Oregon
Theodore R. Kulongoski, Governor

Department of Transportation
Geo-Environmental Section
Transportation Building
355 Capitol St. NE, Rm. 301
Salem, OR 97301-3871

FILE CODE:

Date: **October 22, 2008**

Subject: **Stormwater Treatment Program - BMP Selection Tool**

Executive Summary

The Oregon Department of Transportation (ODOT) has developed a Stormwater Management Program (Program) to streamline the stormwater permitting process, while continuing to meet its mission as a transportation agency. Under the Program, ODOT's goal is to reduce the amount of runoff generated to the extent practicable before relying on engineered stormwater facilities to meet water quantity and water quality requirements. Through this process, ODOT worked internally with management, project delivery and maintenance teams, as well as with representatives from regulatory agencies. The key outcomes from the Program include:

1. Revised water quality (treatment facility) design storm
2. Revised water quantity (flow control) design storm
3. Stormwater treatment guidance: Best Management Practice (BMP) Selection Tool and User's Guide (for water quality facilities)
4. Contributing Impervious Area Guidance
5. Endangered Species Act guidance and pilot ESA consultations
6. Guidance for situations where stormwater cannot be treated to the extent required by regulation

This memorandum focuses on the stormwater treatment guidance component of the Program (item 3 above), and more specifically the BMP Selection Tool. The impetus for developing the BMP Selection Tool was to have a transparent and technically based BMP selection process that documents the decisions and streamlines overall stormwater permitting with the regulatory agencies. The BMP Selection Tool is one component of an overall "Stormwater Treatment Design Process." The Stormwater Treatment Design Process integrates pollution prevention and minimization techniques, low impact development and other practices to reduce the runoff generated by the project once the project goals and objectives have been defined and site characterization has occurred.

Generally, the BMP Selection Tool uses metrics and ratings for treatment suitability (effectiveness) for pollutants of concern, site suitability and physical constraints, maintenance needs and constraints, and costs to document the decision-making process for selecting among a suite of potential BMPs for a project. However, the BMP Selection Tool prioritizes the use of "preferred" BMPs, which include infiltration-focused technologies and those BMPs that have a soil-amendment feature. Input and review by the regulatory agencies is minimized and streamlined when the "preferred" BMPs are selected.

Finally, the BMP Selection Tool uses "primary treatment mechanisms" rather than removal efficiency data reported for specific BMPs to determine the treatment suitability for pollutants of concern (POC). Primary treatment mechanism refers to the prevailing unit operations that result in the removal or chemical breakdown of a given compound. If a BMP employs a given treatment mechanism, then by definition the BMP is considered effective at treating the pollutant of concern.

BMP Selection Tool

1.0 Background

ODOT, the Federal Highway Administration (FHWA), and representatives from the regulatory agencies, developed the Stormwater Management Program to streamline the stormwater permitting process, while continuing to meet the mission of ODOT as a transportation agency. The Program is transparent and technically based, while documenting the decision-making process. ODOT worked internally with its management, project delivery, and maintenance teams to promote integrated stormwater design and low impact development (LID) in its project development and design process. Under the Program, consideration is given to these approaches at the project development and definition phase and throughout the preliminary and final design phases. The goal for ODOT, which is consistent with the regulatory agencies' position, is to reduce the amount of runoff generated to the extent practicable before relying on engineered stormwater facilities to meet water quantity and water quality requirements.

The "traditional" POC for roadway projects (e.g., suspended solids, oil and grease, and particulate metals) are addressed in this process, while added focus is given to BMPs that address pollutants of particular concern to the regulatory agencies, namely dissolved metals and polycyclic aromatic hydrocarbons (PAH).

2.0 Stormwater Treatment Guidance – BMP Selection Tool

The "Stormwater Treatment Design Process" is a comprehensive process that starts with problem definition and continues through development of the conceptual design of the selected stormwater treatment system. **Figure 1** illustrates the conceptual stormwater treatment design process, of which the "BMP Selection Tool" is one part. Through the process, the project delivery team integrates pollution prevention and minimization techniques, LID and other practices to reduce the runoff generated by the project once the project goals and objectives have been defined and site characterization has occurred.

