runoff treatment, determine the area of effective PGIS and PGPS for TDA 1.

- Effective PGIS TDA 1=

  ____

- PGPS TDA 1=

  ____

Part III: Determine Runoff Treatment and Flow Control Requirements for the Two TDAs (continued)

Compare to Minimum Requirement 5 for runoff treatment (fill in your answers or circle the correct answer below):

Minimum Requirement 5: TDA level for **TDA 1**

The project **does/does not** add over 5,000 square feet of effective PGIS to TDA 1

Therefore,

Minimum Requirement 5 **does/does not** apply to the effective PGIS in TDA 1.

Part IV: Selection of Flow Control BMPs

In Part IV, flow control BMPs will be selected. Once a BMP is selected for each TDA, proceed to Part V. Fill in your answers in the space provided: Refer to HRM Figure 5.3.1.

Step 1: Determine whether stormwater mitigation and management can be handled by the natural landscape or infiltration. If any of the three options are selected, proceed to Part V.

- **Option 1: Dispersion**

  Would dispersion, either natural or engineered, be applicable for use in TDA 1? Why or why not? Refer to HRM Section 5-4.2.2.

  ____

  ____

  Describe the siting criteria for natural dispersion:

  ____

  ____

  Describe the site considerations for engineered dispersion areas:

  ____

  ____

- **Option 2: Infiltration**

  Would infiltration for flow control and runoff treatment be applicable in TDA 1 and/or TDA 2? Why or why not? Refer to HRM Section 5-4.2.1.

  ____

  ____

  Site requirements for flow control and runoff treatment infiltration facilities include:

  ____

  ____

Part IV: Selection of Flow Control BMPs (continued)

- **Option 3: Infiltration for flow control**

  Would infiltration for only flow control be applicable in TDA 1? Why or why not? Refer to HRM Section 5-4.2.1.

  ____

  ____

  Site requirements for flow control infiltration facilities areas include:

  ____

  ____

Step 2: Determine whether a regional detention facility is near or within the project limits.

If a regional stormwater flow control is feasible and stormwater discharge is approved, proceed to Part V.

Step 3: Can a combined flow control and runoff treatment facility be designed? Why or why not? Refer to HRM Section 5-4.1.4.

If a combined flow control and runoff treatment facility can be designed for the project, proceed to Part V to determine associated water quality treatment requirements.

____

____

Step 4: Select a detention BMP for TDA 1. Defend your selection. Refer to HRM Figure 5.4.2.3.

____

____

Part V: Selection of Runoff Treatment BMPs

In Part V, runoff treatment BMPs will be selected. Once a BMP is selected, proceed to Part VI. Fill in your answers in the space provided. Refer to HRM Figure 5.3.2.

Do any of the TDAs directly discharge to a basic treatment water body? Refer to HRM Table 3-2.

____

Step 1: Was Option 1 or 2 of Part IV, Step 1 chosen for TDA 1?

If Option 1 or 2 was chosen for TDA 1, no further steps for that TDA are necessary. If this is the case, proceed to Part VI. If not, proceed to Step 2.

____

Step 2: Determine the receiving waters, possible pollutants of concern, and any additional local jurisdictional requirements for the project.

Consider the receiving waters, groundwater, and/or total maximum daily loads (TMDLs).

____

____

Step 3: Determine if oil control is required for the project. Refer to HRM Table 3-1.

If so, select an oil control BMP and proceed to Step 4.

____

Step 4: Determine if phosphorus control is required for the project. Refer to HRM Table 3-1.

If so, select a phosphorus control BMP and proceed to Step 5.

____

Part V: Selection of Runoff Treatment BMPs (continued)

Step 5: Determine if enhanced treatment is required for the project. Refer to HRM Figure 5.3.3.

If so, select an enhanced treatment facility for TDA 1. Refer to HRM Table 3-1. If a combined flow control/runoff treatment facility is selected, describe it here. If enhanced treatment is not necessary, proceed to Step 6.

____

____

Step 6: Select a basic treatment facility for TDA 1.

Explain your selection. If a combined flow control/runoff treatment facility is selected, describe it here.

____

____

Part VI: BMP Validation and Cost-Effectiveness

Summarize the O&M and siting considerations for the selected BMP. Refer to HRM Table 5.3.1.

____

____

____

What If??

Describe how the BMP selection would change if:

- The groundwater protection area was that shown in Figure A-8a.

- Absolutely no infiltration was permitted within the groundwater protection area.

STOP

Example B: State Route (SR) 112 Replacement

The primary purposes of this example project are:

- To illustrate how site conditions can warrant more complex BMP design
- To educate through hands-on examples how to use the HRM Section 5.3 flow charts and tables to choose the most appropriate BMP for a project
- To instill an understanding of the benefits and importance of thoughtful BMP selection.

This example will summarize the steps that should be taken in approaching BMP selection for a project, the information and variables that should be considered, and the impact these have on the stormwater design. This example intends to also underscore the point that stormwater design cannot be limited to providing conveyance to route runoff away from the roadway; there are many other variables that must be considered, and doing so at the proper stage in the design effort will save the project time and money.

Note: these examples are for instructional use only and do not provide design-level guidance, nor should they be used as a reference for future work.

Introduction and Background Information: This section outlines the information necessary to complete the example.

Project Description – SR 112 Replacement

The Washington State Department of Transportation (WSDOT) is progressing on plans for construction to update and widen 1.7 miles of eastbound and westbound SR 112 from MP 28.1 to MP 29.8 on the Olympic Peninsula.

- The existing SR 112 roadway is an undivided highway with one 12-foot travel lane in each direction and two 4-foot gravel shoulders.
- The road will be crowned.
- The entire roadway will be removed and replaced to maintain safety through out this corridor.
- The existing roadway prism will be expanded to include two 12-foot lanes, two paved 4-foot bike lanes, and two 6-foot paved shoulders.
- Traffic volumes in this area are, on average, under 10,000 vehicles per day.
- WSDOT right-of-way extends approximately 200 feet beyond the SR 112 prism. The right-of-way is primarily forested on both sides of the highway and the land within the right-of-way will be protected from future development.

A vicinity map is shown in Handout Figure B-1. The SR 112 project corridor is shown in Handout Figure B-2 and the roadway profile is shown in Handout Figure B-3.

Water Resource Overview

The principal waterways within the project limits are the Pysht River and the Strait of Juan de Fuca.

- The Pysht River and tributaries in the project area are tidally influenced.
- Runoff from the western two-thirds of the site sheet flows from the highway and is collected in shallow drainage ditches, which discharge to the Pysht River.
- Runoff from the eastern one-third of the site sheet flows into roadside ditches and meets the unnamed tributaries after they cross under the highway.
- There are no basin plans or TMDLs for the Pysht River.

Handout Figure B-4 shows the surface water features, wetlands, and drainage paths.

Receiving Waters Characterization

Existing drainage within the project area occurs in roadside ditches and natural drainage channels.

- The project's TDAs are delineated in Handout Figure B-5.
- MGSFlood model results show a greater than 0.1 cfs increase in flow for the 100-year recurrence interval flow for TDAs 1 and 2 and less than a 0.1 cfs increase in flow for the 100-year recurrence interval flow for TDA 3.
- Over half of the project area lies within the Pysht River's 100-year floodplain as shown in Handout Figure B-6.