The process includes the development of key decision documents that will be used by ODOT to assist in the permitting process for their projects. One of the key decision documents is the "output" from the BMP Selection Tool. The BMP Selection Tool is used to:

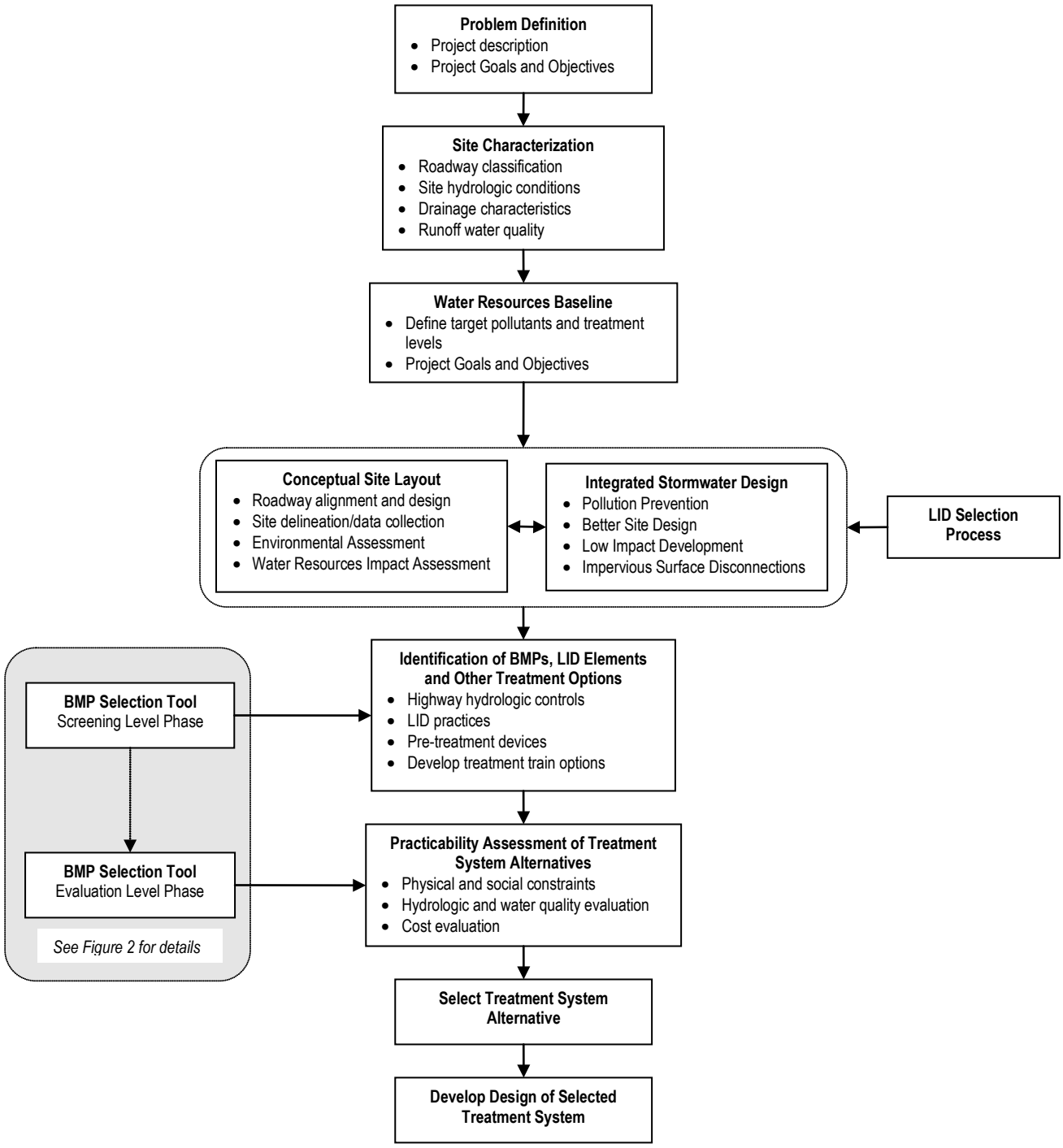
- Evaluate the engineered, post-collection and conveyance facilities used to treat stormwater runoff.

- Document decisions made by ODOT's project development team, which includes water quality specialists, hydraulics engineers, and maintenance staff in a decision support framework.

As **Figure 1** illustrates, the BMP Selection Tool is applied after the project objectives and treatment goals have been defined and after the preliminary conceptual site layout and integrated stormwater design considerations have been developed. At this point, the Project Team has considered appropriate LID options to reduce runoff and the design process is at the point where "end-of-pipe" stormwater treatment options are needed.

The BMP Selection Tool is based on the information from the key references and literature reviewed by the Project Team and a review of other selection processes described in the references and from discussions among the Project Team. The primary references were also used to develop BMP Summary Reports that include the basis for ratings assigned to the metrics in the BMP Selection Tool. **Figure 2** shows the components (or metrics) of the selection process, key "check-in" points within the ODOT Project Team and the regulatory agencies, and the "streamlining benefits" of the BMP selection process.