Environmental Considerations

Surveys indicate the Pysht River supports four species of anadromous fish: steelhead trout, and coho, chinook, and chum salmon.

- Chinook utilize the Pysht River for spawning and rearing habitat.
- The project biologist has determined that the Pysht River and Strait of Juan de Fuca are shorelines of the state (Type 1 waters), which will require 150-foot vegetated buffers.
- Both unnamed tributaries are non-fish bearing (Type 4) and require 50-foot buffers.

Slopes, Soils, and Infiltration

The dominant soil type in the project area is Ozette Silt Loam. Soils in the Queets and Tealwhit series are also present. Soils are shown in Handout Figure B-7.

- The permeability of these soils is moderate to slow.
- The soils exhibit medium runoff rates.
- There are no steep slopes (over 40 percent) within the project area.
- Slopes within the right-of-way are no greater than 14 percent.
- For the purposes of stormwater runoff calculations, the Ozette and Queets soils are in hydrologic group C, and the Tealwhit soils are in hydrologic group D.

Groundwater Conditions

Groundwater in this project area is extremely shallow. Handout Figure B-8 shows the seasonal high depth to groundwater through the project corridor. The area is not over a sole-source aquifer or in a wellhead protection area.

Cultural Resources

There may be cultural resources located in the project area. Though surveys were conducted for this and previous projects though the corridor and no artifacts were found, historical records indicate that the land was previously occupied and artifacts may exist below grade.

Project Conditions and BMP Selection Process (HRM Section 5-3)

The SR 112 project corridor is divided into 3 TDAs. BMPs will be selected for the entire project. TDA 1 extends from Station 0+00 to Station 51+30, TDA 2 runs from Station 51+30 to Station 82+90, and TDA 3 runs from Station 82+90 to the end of project at Station 90+15. TDAs are bound between these stations by the WSDOT right-of-way.

- TDA 1 is defined by the runoff flowing off the roadway and into the shallow drainage ditches adjacent to the highway. From Station 0+00 to Station 22+40, runoff flows through a shallow ditch system on the south side of the highway and into the Pysht River. From Station 22+40 to Station 37+00, runoff flows in a shallow roadside ditch where it meets flow from the roadside ditches along SR 112 up to Station 51+30. The flows combine within one-quarter mile via the shortest flow path making this entire drainage system one TDA.

- TDA 2 drains to the unnamed tributary that crosses SR 112 at Station 57+00. This TDA also has two outlets, but again, they combine within one-quarter mile and define the area as one TDA. Flows from between Station 51+30 and Station 66+00 flow downgradient to Station 57+00 and there they discharge into the unnamed tributary. Flows from SR 112 between Stations 66+00 and 82+90 flow down gradient toward Station 71+00. There they exit the WSDOT right-of-way and flow northwest down a drainage gully/groundwater seep. This gully meets the unnamed tributary within one-quarter mile of leaving the right-of-way; once flows combine, they flow less than one-half mile to the Strait of Juan de Fuca.

- TDA 3 drains to the second unnamed tributary and encompasses the area between Station 82+90 and 90+15. Runoff from this TDA flows less than 1,000 feet before discharging to the Strait of Juan de Fuca.

The following table was developed for determining the minimum requirements. These values are also necessary for BMP selection and design.

Project Conditions and BMP Selection Process (HRM Section 5-3) (continued)

Workbook Table B-1. Surface areas within the SR 112 project corridor.

	Existing Impervious Surface/ PGIS (acres)	New Impervious Surface (acres)	Replaced Impervious Surface (acres)	Effective Impervious Surface (acres)	New PGIS (acres)	Converted Pervious Surface (acres)	PGPS (acres)
TDA 1	3.77	1.41	3.77		1.41	0	0
TDA 2	2.32	0.87	2.32		0.87	0	0
TDA 3	0.54	0.20	0.54		0.20	0	0
Totals for Project	6.63	2.48	6.63		2.48	0	0

1 acre = 43,560 square feet. 5,000 square feet = 0.11 acres.

Part I: Determine Applicable Minimum Requirements and Project-Specific Considerations

BMP Selection Process: This section outlines the BMP selection process as described in HRM Section 5-3.

Using HRM Figure 3.1 determine what minimum requirements are required for the project.

Circle the correct assumptions below:

- Do minimum requirements 1-4 apply to the new and replaced impervious surfaces and land disturbed? Yes/No
- Do minimum requirements 5-9 apply to the new impervious surfaces and converted pervious surfaces? Yes/No
- Do minimum requirements 5-9 apply to the replaces impervious surfaces? Yes/No

Part II: Select Source Control BMPs

List activities and/or facilities that may require source control BMPs (see Section 2.2 of Volume IV of the *Stormwater Management Manual for Western Washington*. This is included in Section 6 of this workbook):

____

____

Part III: Determine Runoff Treatment and Flow Control Requirements for TDAs

Step A: Review definitions (write a summary of the following terms):

- Effective impervious surface:
- Non-effective impervious surface:
- Replaced impervious surface:
- Pollution-generating impervious surface (PGIS):
- Pollution-generating pervious surface (PGPS):
- Converted pervious surface:
- Threshold discharge area (TDA):

Part III: Determine Runoff Treatment and Flow Control Requirements for TDAs (continued)

Step B: Check Step 1 in HRM Section 3-3.6.3 and Step 1 in HRM Section 3-3.5.3

These are project-level thresholds. If the threshold is exceeded, proceed to Step C.

<u>Minimum Requirement 6: Project level</u>

The SR 112 project **does/does not** add over 5,000 square feet of new impervious surfaces➔Minimum Requirement 6 **does/does not** apply to the new impervious surfaces in the project corridor.

and

The SR 112 project **does/does not** add greater than 50 percent to the existing impervious surface area➔Minimum Requirement 6 **does/does not** apply to the replaced impervious surfaces in the project corridor.

<u>Minimum Requirement 5: Project level</u>

The SR 112 project **does/does not** add over 5,000 square feet of new PGIS➔Minimum Requirement 5 **does/does not** apply to the new impervious surfaces in the project area.

and

The SR 112 project **does/does not** add greater than 50 percent of the existing PGIS area➔Minimum Requirement 5 **does/does not** apply to the replaced PGIS in the project area.

Step C: Outline TDAs

TDAs for the SR 112 replacement have already been delineated. All TDAs are shown in Figure B-5. BMPs will be selected for all three TDAs.

Part III: Determine Runoff Treatment and Flow Control Requirements for TDAs (continued)

Step D: For flow control, determine the area of effective impervious surfaces and converted impervious surfaces in TDA 1, TDA 2, and TDA 3. Refer to Workbook Table 4C-1.

- Effective impervious surface TDA 1=

  ____

- Converted pervious surface TDA 1=

  ____

- Effective impervious surface TDA 2=

  ____

- Converted pervious surface TDA 2=

  ____

- Effective impervious surface TDA 3=

  ____

- Converted pervious surface TDA 3=

  ____

Compare to Minimum Requirement 6 for flow control (fill in your answers or circle the correct answer below):

- Does TDA 1 discharge to a flow control exempt surface water? Refer to HRM Table 3-5.

  ____

- Does TDA 2 discharge to a flow control exempt surface water? Refer to HRM Table 3-5.

  ____

- Does TDA 3 discharge to a flow control exempt surface water? Refer to HRM Table 3-5.

  ____

Part III: Determine Runoff Treatment and Flow Control Requirements for TDAs (continued)

<u>Minimum Requirement 6: TDA level for **TDA 1**</u>

The project **does/does not** add over 10,000 square feet of effective impervious surface to TDA 1

—or—

The project **does/does not** convert ¾ acre of native vegetation to lawn or landscaped area in TDA 1

—or—

For TDA 1, MGSFlood model results **do/do not** show a greater than 0.1 cfs or more increase in the 100-year recurrence interval flow.

Therefore,

Minimum Requirement 6 **does/does not** apply to the effective impervious surfaces and converted pervious surfaces in TDA 1.

<u>Minimum Requirement 6: TDA level for **TDA 2**</u>

The project **does/does not** add over 10,000 square feet of effective impervious surface to TDA 2

—or—

The project **does/does not** convert ¾ acre of native vegetation to lawn or landscaped area in TDA 2

—or—

For TDA 2, MGSFlood model results **do/do not** show a greater than 0.1 cfs or more increase in the 100-year recurrence interval flow.

Therefore,

Minimum Requirement 6 **does/does not** apply to the effective impervious surfaces and converted pervious surfaces in the TDA 2.

Part III: Determine Runoff Treatment and Flow Control Requirements for TDAs (continued)

Minimum Requirement 6: TDA level for **TDA 3**

The project **does/does not** add over 10,000 square feet of effective impervious surface to TDA 3

—or—

The project **does/does not** convert ¾ acre of native vegetation to lawn or landscaped area in TDA 3

—or—

For TDA 3, MGSFlood model results **do/do not** show a greater than 0.1 cfs or more increase in the 100-year recurrence interval flow.

Therefore,

Minimum Requirement 6 **does/does not** apply to the effective impervious surfaces and converted pervious surfaces in TDA 3.

Step E: For runoff treatment, determine the area of effective PGIS and PGPS for TDA 1, TDA 2, and TDA 3.

- Effective PGIS TDA 1=

  ____

- PGPS TDA 1=

  ____

- Effective PGIS TDA 2=

  ____

- PGPS TDA 2=

  ____

- Effective PGIS TDA 3=

  ____

- PGPS TDA 3=

  ____

Part III: Determine Runoff Treatment and Flow Control Requirements for TDAs (continued)

Compare to Minimum Requirement 5 requirements for runoff treatment (fill in your answers or circle the correct answer below):

Minimum Requirement 5: TDA level for **TDA 1**

The project **does/does not** add over 5,000 square feet of effective PGIS to TDA 1

—or—

The project **does/does not** add ¾ acre of PGPS in TDA 1.

Therefore,

Minimum Requirement 5 **does/does not** apply to the effective PGIS in TDA 1.

Minimum Requirement 5: TDA level for **TDA 2**

The project **does/does not** add over 5,000 square feet of effective PGIS to TDA 2

—or—

The project **does/does not** add ¾ acre of PGPS in TDA 2.

Therefore,

Minimum Requirement 5 **does/does not** apply to the effective PGIS in TDA 2.

Minimum Requirement 5: TDA level for **TDA 3**

The project **does/does not** add over 5,000 square feet of effective PGIS to TDA 3

—or—

The project **does/does not** add ¾ acre of PGPS in TDA 3

Therefore,

Minimum Requirement 5 **does/does not** apply to the effective PGIS in TDA 3.

Part IV: Select Flow Control BMPs

In Part IV, flow control BMPs will be selected. Once a BMP is selected for each TDA, proceed to Part V. Fill in your answers in the space provided. Refer to HRM Figure 5-3.1.

Step 1: Determine whether stormwater mitigation and management can be handled by the natural landscape or infiltration for any of the TDAs. If any of the three options are selected, proceed to Part V for that TDA.

- **Option 1: Dispersion**

  Would dispersion, either natural or engineered be applicable for use in TDA 1? Would it be applicable in TDA 2? TDA 3? Why or why not? Refer to HRM Section 5-4.2.2.

  ____

  ____

  ____

  Describe the siting criteria for natural dispersion:

  ____

  ____

  Describe the site considerations for engineered dispersion areas:

  ____

  ____

- **Option 2: Infiltration**

  Would infiltration for flow control and runoff treatment be applicable in TDA 1 and/or TDA 2 or 3? Why or why not? Refer to HRM Section 5-4.2.1.

  ____

  ____

  ____

  Site requirements for flow control and runoff treatment infiltration facilities include:

  ____

  ____

Part IV: Select Flow Control BMPs (continued)

- **Option 3: Infiltration for flow control**

  Would infiltration for only flow control be applicable in TDA 1, TDA 2, or TDA 3? Why or why not? Refer to HRM Section 5-4.2.1.

  ____

  ____

  ____

  Site requirements for flow control infiltration facilities include:

  ____

  ____

If infiltration or dispersion is chosen, proceed to Part V.

Step 2: Determine whether a regional detention facility is near or within the project limits.

There is not a regional facility in the area.

If a regional stormwater flow control is feasible and stormwater discharge is approved, proceed to Part V.

Step 3: Can a combined flow control and runoff treatment facility be designed for the TDAs? Why or why not? Refer to HRM Section 5-4.1.4.

____

____

If a combined flow control and runoff treatment facility can be designed for the project, proceed to Part V.

Step 4: Select a detention BMP for TDA 1, TDA 2, and TDA 3. Defend your selection. Refer to HRM Section 5-4.2.3.

____

____

____

Part V: Select Runoff Treatment BMPs

In Part V, runoff treatment BMPs will be selected. Once a BMP is selected for each TDA, proceed to Part VI. Fill in your answers in the space provided. Refer to HRM Figure 5.3.2.

- Do any of the TDAs discharge to a basic treatment surface water? Refer to HRM Table 3-2.

____

Step 1: Was Option 1 or 2 of Part IV, Step 1 chosen for any of the TDAs?

- If Option 1 or 2, was chosen for TDA 1 or TDA 2, no further steps for that TDA are necessary. If this is the case, proceed to Part VI. If not, proceed to Step 2.

____

Step 2: Determine the receiving waters, possible pollutants of concern, and any additional local jurisdictional requirements for the project.

- Consider the receiving waters, groundwater, and/or TMDLs.

____

____

____

Step 3: Determine if oil control is required for the project. Refer to HRM Table 3-1.

- If so, select an oil control BMP and proceed to Step 4.

____

Step 4: Determine if phosphorus control is required for the project. Refer to HRM Table 3-1.

- If so, select a phosphorus control BMP and proceed to Step 5.

____

Part V: Select Runoff Treatment BMPs (continued)

Step 5: Determine if enhanced treatment is required for the project. Refer to HRM Figure 5.3.3.

- If so, select an enhanced treatment facility for TDA 1 and TDA 2. Refer to HRM Table 3-1. If a combined flow control/runoff treatment facility is selected, describe it here. If enhanced treatment is not necessary, proceed to Step 6.

____

____

Step 6: Select a basic treatment facility for TDA 1, TDA2, and TDA 3.

- Explain your selection. If a combined flow control/runoff treatment facility is selected describe it here.

____

____

____

Part VI: BMP Validation and Cost-Effectiveness

Summarize the O&M and siting considerations for the selected BMP. Refer to HRM Table 5.3.1.

What if??

Describe how the BMP selection would change if:

- Flows from TDA 1 were discharged to wetlands instead of the Pysht River.