Figure 1. Conceptual Stormwater Treatment Design Process



The BMP Selection Tool includes metrics and ratings for treatment suitability (effectiveness) of pollutants of concern, site suitability and physical constraints, maintenance needs and constraints, and costs. The selection process is generally applied in two steps: (i) BMP screening level; and (ii) treatment train alternatives evaluation. The BMP screening step in the selection process evaluates individual BMPs and is used to identify the most appropriate BMPs for the project. Those BMPs that are screened through are used to develop treatment train alternatives. These alternatives are evaluated further and in more detail with respect to conceptual design layouts for the individual components of the treatment train. The alternatives are evaluated using similar metrics from the screening step. As **Figure 2** shows, there are at least two opportunities for the regulatory agencies and the Project Team to discuss documented decisions in the selection process.

"Preferred" BMPs were identified as part of the literature review for treatment effectiveness. Preferred BMPs include infiltration-focused technologies and those BMPs that have a soil-amendment feature. Amending soils in an existing treatment facility may also qualify for "preferred BMP" status. If "preferred" BMPs *for the target pollutants* are feasible and appropriate for the project site, streamlining of the BMP selection process is possible and the formal evaluation and scoring process can be by-passed, as illustrated in **Figure 2**. While the stormwater/hydraulics engineer still needs to design the system and ensure that the BMP is feasible and meets ODOT's design standards, input and review by the regulatory agencies is minimized and streamlined when the preferred BMPs are selected.

3.0 BMPs in the Selection Tool

The *ODOT Hydraulics Manual* is currently being updated. A focused effort is being placed on updating the types and descriptions of water quality BMPs to be consistent with the stormwater treatment design process developed by the Project Team. Additional revisions are being made to the *ODOT Hydraulics Manual* based on input received from the Project Team with respect to new engineered water quality BMPs. To-date, ODOT has included the following specific water quality treatment BMPs in *Chapter 14 - Water Quality*:

- Extended detention dry ponds
- Grass swale
- Filter strips

The *ODOT Hydraulics Manual* will also include a section on BMP system "components" that are typically part of any water quality treatment facility design. These components include:

- Pretreatment facilities: (i) oil-water separators, (ii) sediment control
- Inlet/outlet structures
- Soil amendments (being developed)

The ODOT Geo-Environmental Section is continuing to update the *ODOT Hydraulics Manual*, which will also eventually include the following BMPs:

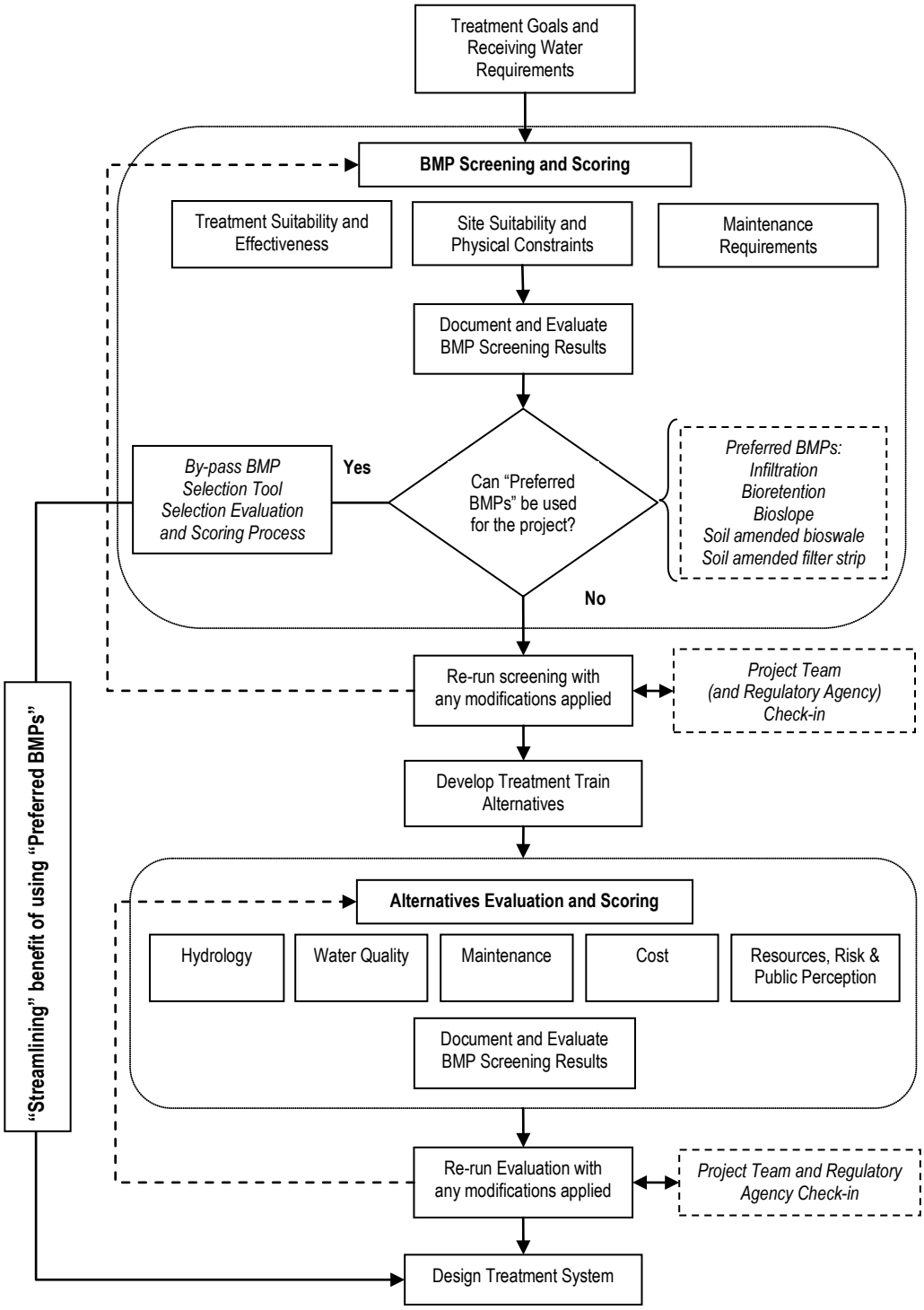
- Infiltration trench/pond
- Constructed wetlands
- Wet ponds
- Wet vaults