  ____

  ____

  ____

  ____

- Groundwater throughout the entire project area was less than 3 feet from the surface.

  ____

  ____

  ____

  ____

STOP

Example C: Interstate 405 (I-405) Kirkland Nickel Project

The primary purposes of this example project are:

- To illustrate how site conditions can warrant more complex BMP design.
- To educate through hands-on examples how to use the HRM Section 5-3 flow charts and tables to choose the most appropriate BMP for a project.
- To instill an understanding of the benefits and importance of thoughtful BMP selection.

This example will summarize the steps that should be taken in approaching BMP selection for a project, the information and variables that should be considered, and the impact this has on the stormwater design. This example intends also to underscore the point that stormwater design cannot be limited to providing conveyance to route runoff away from the roadway; there are many other variables that must be considered, and doing so at the proper stage in the design effort will save the project time and money.

Note: These examples are for instructional use only and do not provide design-level guidance, nor should they be used as a reference for future work.

Introduction and Background Information: This section outlines the information necessary to complete the example.

Project Description - I-405 Kirkland Nickel Project

I-405 is the second-most traveled corridor in Washington carrying over 600,000 people and averaging up to 12 hours of gridlock every day. This exercise will evaluate the plans to add one lane in each direction in the Kirkland area, between SR 520 and SR 522.

- The project extends from the on- and off-ramps on the north side of the I-405 interchange with SR 520, north along the I-405 corridor, and ends at approximately the on- and off-ramps on the south side of the I-405 interchange with SR 522.
- The proposed improvements generally consist of the addition of one 12-foot southbound lane with a 10-foot shoulder through most of the project area, and one 12-foot northbound lane with a 10-foot shoulder through roughly half of the area.
- The WSDOT right-of-way in this area is limited and currently exists as urban/developed land. The existing adjacent land is developed is cannot be protected from future development.
- A vicinity map is shown in Handout Figure C-1. The project corridor is shown in Handout Figure C-2 and a roadway profile is shown in Handout Figure C-3.

Water Resource Overview

The Kirkland Nickel project corridor is bound by Lake Washington to the west and the foothills of the Cascade Mountains to the east. The project is located in the lower elevations of the Lake Washington watershed, and intersects a number of contributing rivers, streams, and smaller tributaries including Forbes Creek, Juanita Creek, and the Sammamish River (see Handout Figure C-4).

Receiving Waters Characterization

- The Kirkland Nickel project spans four watershed basins: Lake Washington, Forbes Creek, Juanita Creek, and the Sammamish River.
- Due to the number of TDAs through the project area (18), BMP analysis will only be performed for one TDA in the Sammamish River basin.
- Three floodplains have been identified in the I-405 Kirkland segment. The floodplains are delineated in Handout Figure C-5.
- MGSFlood modeling shows the additional impervious surface increases the 100-year flow by at least 0.1 cfs in each TDA.

Environmental Considerations

- The project biologist has determined that the Sammamish River is a shoreline of the state (i.e., Type S water), which will require a 100-foot vegetated buffer.

- According to the local code, all other streams in the project area are Class A streams (i.e., fish bearing) and require 75-foot buffers.

- The project biologist has concluded there are no wetlands within the WSDOT right-of-way throughout the project corridor.

- The following species have been documented in the project area:

  -chinook salmon
  -bull trout
  -coho salmon
  -sockeye salmon
  -cutthroat trout
  -mountain whitefish
  -steelhead trout

- In addition, the project area lies within the recognized and court-affirmed treaty fishing areas of the federally recognized Muckleshoot Tribe, whose staff of fisheries biologists has taken an active role in managing salmon in the area.

Slopes, Soils, and Infiltration

The geotechnical analysis reports that the most prevalent soil type is Kitsap Silt Loam. This is a gravelly, sandy loam that forms on glacial till.

- The permeability is relatively rapid above a hardpan layer, then very slow through it. Available infiltration capacity is low.

- There are no slopes greater than 30 percent within the project area.

For a soils map, see Handout Figure C-6.

Groundwater Conditions	There is no substantial regional groundwater flow system in the project area.
Cultural Resources	There are no identified cultural resources within the project corridor.

Project Conditions and BMP Selection Process (HRM Section 5-3)

The Kirkland Nickel project corridor is lengthy and complex, so for the sake of completing a full example, BMPs will be selected for only one of the project's 18 TDAs. This example will step through the selection and design process for TDA 1. TDA 1 is located at the intersection of Juanita-Woodinville Way and I-405. It is the southernmost TDA in the Sammamish River basin. A description of TDA 1 is below. TDA 1 limits and flow paths are shown in Handout Figure C-7.

- TDA 1 includes an area of highway mainline, the 160th Street interchange and adjacent right-of-ways. The existing drainage system for TDA 1 allows runoff to discharge in sheet flows from the western edge of the freeway into a roadside ditch. It then flows down gradient, to the north, to collect in catch basins and a pipe network running adjacent to the freeway. Runoff collected in the median also joins this pipe network. Runoff to this area is generated almost entirely by roadway surfaces and embankments.

The following table was developed for determining minimum requirements in Module 2. These values are also necessary for BMP selection and design.

Workbook Table C-1. Surface areas within the I-405 project corridor.

	Existing Impervious Surface/ PGIS (acres)	New Impervious Surface (acres)	Replaced Impervious Surface (acres)	Effective Impervious Surface (acres)	New PGIS (acres)	Converted Pervious Surface (acres)	New PGPS (acres)
TDA 1	6.34	0.21	0.25		0.21	0	0
Totals for Project	1,429,000	15.8	17.0		15.8	0	0

1 acre = 43,560 square feet. 5,000 square feet = 0.11 acres. 10,000 square feet = 0.23 acre.

Part I: Determine Applicable Minimum Requirements and Project-Specific Considerations

BMP Selection Process: This section outlines the BMP selection process as described in HRM Section 5-3.

Using HRM Figure 3.1 determine what minimum requirements are required for the project.

Circle the correct assumptions below:

- Do minimum requirements 1-4 apply to the new and replaced impervious surfaces and land disturbed? Yes/No
- Do minimum requirements 5-9 apply to the new impervious surfaces and converted pervious surfaces? Yes/No
- Do minimum requirements 5-9 apply to the replaces impervious surfaces? Yes/No

Part II: Select Source Control BMPs

List activities and/or facilities that may require source control BMPs (see Section 2.2 of Volume IV of the *Stormwater Management Manual for Western Washington*. The source control BMPs are included in Section 6 of this workbook.):

____

____

____

____

Part III: Determine Runoff treatment and Flow Control Requirements for TDAs

Part III reviews relevant key definitions and determines which minimum requirements apply to the TDA.

Step A: Review definitions (write a summary of the following terms):

- Effective impervious surface:

  ____

  ____

- Non-effective impervious surface:

  ____

  ____

- Replaced impervious surface:

  ____

  ____

- Pollution-generating impervious surface (PGIS):

  ____

  ____

- Pollution-generating pervious surface (PGPS):

  ____

  ____

- Converted pervious surface:

  ____

  ____

- Threshold discharge area (TDA):

  ____

  ____

Part III: Determine Runoff treatment and Flow Control Requirements for TDAs (continued)

Step B: Check Step 1 in HRM Section 3-3.6.3 and Step 1 in HRM Section 3-3.5.3

These are project level thresholds. If either threshold is exceeded, proceed to Step C.