- Media filters

Through discussion among the Project Team and ODOT Geo-Environmental staff, the following water quality treatment BMPs are being included in the BMP Selection Tool and are being developed for inclusion in the *ODOT Hydraulics Manual*:

- Bioslope (general form of the "Ecology Embankment" per Washington State Department of Transportation [WSDOT])
- Bioretention
- Soil amendments (to be included in the "BMP Components" section of the *ODOT Hydraulics Manual*)

Figure 2. Schematic of BMP Selection Tool



ODOT expects that the class of "standard" BMPs included in the *ODOT Hydraulics Manual* and BMP Selection Tool will change as new technologies are developed and evaluated for their performance to meet ODOT standards. For the purposes of developing the guidance and tool, only the engineered facilities listed above are included in the BMP Selection Tool.

Other methods of treating stormwater runoff may be proposed but must be evaluated on a project-by-project basis to determine if the proposed treatment methods are adequate. A hydraulic design deviation request must be submitted to the Region hydraulics engineer for consideration. Concurrence from the Region hydraulics engineer is required and is submitted to the Senior Hydraulics Engineer for approval. After an experimental BMP or Emerging Technology is approved for use on a specific ODOT project it is placed on an evaluation list. The performance of all BMPs or Emerging Technologies placed on the evaluation list will be assessed and only the approved stormwater management approaches would be added to future revisions to the water quality chapter of the *ODOT Hydraulics Manual*. In the interim, technical bulletins will be published for the experimental emerging technologies for use by ODOT engineers and consultants.

In addition to the structural BMPs, there are also non-structural, pollution prevention, and "low impact development" (LID)-type BMPs, which essentially act to reduce the amount of pollution generation or pollution-carrying runoff. These BMPs are to be considered prior to the BMP Selection Tool step (see **Figure 1**).

4.0 Defining Treatment Effectiveness Using Treatment Mechanisms

The key issue with rating the treatment effectiveness of BMPs in the BMP Selection Tool is the wide range of removal efficiencies reported for the BMPs. One approach is to rate a BMP's treatment effectiveness based on the removal efficiencies reported in literature. However, the reported efficiencies vary greatly (e.g., at times from 20-80 percent removal by concentration). The wide range in removal efficiencies is a result primarily of the varying site conditions, influent concentrations, flow rates, and specific BMP designs. In addition, the number of studies reported in the literature for each BMP is still relatively limited, despite the development of such databases as the *International BMP Database*. Efforts to add to the dataset have so far not resulted in any clear increase in the precision of effectiveness data.

In an attempt to address this issue, ODOT, FHWA, and the regulatory agencies agreed that treatment effectiveness be defined in terms of their "primary treatment mechanisms" rather than by removal efficiency data reported for specific BMPs. Primary treatment mechanism refers to the prevailing unit operations or processes – borrowing the term from the wastewater treatment field – that results in the removal or chemical breakdown of a given compound. The approach defines a given treatment mechanism as effectively treating a specific target pollutant, and if a BMP employs that treatment mechanism, then by definition the BMP would be considered effective at treating for the POC. Ratings of "high, medium, low" are used.