Minimum Requirement 6: Project level

The Kirkland Nickel project **does/does not** add over 5,000 square feet of new impervious surfaces➔Minimum Requirement 6 **does/does not** apply to the new impervious surfaces in the Lake Washington, Forbes Creek, Juanita Creek, and Sammamish River basins.

and

The Kirkland Nickel project **does/does not** add greater than 50 percent to the existing impervious surface area➔Minimum Requirement 6 **does/does not** apply to the replaced impervious surfaces in the Lake Washington, Forbes Creek, Juanita Creek, and Sammamish River basins.

Minimum Requirement 5: Project level

The Kirkland Nickel project **does/does not** add over 5,000 square feet of new PGIS➔Minimum Requirement 5 **does/does not** apply to the new impervious surfaces in the Lake Washington, Forbes Creek, Juanita Creek, and Sammamish River basins

and

The Kirkland Nickel project **does/does not** add greater than 50 percent of the existing PGIS area➔Minimum Requirement 5 **does/does not** apply to the replaced PGIS in the Lake Washington, Forbes Creek, Juanita Creek, and Sammamish River basins.

Step C: Outline TDAs

TDAs for the Kirkland Nickel project have already been delineated in Module 2. All TDAs in the Sammamish River basin are shown in Handout Figure C-5. TDA 1 is the TDA for which BMPs will be selected and designed. It is shown in Handout Figure C-7.

Part III: Determine Runoff treatment and Flow Control Requirements for TDAs (continued)

Step D: For flow control, determine the area of effective impervious surfaces and converted impervious surfaces in TDA 1. Refer to Workbook Table C-1.

- Effective impervious surface TDA 1:

  ____

- Converted pervious surface TDA 1:

  ____

- Does TDA 1 discharge to a flow control exempt surface water(s)? Refer to HRM Table 3-5.

  ____

Compare to Minimum Requirement 6 for flow control (fill in your answers or circle the correct answer below):

<u>Minimum Requirement 6: TDA level for **TDA 1**</u>

The project **does/does not** add over 10,000 square feet of effective impervious surface to TDA 1

—or—

The project **does/does not** convert ¾ acre of native vegetation to lawn or landscaped area in TDA 1

—or—

For TDA 1, MGSFlood model results **do/do not** show a greater than 0.1 cfs or more increase in the 100-year recurrence interval flow.

Therefore,

Minimum Requirement 6 **does/does not** apply to the effective impervious surfaces and converted pervious surfaces in TDA 1.

Part III: Determine Runoff treatment and Flow Control Requirements for TDAs (continued)

Step E: For runoff treatment, determine the area of effective PGIS and PGPS for TDA 1.

- Effective PGIS TDA 1:

  ____

- PGPS TDA 1:

  ____

Compare to Minimum Requirement 5 for runoff treatment (fill in your answers or circle the correct answer below):

- Does TDA 1 discharge to a basic treatment surface water? Refer to HRM Table 3-2.

  ____

<u>Minimum Requirement 5: TDA level for **TDA 1**</u>

The project **does/does not** add over 5,000 square feet of effective PGIS to TDA 1

—or—

The project **does/does not** add ¾ acre of PGPS in TDA 1.

Therefore,

Minimum Requirement 5 **does/does not** apply to the effective PGIS in TDA 1.

Part IV: Select Flow Control BMPs

In Part IV, flow control BMPs will be selected. Once a BMP is selected for each TDA, proceed to Part V. Fill in your answers in the space provided. Refer to HRM Figure 5.3.1.

Step 1: Determine whether stormwater mitigation and management can be handled by the natural landscape or infiltration for TDA 1. If any of the three options are selected, proceed to Part V for that TDA.

- **Option 1: Dispersion**

  Would dispersion, either natural or engineered be applicable for use in TDA 1? Why or why not? Refer to HRM Section 5-4.2.2.

  ____

  ____

  Describe the siting criteria for natural dispersion:

  ____

  ____

  Describe the site considerations for engineered dispersion areas:

  ____

  ____

- **Option 2: Infiltration**

  Would infiltration for flow control and runoff treatment be applicable in TDA 1? Why or why not? Refer to HRM Section 5-4.2.1.

  ____

  ____

  Site requirements for flow control and runoff treatment infiltration facilities include:

  ____

  ____

Part IV: Select Flow Control BMPs (continued)

- **Option 3: Infiltration for flow control**

  Would infiltration for only flow control be applicable in TDA 1? Why or why not? Refer to HRM Section 5-4.2.1.

  ____

  ____

  Site requirements for flow control infiltration facilities areas include:

  ____

  ____

Step 2: Determine whether a regional detention facility is near or within the project limits.

- If a regional stormwater flow control is feasible and stormwater discharge is approved, proceed to Part V.

  Assume there is not.

Step 3: Can a combined flow control and runoff treatment facility be designed for the TDA? Refer to HRM Section 5-4.1.4.

- Explain if a combined facility would work for this site. Why or why not? If a combined flow control and runoff treatment facility can be designed for the project, proceed to Part V.

  ____

  ____

Step 4: Select a detention BMP for TDA 1. Refer to HRM Section 5-4. 2.3.

- Explain your selection.

  ____

  ____

Part V: Select Runoff Treatment BMPs

In Part V, runoff treatment BMPs will be selected. Once a BMP is selected for each TDA, proceed to Part VI. Fill in your answers in the space provided. Refer to HRM Figure 5.3.2.

- Does TDA 1 discharge to a basic treatment surface water? Refer to HRM Table 3-2.

____

Step 1: Was Option 1 or 2 of Part IV, Step 1 chosen for TDA 1?

- If Option 1 or 2 was chosen for TDA 1, no further steps for the TDA are necessary. If this is the case, proceed to Part VI. If not, proceed to Step 2.

____

____

Step 2: Determine the receiving waters, possible pollutants of concern, and any additional local jurisdictional requirements for the project.

- Consider the receiving waters, groundwater, and/or TMDLs.

____

____

Step 3: Determine if oil control is required for the project. Refer to HRM Table 3-1.

- If so, select an oil control BMP and proceed to Step 4.

____

____

Step 4: Determine if phosphorus control is required for the project. Refer to HRM Table 3-1.

- If so, select a phosphorus control BMP and proceed to Step 5.

____

____

Part V: Select Runoff Treatment BMPs (continued)

Step 5: Determine if enhanced treatment is required for the project. Refer to HRM Figure 5.3.3.

- If so, select an enhanced treatment facility for TDA 1. Refer to HRM Table 3-1. If a combined flow control/runoff treatment facility is selected, describe it here. If enhanced treatment is not necessary, proceed to Step 6.

____

____

Step 6: Select a basic treatment facility for TDA 1.

- Explain your selection. If a combined flow control/runoff treatment facility is selected describe it here.

____

____

Part VI: BMP Validation and Cost-Effectiveness

Summarize the O&M and siting considerations for the selected BMP. Refer to HRM Table 5.3.1.

____

____

____

What if??

There is insufficient space within the intersection to construct any type of pond.

STOP

6. Department of Ecology's Source Control Standards

These source control BMPs are from the Washington State Department of Ecology *Stormwater Management Manual for Western Washington* and *Stormwater Management Manual for Eastern Washington*. This is not a comprehensive list and for projects designed outside of this classroom setting, the complete stormwater manuals should be used as references.

BMPs for Deicing and Anti-Icing Operations (Airports and Streets)

Description of Pollutant Sources:
Deicing and (or) anti-icing compounds are used on highways, streets, airport runways, and aircraft to control ice and snow. Typically ethylene glycol and propylene glycol are deicers used on aircraft. Deicers commonly used on highways and streets include calcium magnesium acetate (CMA), calcium chloride, magnesium chloride, sodium chloride, urea, and potassium acetate. The deicing and anti-icing compounds become pollutants when they are conveyed to storm drains or to surface water after application. Leaks and spills of these chemicals can also occur during their handling and storage.

Applicable BMPs for Streets and Highways:
- Select de and anti-icers that cause the least adverse environmental impact. Apply only as needed using minimum quantities.
- Where feasible and practicable use roadway deicers, such as calcium magnesium acetate, potassium acetate, or similar materials, that cause less adverse environmental impact than urea and sodium chloride.
- Store and transfer de/anti-icing materials on an impervious containment pad in accordance with BMP Storage or Transfer (Outside) of Solid Raw Materials, By-Products, or Finished Products in this document.
- Sweep/clean up accumulated de/anti-icing materials and grit from roads as soon as practicable after the road surface clears.

Recommended Additional BMPs:
- Intensify roadway cleaning in early spring to help remove particulates from road surfaces.
- Include limits on toxic metals in the specifications for deicers and anti-icers.

BMPs for Landscaping and Lawn/Vegetation Management

Description of Pollutant Sources:
• Landscaping can include grading, soil transfer, vegetation removal, pesticide and fertilizer applications, and watering. Stormwater contaminants include toxic organic compounds, heavy metals, oils, total suspended solids, coliform bacteria, fertilizers, and pesticides.
• Lawn and vegetation management can include control of objectionable weeds, insects, mold, bacteria and other pests with chemical pesticides and is conducted commercially at commercial, industrial, and residential sites. Examples include weed control on golf course lawns, access roads, utility corridors, and during landscaping; sap stain and insect control on lumber and logs; rooftop moss removal; killing nuisance rodents; fungicide application to patio decks, and residential lawn/plant care.
• Toxic pesticides such as pentachlorophenol, carbamates, and organometallics can be released to the environment by leaching and dripping from treated parts, container leaks, product misuse, and outside storage of pesticide contaminated materials and equipment. Poor management of the vegetation and poor application of pesticides or fertilizers can cause appreciable stormwater contamination.

Pollutant Control Approach:
• Control fertilizer and pesticide applications, soil erosion, and site debris to prevent contamination of stormwater. Develop and implement an Integrated Pest Management (IPM) Plan and use pesticides only as a last resort. If pesticides/herbicides are used they must be carefully applied in accordance with label instructions on U.S. Environmental Protection Agency (U.S. EPA) registered materials.
• Maintain appropriate vegetation, with proper fertilizer application where practicable, to control erosion and the discharge of stormwater pollutants.
• Where practicable grow plant species appropriate for the site, or adjust the soil properties of the subject site to grow desired plant species.

Applicable Operational BMPs for Landscaping:
• Install engineered soil/landscape systems to improve the infiltration and regulation of stormwater in landscaped areas.
• Do not dispose of collected vegetation into waterways or storm drainage systems.

Recommended Additional Operational BMPs for Landscaping:
• Conduct mulch-mowing whenever practicable
• Dispose of grass clippings, leaves, sticks, or other collected vegetation, by composting, if feasible.
• Use mulch or other erosion control measures when soils are exposed for more than one week.
• If oil or other chemicals are handled, store and maintain appropriate oil and chemical spill cleanup materials in readily accessible locations. Ensure that employees are familiar with proper spill cleanup procedures.
• Till fertilizers into the soil rather than dumping or broadcasting onto the surface. Determine the proper fertilizer application for the types of soil and vegetation encountered.
• Till a topsoil mix or composted organic material into the soil to create a well-mixed transition layer that encourages

deeper root systems and drought-resistant plants.

• Use manual and (or) mechanical methods of vegetation removal rather than applying herbicides, where practical.

Applicable Operational BMPs for the Use of Pesticides:

• Develop and implement an IPM and use pesticides only as a last resort.

• Implement a pesticide-use plan and include at a minimum: a list of selected pesticides and their specific uses; brands, formulations, application methods and quantities to be used; equipment use and maintenance procedures; safety, storage, and disposal methods; and monitoring, record keeping, and public notice procedures. All procedures shall conform to the requirements of Chapter 17.21 RCW and Chapter 16-228 WAC.

• Choose the least toxic pesticide available that is capable of reducing the infestation to acceptable levels. The pesticide should readily degrade in the environment and (or) have properties that strongly bind it to the soil. Any pest control used should be conducted at the life stage when the pest is most vulnerable. For example, if it is necessary to use a Bacillus thuringiens application to control tent caterpillars, it must be applied before the caterpillars form a cocoon or the application will be ineffective. Any method used should be site-specific and not used wholesale over a wide area.

• Apply the pesticide according to label directions. Under no conditions shall pesticides be applied in quantities that exceed manufacturer's instructions.

• Mix the pesticides and clean the application equipment in an area where accidental spills will not enter surface or groundwaters, and will not contaminate the soil.

• Store pesticides in enclosed areas or in covered impervious containment. Ensure that pesticide contaminated stormwater or spills/leaks of pesticides are not discharged to storm drains. Do not hose down the paved areas to a storm drain or conveyance ditch.

• Store and maintain appropriate spill cleanup materials in a location known to all near the storage area.

• Clean up any spilled pesticides and ensure that the pesticide contaminated waste materials are kept in designated covered and contained areas.

• The pesticide application equipment must be capable of immediate shutoff in the event of an emergency.

• Do not spray non-permitted pesticides within 100 feet of open waters including wetlands, ponds, and streams, sloughs and any drainage ditch or channel that leads to open water except when approved by Ecology or the local jurisdiction. All sensitive areas including wells, creeks, and wetlands must be flagged prior to spraying.

• As required by the local government or by Ecology, complete public posting of the area to be sprayed prior to the application.

• Spray applications should only be conducted during weather conditions as specified in the label direction and applicable local and state regulations. Do not apply during rain or immediately before expected rain.

Recommended Additional Operational BMPs for the Use of Pesticides:

• Consider alternatives to the use of pesticides such as covering or harvesting weeds, substitute vegetative growth, and manual weed control/moss removal.

• Consider the use of soil amendments, such as compost, that are known to control some common diseases in plants, such as Pythium root rot, ashy stem blight, and parasitic nematodes. The following are three possible mechanisms for disease control by compost addition (U.S. EPA Publication 530-F-9-044):

1. Successful competition for nutrients by antibiotic production;
2. Successful predation against pathogens by beneficial microorganism; and
3. Activation of disease-resistant genes in plants by composts.

Installing an amended soil/landscape system can preserve both the plant system and the soil system more effectively. This type of approach provides a soil/landscape system with adequate depth, permeability, and organic matter to sustain itself and to continue working as an effective stormwater infiltration system and a sustainable nutrient cycle.

• Once a pesticide is applied, its effectiveness should be evaluated for possible improvement. Records should be kept showing the applicability and inapplicability of the pesticides considered.