Types of Treatment Mechanisms. In general, a limited set of unit processes exist that different BMPs rely on to remove constituents from water. The reality of stormwater treatment is that the more complex unit processes, such as ultraviolet disinfection or chemical

precipitation/flocculation, will generally not be used because of the economics of treating such large volumes of water.

The treatment effectiveness of a BMP is essentially related to which processes are actually utilized by the BMP and the ability of the BMP to maximize the process(es). Six primary treatment mechanisms are considered most appropriate for stormwater. The descriptions of these mechanisms are summarized in the attachment to this memo, based primarily on information from *NCHRP Report, "Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control" (2007)*. A brief summary of the primary treatment mechanisms are described below.

- *Hydrologic attenuation* – Hydrologic attenuation achieves pollutant reduction through runoff volume reduction. Infiltration is the primary means of hydrologic attenuation for the purposes of the types of BMPs used in stormwater management. Attenuation reduces the pollutant load discharged to surface waters, but does not necessarily reduce pollutant concentrations. Infiltration includes several different treatment mechanisms. Processes such as sorption, filtration, and microbial degradation occur as runoff infiltrates through the soil matrix.

- *Sedimentation/density separation* - Density separation refers to the unit processes of sedimentation and flotation that are dependent on the density differences between the pollutant and the water to effect removal. Sedimentation is the gravitational settling of particles having a density greater than water. Flotation is similar to gravitational sedimentation except in the opposite direction. Typically, floatable materials such as trash, debris, and hydrocarbons are removed through treatment processes that utilize the location of these pollutants on the water surface for removal. Stormwater treatment that incorporates vegetation and or permanent water bodies usually has a diverse microbial population, and it is not possible to optimize conditions for all beneficial species.

- *Sorption* - Sorption refers to the individual unit processes of both absorption and adsorption. Absorption is a physical process whereby a substance of one state is incorporated into another substance of a different state (e.g., liquids being absorbed by a solid or gases being absorbed by water). Adsorption is the physiochemical adherence or bonding of ions and molecules (ion exchange) onto the surface of another molecule. In stormwater treatment application, particularly for highway runoff, the primary pollutant types targeted with absorption unit processes are petroleum hydrocarbons, while adsorption processes typically target dissolved metals, nutrients, and organic toxicants such as pesticides and polycyclic aromatic hydrocarbons (PAHs). Different types of filter media may provide either or both of these unit processes.

- *Filtration* - Filtration can encompass a wide range of physical and chemical mechanisms, depending on the filtering media, typically some sand media, natural soil, grassy vegetation, or mixes of chemically active ingredients such as perlite, zeolite, and granular activated carbon. Filtration removes particulate matter either on the surface of the filter or within the pore space of the filter. Filtration such as a sand filter can provide the added benefit of removing stormwater constituents that may be attached to solids such as metals and bacteria.

Filtration can also provide opportunities for sorption processes to occur, reducing dissolved and fine suspended constituents. Filtration can often be an effective preliminary treatment for stormwater, by increasing the longevity of downstream BMPs and reducing maintenance frequency.

- *Uptake/Storage* - Uptake and storage refer to the removal of organic and inorganic constituents by plants and microbes through nutrient uptake and bioaccumulation. Nutrient uptake converts required micro- and macro-nutrients into living tissue. In addition to nutrients, various algae and wetland and terrestrial plants accumulate organic and inorganic constituents in excess of their immediate needs (bioaccumulation). The ability of plants to accumulate and store metals varies greatly. Significant metal uptake by plants will not occur unless the appropriate species are selected.

- *Microbially mediated transformation* – Microbial activity promotes or catalyzes redox reactions and transformations including degradation of organic and inorganic pollutants and immobilization of metals. Bacteria, algae, and fungi present in the soil or water column are primarily responsible for the transformations. Stormwater treatment that incorporates vegetation or permanent water pools usually has a diverse microbial population. These transformations can remove dissolved nitrogen species, metals, and simple and complex organic compounds. Soils may be inoculated with desirable microbes to promote specific reactions.

Table 2 summarizes the stormwater-related pollutants of concern considered to be effectively removed by each treatment mechanism.

Table 2. Treatment Mechanism - Target Pollutant Matrix		Mechanism					
		Hydrologic Attenuation (1)	Density Separation	Sorption (chemical activity)	Filtration	Uptake/Storage (2)	Microbial Transformation (3)
Target Pollutant	Sediment/Particulate (suspended solids)	■	■		■		
	Nutrients (4)	■		■		■	■
	Oil and Grease	■	■	■	■		■
	Polycyclic Aromatic Hydrocarbons (PAH)	■	□	■	□	■	■
	Metals (particulate)	■	■		■		
	Metals (dissolved)	■		■	□	□	□

■ = *Treatment mechanism effective for target pollutant removal*

□ = *Depending on chemical activity of filter media*

(1) *Refers to infiltration which is credited for overall pollutant mass load reduction of all target pollutants primarily through volume reduction; pollutant removal is also achived through filtering, sorption, and microbial transformation in the soil column.*

(2) *Dependent on plant species*

(3) *Dependent on types of microbes present (in soil or water column)*

(4) *May not be considered a highway target pollutant, but included for completeness*

Treatment Effectiveness Matrix. Based on information compiled in the BMP Summary Reports, **Table 3** relates the treatment mechanisms utilized by each of the BMPs included in the BMP Selection Tool. The table indicates whether the treatment mechanism is a key (or main) pollutant removal mechanism of the BMP, or whether it is a secondary (or "associated") mechanism.

The lower portion of **Table 3** cross references **Table 2** with the current list of BMPs to identify which target pollutants are addressed by each BMP. The table indicates whether the BMP has high, moderate, or low capability of removing a target pollutant. The rating is largely a function of whether the BMP employs the key treatment mechanism identified to be effective at removing that particular pollutant. A BMP may be rated moderate or low for a target pollutant if the key treatment mechanism is a secondary process within the BMP. Alternatively, a BMP may be rated high for a target pollutant if at least one key treatment mechanism occurs as part of the BMP treatment process.

In application, this approach indicates that all of the BMPs included in the BMP Selection Tool are considered highly capable of removing particulates and total suspended solids, while infiltration, bioretention, bioslope, and constructed wetlands are the BMPs with high capability to remove dissolved metals. Porous pavements are also considered effective at removing dissolved metals, but are not considered to be stand-alone BMPs and will require the approval of the ODOT Pavement Engineer prior to use on a project. Soil-amended grass swales and filter strips, extended dry detention ponds and wet ponds, proprietary filtration facilities and media

filters may also be moderately effective for dissolved metals. Similarly, the matrix can be used to identify which BMPs are considered effective in removing the other target pollutants.

Table 3. Treatment Mechanism - BMP Matrix		Best Management Practice																
		Pretreatment		Infiltration				Filtration				Pool-Ponds			Space-constrained or Urban Application			
		Oil Control Facilities (pretreatment)	Sediment Control (pretreatment)	Infiltration pond	Bioretention	Bioslope	Porous Pavement (not stand-alone)	Grass Swale (soil amended)	Filter Strip (soil amended)	Grass Swale (no soil amendment)	Filter Strip (no soil amendment)	Constructed Wetlands	Extended Detention Dry Pond	Wet Ponds	Wet Vaults	Media Filters (non-proprietary)	Proprietary Separation (pretreatment)	Proprietary Filtration Facilities
Treatment Mechanism	Hydrologic Attenuation			■	■	■	■	□	□	□	□	□	■	□				
	Density Separation (Sedimentation or Flotation)	■	■	□	□	□		□	□	□	□	■	■	■	■		■	
	Sorption	□		□	■	■		■	■	□	□	■	□	□		□	□	■
	Filtration	□	□	■	■	■		■	■	■	■	□	□	□		■	□	■
	Uptake/Storage[1]			□	■	□		□	□	□	□	■	□	□				
	Microbial Transformation[1]			□	■	□		□	□	□	□	■	□	□		□		□
Target Pollutant	Sediment/Particulate (suspended solids)	○	●	●	●	●	○	●	●	●	●	●	●	●	○	●	●	●
	Nutrients			●	●	●	○	○	○	○	○	●	○	○		-		
	Oil and Grease	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○
	Polycyclic Aromatic Hydrocarbons (PAH)			●	●	●	○	○	○	○	○	●	○	○		○		
	Metals (particulate)	○	○	●	●	●	○	●	●	●	●	●	●	●	○	●	●	●
	Metals (dissolved)			●	●	●	-	●	●	○	○	●	○	○		○		●

■ = *Key treatment mechanism for BMP*

□ = *Associated treatment mechanism for BMP; dependent on plant species/microbes present*

● = *High capability to remove target pollutant*

○ = *Moderate capability to remove target pollutant*

\- = *Low capability to remove target pollutant*

(1) *Dependent on types of plant species or microbes (in soil or water column) present*

Using "treatment mechanisms" (or unit processes) to define a BMP's effectiveness at removing target pollutants circumvents the need to rely strictly on the wide-ranging removal efficiency data for this purpose. ODOT, FHWA, and the regulatory agencies have stated their support in using this approach to define treatment effectiveness of the BMPs in the BMP Selection Tool. It also allows for new BMPs to be easily integrated into the framework.