• An annual evaluation procedure should be developed including a review of the effectiveness of pesticide applications, impact on buffers and sensitive areas (including potable wells), public concerns, and recent toxicological information on pesticides used/proposed for use.

• If individual or public potable wells are located in the proximity of commercial pesticide applications contact the regional Ecology hydrogeologist to determine if additional pesticide application control measures are necessary.

• Rinsate from equipment cleaning and (or) triple-rinsing of pesticide containers should be used as product or recycled into product.

• The application equipment used should be capable of immediate shutoff in the event of an emergency.

Applicable Operational BMPs for Vegetation Management:

• Use at least an 8-inch topsoil layer with at least 8 percent organic matter to provide a sufficient vegetation-growing medium.

• Amending existing landscapes and turf systems by increasing the percent organic matter and depth of topsoil can substantially improve the permeability of the soil, the disease and drought resistance of the vegetation, and reduce fertilizer demand. This reduces the demand for fertilizers, herbicides, and pesticides. Organic matter is the least water-soluble form of nutrients that can be added to the soil.

• Composted organic matter generally releases only between two and ten percent of its total nitrogen each year, and this release corresponds closely to the plant growth cycle. If natural plant debris and mulch are returned to the soil, this system can continue recycling nutrients indefinitely.

• Select the appropriate turf grass mixture for your climate and soil type. Certain tall fescues and rye grasses resist insect attack, because the symbiotic endophytic fungi found naturally in their tissues repel or kill common leaf and stem-eating lawn insects. They do not, however, repel root-feeding lawn pests such as Crane Fly larvae, and are toxic to ruminants such as cattle and sheep. The fungus causes no known adverse effects to the host plant or to humans. Endophytic grasses are commercially available and can be used in areas such as parks or golf courses where grazing does not occur. The local Cooperative Extension office can offer advice on which types of grass are best suited to the area and soil type.

• Use the appropriate seeding and planting BMPs in Chapter 7, or equivalent BMPs, to obtain information on grass mixtures, temporary and permanent seeding procedures, maintenance of a recently planted area, and fertilizer application rates.

• Selection of desired plant species can be made by adjusting the soil properties of the subject site. For example, a constructed wetland can be designed to resist the invasion of reed canarygrass by layering specific strata of organic matters (e.g., compost forest product residuals), and creating a mildly acidic pH and carbon-rich soil medium. Consult a soil restoration specialist for site-specific conditions.

• Aerate lawns regularly in areas of heavy use where the soil tends to become compacted. Aeration should be conducted while the grasses in the lawn are growing most vigorously. Remove layers of thatch greater than ¾ inches deep.

• Mowing is a stress-creating activity for turf grass. When grass is mowed too short its productivity is decreased and there is less growth of roots and rhizomes. The turf becomes less tolerant of environmental stresses, more disease prone, and more reliant on outside means, such as pesticides, fertilizers, and irrigation to remain healthy. Set the mowing height at the highest acceptable level and mow at times and intervals designed to minimize stress on the turf. Generally mowing only 1/3 of the grass blade height will prevent stressing the turf.

Irrigation:

• The depth from which a plant normally extracts water depends on the rooting depth of the plant. Appropriately irrigated lawn grasses normally root in the top six to twelve inches of soil; lawns irrigated on a daily basis often root only in the top one inch of soil. Improper irrigation can encourage pest problems, leach nutrients, and make a lawn completely dependent on artificial watering. The amount of water applied depends on the normal rooting depth of the turf grass species used, the available water holding capacity of the soil, and the efficiency of the irrigation system. Consult with the local water utility, Conservation District, or Cooperative Extension office to help determine optimum irrigation practices.

Fertilizer Management:

• Turf grass is most responsive to nitrogen fertilization, followed by potassium and phosphorus. Fertilization needs vary by site depending on plant, soil and climatic conditions. Evaluation of soil nutrient levels through regular testing ensures the best possible efficiency and economy of fertilization. For details on soils testing, contact the local Conservation District or Cooperative Extension Service.

• Fertilizers should be applied in amounts appropriate for the target vegetation and at the time of year that minimizes losses to surface and groundwaters. Do not fertilize during a drought or when the soil is dry. Alternatively, do not apply fertilizers within three days prior to predicted rainfall. The longer the period between fertilizer application and either rainfall or irrigation, the less fertilizer runoff occurs.

• Use slow release fertilizers such as methylene urea, IDBU, or resin-coated fertilizers, when appropriate, generally in the spring. Use of slow release fertilizers is especially important in areas with sandy or gravelly soils.
• Time the fertilizer application to periods of maximum plant uptake. Generally fall and spring applications are recommended, although WSU turf specialists recommend four fertilizer applications per year.
• Properly trained persons should apply all fertilizers. At commercial and industrial facilities fertilizers should not be applied to grass swales, filter strips, or buffer areas that drain to sensitive water bodies unless approved by the local jurisdiction.

Integrated Pest Management:
An IPM program might consist of the following steps:
Step 1: Correctly identify problem pests and understand their life cycle.
Step 2: Establish tolerance thresholds for pests.
Step 3: Monitor to detect and prevent pest problems.
Step 4: Modify the maintenance program to promote healthy plants and discourage pests.
Step 5: Use cultural, physical, mechanical, or biological controls first when pests exceed the tolerance thresholds.
Step 6: Evaluate and record the effectiveness of the control, and modify maintenance practices to support lawn or landscape recovery and prevent recurrence.

BMPs for Maintenance and Repair of Vehicles and Equipment

Description of Pollutant Sources:
• Pollutant sources include parts/vehicle cleaning, spills/leaks of fuel and other liquids, replacement of liquids, outdoor storage of batteries/liquids/parts, and vehicle parking.

Pollutant Control Approach:
• Control of leaks and spills of fluids using good housekeeping, and cover and containment BMPs.

Applicable Operational BMPs:
• Inspect for leaks all incoming vehicles, parts, and equipment stored temporarily outside.
• Use drip pans or containers under parts or vehicles that drip or are likely to drip liquids, such as during dismantling of liquid containing parts, or removal or transfer of liquids.
• Remove batteries and liquids from vehicles and equipment in designated areas designed to prevent stormwater contamination. Store cracked batteries in a covered non-leaking secondary containment system.
• Empty oil and fuel filters before disposal. Provide for proper disposal of waste oil and fuel.
• Do not pour/convey wash water, liquid waste, or other pollutant into storm drains or to surface water. Check with the local jurisdiction for approval to convey to a sanitary sewer.
• Do not connect maintenance and repair shop floor drains to storm drains or to surface water. To allow for snowmelt during the winter a drainage trench with a sump for particulate collection can be installed and used only for draining the snowmelt and not for discharging any vehicular or shop pollutants.

Applicable Structural Source Control BMPs:
• Conduct all maintenance and repair of vehicles and equipment in a building, or other covered impervious containment area sloped to prevent run-on of uncontaminated stormwater and runoff of contaminated stormwater.
• The maintenance of refrigeration engines in refrigerated trailers may be conducted in the parking area with due caution to avoid the release of engine or refrigeration fluids to storm drains or surface water.
• Park large mobile equipment, such as log stackers, in a designated contained area.