5.0 BMP Selection Tool – Metric Ratings

As noted in Section 2, the BMP Selection Tool includes metrics and ratings for treatment suitability (effectiveness) for POC, site suitability and physical constraints, maintenance needs and constraints, and costs. The draft ratings for the BMPs included in the BMP Selection Tool are summarized in **Table 4.**

The treatment effectiveness ratings are based on the approach described in this memorandum. ODOT maintenance staff were consulted to develop the ratings for the maintenance metrics. The site suitability and physical constraints metrics are based on information from the literature review and design criteria in the *ODOT Hydraulics Manual*.

Table 4. BMP Performance Summary Table*

Rank:
● = high ○ = medium - = low
blank = none/not applicable

		Best Management Practice																
		Pretreatment		Infiltration				Filtration				Pool-Ponds			Space-constrained or Urban Application			
		Oil Control Facilities (pretreatment)	Sediment Control (pretreatment)	Infiltration Pond	Bioretention	Bioslope	Porous Pavement (not stand-alone)	Grass Swale (soil amended)	Filter Strip (soil amended)	Grass Swale (no soil amendement)	Filter Strip (no soil amendment)	Wetlands	Extended Detention Dry Pond	Wet Ponds	Wet Vaults	Media Filters (non-proprietary)	Proprietary Separation Facilities *	Proprietary Filtration Facilities *
Application to Stormwater Management Objectives[1]	Water Quality	-	-	○	●	●	○	●	●	●	●	●	○	○	○	●	●	●
	Channel Protection			●	●	○	●	-	-	-	-	●	●	○	●			
	Peak Discharge			●	●	○	●	-	-	-	-	●	●	●	●	-		
	Recharge			●	○	●	●	-	-	-	-	-	-	-				
Receiving Water Application[2]	Drinking Water Protection	-	-	-	○	○	-	○	○	○	○	●	○	●	●	●	●	●
	Aquatic Species Protection	-	-	●	○	●	●	○	○	○	○	●	○	○	○	○	-	-
	Water Quality Protection	-	-	●	●	●	●	○	○	○	○	●	○	●	-	○	●	●
	Wetlands Protection	-	-	○	○	●	○	○	○	○	○	●	○	●	-	-	-	-
	Sensitive Lakes Protection	-	-	○	○	●	○	-	-	-	-	○	○	●	-	-	-	-
Water Quality - Treatment Effectiveness[3]	Sediments (TSS)	○	●	●	●	●	○	●	●	●	●	●	●	●	○	●	●	●
	Nutrients:			●	●	●	○	○	○	○	○	●	○	○		-		
	Oil and Grease	●	○	○	○	○	○	○	○	○	○	○	○	○	○	○	●	○
	Polycyclic Aromatic Hydrocarbons			●	●	●	○	○	○	○	○	●	○	○		○		
	Metals (particulate)	○	○	●	●	●	○	●	●	●	●	●	●	●	○	●	●	●
	Metals (dissolved)			●	●	●	-	●	●	○	○	●	○	○		○		●

Rank:
↑ = large ↔ = medium ↓ = small blank = none/not applicable

Physical Site Suitability[4]	Surface Area (large is greater area)	↓	↓	↔	↓	↔	↓	↔	↔	↔	↔	↑	↑	↑	↓	↔	↓	↓
	Drainage Area (large is greater area)	↓	↓	↑	↓	↔	↓	↔	↔	↔	↔	↑	↑	↑	↓	↓	↓	↓
	Soil Infiltration Rate (large is higher rate)			↑	↑	↑	↑	↔	↔	↔	↔	↓	↓	↓				
	Slope (gradient) (large is steeper)			↓	↔	↓	↓	↔	↔	↔	↔	↓	↔	↓		↓		
	Groundwater depth (large is deeper)			↔	↔	↔	↔	↔	↔	↔	↔	↑	↑	↑		↑		
	Confined space/safety (large is greater required)	↑	↔	↓	↓	TBD	TBD	↓	↓	↓	↓	↓	↔	↔	↑	↓	↑	↑
	Dependency on Soil Characteristics		↓	↑	↑	↔	↑	↔	↔	↔	↔	↑	↑	↑				

Rank:
H = High M = Medium L = Low blank = none/not applicable

Maintenance Factors	Maintenance level of effort	M	M+	M+	M	TBD	TBD	L	L	L	L	L	M	M+	H	M	H+	H
	Frequency of maintenance	M	M+	M+	M+	TBD	TBD	L	L	L	L	L	M	M+	H	M	H	H
	Reliability/durability (appurtenances)	M	L	L	L	TBD	TBD	L	L	L	L	L	L	M+	H	L	H	H
	Need for "specialized" equipment	M	L	H	L	TBD	TBD	L	L	L	L	L	L	M	H	L	H+	H
	O&M Cost (including waste disposal)	H	M+	H	M	TBD	TBD	L	L	L	L	H	M+	H	H	M	H+	H

Rank:
"+" = Favorable "/" = Neutral "-" = Unfavorable blank = none/not applicable

Non-Design Factors[5]	Community Acceptance	/	/	/	+	+	/	/	/	/	/	+	/	/	/	/	/	/
	Construction Cost	/	/	-	/	/	-	+	+	+	+	-	-	-	-	/	/	/
	Wildlife Habitat			/	+	/		/	/	/	/	+	/	+				

**See notes for Rating Categories on the next page.*
Assumes soil amendmants (compost; organic materials) are used to enhance pollutant removal and effectiveness
Assumes appropriate plantings (e.g. metal hyper-accumulating species) are used.

Notes to for Table 4.

1. Application to Stormwater Management Objectives

Water Quality – Objective for sites subject to water quality goals or requirements (see Matrix Component 2). In almost all cases, water quality objective is applicable. Specific water quality objectives are addressed further under Matrix Component 2.
Channel Protection – Objective for sites subject to channel protection requirements to protect streams.
Peak Discharge – Objective for sites subject to flood control. In almost all cases, flood control objective is applicable.
Recharge – Objective for sites subject to a recharge requirement to infiltrate runoff.
(1) Ratings (low, medium, high) are qualitative in nature and are based on a compilation of design criteria and effectiveness factors. These rating are to be applied in the context of comparing BMPs within the BMP selection process.

2. Receiving Water Application

Drinking water Protection – For groundwater; use the sensitive lakes category to define BMP design restrictions for surface water drinking supplies.
Aquatic Species Protection – minimizes channel erosion; provides channel protection; promotes baseflow; stream temperature.
Water Quality Protection – provides enhanced pollutant removal for TMDL/303(d) listed pollutants of concern (corresponds with Matrix Component 3).
Wetlands Protection – maintains wetland hydroperiods and provides enhanced removal of nutrient (phosphorus) loads.
Sensitive Lakes Protection – provides enhanced removal of nutrient loads (primarily phosphorus).
***Rating Notes:*
High – provides positive benefits to meet needs under receiving water category.
Medium – provides limited benefit or is not a detriment to receiving water category.
Low – Potentially detrimental to receiving water category.

3. Water Quality Treatment Effectiveness

Based on treatment mechanisms documented in this memo.
Data Sources:
NCHRP. 2006. Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control.
Portland Bureau of Environmental Services. 2006. Effectiveness Evaluation of Best Management Practices for Stormwater Management in Portland, Oregon.
Water Environment Research Federation. Undated. International Stormwater BMP Database. www.bmpdatabase.org

4. Physical Site Suitability

Surface Area – size of surface area BMP requires in terms of percentage total contributing surface area.
Surface Area Rating: Small <5%; Medium <10%, Large >10% of impervious area
Drainage Area – size of drainage area generally acceptable for the "conventional" application of the BMP.
Drainage Area Rating: Small < 2 acres; Medium <10 acres, Large >10 acres of drainage area
Soil Infiltration Rate – acceptable soil infiltration rates for optimum BMP performance.
Soil Infiltration Rate Rating: Small < 0.5 in/hr; Medium <2.5 in/hr; Large >2.5 in/hr
Slope (gradient) – acceptable site slopes/topography to construct BMP and allow proper function.
Slope Rating: Small <2%; Medium <5%; Large >5% slope
Groundwater level – depth to groundwater allowable for proper function of BMP
Groundwater Level Rating: Shallow/Small <10 ft below ground surface; Medium <50 ft bgs; Deep/Large >50 feet bgs
Dependency on Soil Characteristics – Dependency as it relates to maintaining treatment effectiveness.

5. Maintenance Factors

Based on input provided by ODOT maintenance staff and consideration of literature.
Data Sources:
NCHRP. 2006. Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control.

6. Non-Design Factors

Community acceptance – accounts for general sense of visual preference, reported nuisance problems, vegetative management; subjective in nature.
Construction Cost – general cost rating to construct the BMP. Rating should not preclude preparing design-level engineering cost estimates when evaluating the preferred alternative.
Wildlife Habitat – provides potential habitat for wildlife.
***Ratings (favorable, neutral, unfavorable) are qualitative in nature and are based on a compilation of information from references on these factors. The rating is to be applied in the context of comparing BMPs within the BMP selection process.*