For Additional Applicable BMPs Refer to the Following BMPs:
• Fueling at Dedicated Stations; Washing and Steam Cleaning Vehicle/Equipment/Building Structures; Loading and Unloading Areas for Liquid or Solid Material; Storage of Liquids in Permanent Above-Ground Tanks; Storage of Liquid, Food Waste, or Dangerous Waste Containers; Storage or Transfer (Outside) of Solid Raw Materials, By-Products, or Finished Products; Spills of Oil and Hazardous Substances; Illicit Connections to Storm Drains; and other BMPs provided in this chapter.

Applicable Treatment BMPs:
• Contaminated stormwater runoff from vehicle staging and maintenance areas must be conveyed to a sanitary sewer, if allowed by the local jurisdiction, or to an API or CP oil and water separator followed by a water quality treatment BMP (see Chapter 5), applicable filter, or other equivalent oil treatment system.

***Note**: A treatment BMP is applicable for contaminated stormwater.*

Recommended Additional Operational BMPs:

• Consider storing damaged vehicles inside a building or other covered containment, until all liquids are removed. Remove liquids from vehicles retired for scrap.

• Clean parts with aqueous detergent based solutions or non-chlorinated solvents, such as kerosene or high flash mineral spirits, and (or) use wire brushing or sand blasting whenever practicable. Avoid using toxic liquid cleaners, such as methylene chloride, 1,1,1-trichloroethane, trichloroethylene or similar chlorinated solvents. Choose cleaning agents that can be recycled.

• Inspect all BMPs regularly, particularly after a significant storm. Identify and correct deficiencies to ensure that the BMPs are functioning as intended.

• Avoid hosing down work areas. Use dry methods for cleaning leaked fluids.

• Recycle greases, used oil, oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic fluids, transmission fluids, and engine oils (see Appendix IV-C of the *Stormwater Management Manual for Western Washington*).

• Do not mix dissimilar or incompatible waste liquids stored for recycling.

BMPs for Maintenance of Roadside Ditches

Description of Pollutant Sources:
Common road debris, including eroded soil, oils, vegetative particles, and heavy metals, can be a source of stormwater pollutants.

Pollutant Control Approach:
Roadside ditches should be maintained to preserve the condition and capacity for which they were originally constructed, and to minimize bare or thinly vegetated ground surfaces. Maintenance practices should provide for erosion and sediment control. (Refer to BMP Landscaping and Lawn/Vegetation Management.)

Applicable Operational BMPs:
• Inspect roadside ditches regularly, as needed, to identify sediment accumulations and localized erosion.
• Clean ditches on a regular basis, as needed. Ditches should be kept free of rubbish and debris.
• In situations where appropriate, vegetation in ditches often prevents erosion and cleanses runoff waters. Remove vegetation only when flow is blocked or excess sediments have accumulated. Conduct ditch maintenance (seeding, fertilizer application, harvesting) in late spring and (or) early fall, where possible. This allows vegetative cover to be re-established by the next wet season, thereby minimizing erosion of the ditch as well as making the ditch effective as a biofilter.
• In the area between the edge of the pavement and the bottom of the ditch, commonly known as the "bare earth zone," use grass vegetation, wherever possible. Vegetation should be established from the edge of the pavement, if possible, or at least from the top of the slope of the ditch.
• Diversion ditches on top of cut slopes that are constructed to prevent slope erosion by intercepting surface drainage must be maintained to retain their diversion shape and capability.
• Ditch cleanings are not to be left on the roadway surfaces. Sweep dirt and debris remaining on the pavement at the completion of ditch cleaning operations.
• Roadside ditch cleanings, not contaminated by spills or other releases and not associated with a stormwater treatment system, such as a bioswale, may be screened to remove litter and separated into soil and vegetative matter (leaves, grass, needles, branches, etc.). The soil fraction may be handled as 'clean soils' and the vegetative matter can be composted or disposed of in a municipal waste landfill.
• Roadside ditch cleanings contaminated by spills or other releases known, or suspected, to contain dangerous waste must be handled following the Dangerous Waste Regulations (Chapter 173-303 WAC), unless testing determines it is not dangerous waste.
• Examine culverts on a regular basis for scour or sedimentation at the inlet and outlet and repair, as necessary. Give priority to those culverts conveying perennial and (or) salmon-bearing streams and culverts near streams in areas of high sediment load, such as those near subdivisions during construction.

Recommended Treatment BMPs:
• Install biofiltration swales and filter strips (see Chapter 5) to treat roadside runoff, wherever practicable, and use engineered topsoils, wherever necessary, to maintain adequate vegetation (CH2M Hill, 2000). These systems can improve infiltration and stormwater pollutant control upstream of roadside ditches.

BMPs for Maintenance of Stormwater Drainage and Treatment Systems

Description of Pollutant Sources:

• Facilities include roadside catch basins on arterials and within residential areas, conveyance systems, detention facilities, such as ponds and vaults, oil and water separators, biofilters, settling basins, infiltration systems, and all other types of stormwater treatment systems presented in Chapter 5. Roadside catch basins can remove from 5 to 15 percent of the pollutants present in stormwater. When catch basins are about 60 percent full of sediment, they cease removing sediments. Oil and grease, hydrocarbons, debris, heavy metals, sediments, and contaminated water are found in catch basins, oil and water separators, settling basins, etc.

Pollutant Control Approach:

• Provide maintenance and cleaning of debris, sediments, and oil from stormwater collection, conveyance, and treatment systems to obtain proper operation.

Applicable Operational BMPs:

Maintain stormwater treatment facilities according to the operation and maintenance (O&M) procedures presented in this manual in addition to the following BMPs:

• Inspect and clean treatment BMPs, conveyance systems, and catch basins, as needed, and determine whether improvements in O&M are needed.

• Promptly repair any deterioration threatening the structural integrity of the facilities. These include: replacement of clean-out gates, catch basin lids, and rock in emergency spillways.

• Ensure that storm sewer capacities are not exceeded and that heavy sediment discharges to the sewer system are prevented.

• Regularly remove debris and sludge from BMPs used for peak-rate control, treatment, etc., and discharge to a sanitary sewer, if approved by the local jurisdiction, or truck to a local or state government approved disposal site.

• Clean catch basins when the depth of deposits reaches 60 percent of the sump depth, as measured from the bottom of basin to the invert of the lowest pipe into or out of the basin. However, in no case should there be less than six inches clearance from the debris surface to the invert of the lowest pipe. Some catch basins (for example, WSDOT Type 1L basins) may have as little as 12 inches sediment storage below the invert. These catch basins will need more frequent inspection and cleaning to prevent scouring. Where these catch basins are part of a stormwater collection and treatment system, the system owner/operator may choose to concentrate maintenance efforts on downstream control devices as part of a systems approach.

• Clean woody debris in a catch basin as frequently as needed to ensure proper operation of the catch basin.

• Post warning signs; “Dump No Waste - Drains to Groundwater,” “Streams,” “Lakes,” or emboss on or adjacent to all storm drain inlets where practical.

• Disposal of sediments and liquids from the catch basins must comply with “Recommendations for Management of Street Wastes” described in Appendix 8B.

Additional Applicable BMPs:

Select additional applicable BMPs from this chapter depending on the pollutant sources and activities conducted at the facility. Those BMPs include:

- BMPs for Soil Erosion and Sediment Control at Industrial Sites
- BMPs for Storage of Liquid, Food Waste, or Dangerous Waste Containers
- BMPs for Spills of Oil and Hazardous Substances
- BMPs for Illicit Connections to Storm Drains
- BMPs for Urban Streets