CHAPTER 4:

4 CONSTRUCTION SITE BEST MANAGEMENT PRACTICES

A critical next step in protecting water quality is the implementation of stormwater, non stormwater, and waste management control BMPs during construction. Construction Site BMPs are applied during construction activities to reduce the pollutants in storm water discharges throughout construction. These Construction Site BMPs provide both temporary erosion and sediment control. There are six categories of BMPs suitable for temporary erosion and sediment control on construction sites. They are:

- Soil Stabilization Practices;
- Sediment Control Practices;
- Tracking Control Practices;
- Wind Erosion Control;
- Non-storm Water Controls; and
- Waste Management and Material Pollution Controls.

It is generally accepted that practices that perform well by themselves can be complemented by other practices to raise the collective level of erosion control effectiveness and sediment retention. Effective erosion and sediment control planning relies on a system of BMPs (e.g., mulches for source control, fiber rolls on slopes for reducing runoff velocities, silt fence at the toe of slopes for capturing sediment, etc.) which is commonly referred to as a treatment train.

The greatest water pollution threat from soil-disturbing activities is the introduction of sediment from the construction site into storm drain systems or natural receiving waters. Soil-disturbing activities such as clearing, grading, grubbing, and earthwork increase the exposure of soils to wind, rain, and concentrated flows that cause erosion. A three-pronged approach is necessary to combat this storm water threat:

- Temporary soil stabilization practices reduce erosion associated with disturbed soil areas (DSAs).
- Temporary run-on control practices prevent storm water flows (sheet and concentrated) from contacting DSAs.
- Temporary sediment control practices reduce sediment caused by erosion from entering a storm drain system or receiving water.

Soil stabilization BMPs reduce the erosive impact of rain on exposed soil. Run-on control practices reduce the erosive impacts by preventing storm water flows from contacting DSAs. Sediment control BMPs remove sediment from storm water by ponding and settling, and/or filtering prior to discharge offsite. It is imperative that soil stabilization and sediment control BMPs are implemented together to reduce the discharge of sediment from the construction site.

The following conditions on construction sites contribute to erosion caused by storm water flows:

- Larger areas of impermeable structures and surfaces reduce natural infiltration resulting in increased storm water flow volume and velocity.
- Changes to surface flow patterns cause storm water flows to be more erosive.
- Concentration of flows to areas that are not naturally subjected to such runoff volume increases erosion.

Proper management of a construction project minimizes or prevents soil erosion and sediment discharges. Good construction management for soil conservation requires an understanding of the following basic principles:

Soil Erosion Control – The First Line of Defense

Soil stabilization is a key component in the control of erosion. By stabilizing DSAs with covers or binders, the exposed soils are less likely to erode from the effects of wind or rain.

Prevent Storm Water Flows from Contacting DSAs – The Second Line of Defense

Another key component in the control of erosion is the diversion of storm water flows around DSAs or the conveyance of flows through DSAs in a non-erosive manner.

Sediment Control – The Last Line of Defense

Storm water runoff may originate from active or inactive DSAs whether or not proper erosion and/or run-on controls have been implemented. Implementing proper sediment control BMPs can reduce sediment amounts in storm water discharges.

Combine Soil Erosion and Sediment Control – Effective Protection

An effective combination of soil erosion and sediment controls should be implemented to prevent sediment from leaving the site and/or entering a storm water drainage system or receiving water.

Soil stabilization and other erosion control BMPs are not 100 percent effective at preventing erosion. Soil erosion control BMPs must be supported by sediment control BMPs to capture sediment on the construction site.

Sediment control BMPs alone are not 100 percent effective primarily due to their capacity limits. To be effective for storm water protection, the amount of sediment must be reduced at the source using soil erosion control BMPs, and then sediment control BMPs are used to further reduce the sediment that leaves the site or enters the storm drain system.

Inspection and Maintenance – Ensure Protection for the Duration of the Project

Inspection and maintenance are required for all BMPs (soil stabilization, run-on control, and sediment control) to maintain effectiveness for reducing or eliminating the amount of sediment that leaves a site.

Post Construction

The key to getting the post-project site to function (from a stormwater runoff standpoint) similar to a natural, undisturbed site is to restore the functionality that has been removed. In general, the successful and sustainable erosion control solution addresses:

1. Soil Cover:

   Bare soil requires the protective cover provided by a mulch product (bark mulch, compost blanket, pine needles, straw, duff) or hydroseeding. These products protect the soil surface from erosion due to raindrop impact and sheet flow.

2. Healthy Soil:

   Healthy soils maintain stormwater quality and control erosion by their open structure that facilitates infiltration of runoff, and by providing the nutrients and soil biota necessary to support long-term sustainable vegetative cover. To maintain stormwater quality, disturbed roadsides that feature highly compacted sterile soils typically require de-compaction and/or incorporation of organics such as compost to restore soil health.

3. Sustainable Vegetation:

   Sustainable vegetation is dependent upon selecting the proper mixture of plant types (grass, annual, perennial, forb, cutting, sod, liner, woody shrub) and species for specific site environmental conditions (geographic location, elevation, exposure, soil type). The short-term goal is to quickly establish vegetative cover to provide protection from raindrop impact and sheet-flow erosive forces. The long-term goal is to establish healthy mature vegetation that requires minimal replanting, supplemental water, or maintenance.

An erosion control solution that ensures that well drained soil including organic material and healthy soil biota, a surface mulch layer of duff/mulch, together with regionally appropriate plant material mimics the functionality of the natural environment, and with time should perform in a similar manner - protecting water quality and managing the runoff rate and volume.

4.1 Construction Operations and Applicable Best Management Practices Matrix

Prior to any ground disturbing activities, the physical condition of the construction site and adjacent areas should be reviewed by members of the PDT and Contractor Construction Staff. A project design package showing what is being constructed, limits of construction, avoidance areas/ sensitive areas, project schedule, and contract requirements will be provided to contractor. Site characteristics including drainage patterns, soils, vegetation, surface water bodies, and steep or unstable slopes should be noted. If available, the hydrology report, soils report, and a grading/drainage plan should also be consulted. Physical conditions at the site will change as construction progresses; BMP application should change accordingly to ensure effective protection is maintained throughout construction milestones.

To meet regulatory requirements and protect the site resources, every project must include an effective combination of erosion and sediment control measures within the SWPPP/IWPPP. These measures must be selected from all of the BMP categories presented in this section: soil stabilization practices, sediment control practices, tracking control practices, and wind erosion control practices. Additionally, the project plan must include non-storm water controls, waste management and material pollution controls. These practices are identified in the erosion control plan, also known as the SWPPP.

The SWPPP/IWPPP is more than just and erosion control plan. A SWPPP is a tool that aids in managing pollution during construction. A SWPPP is a written documents that describe the pollution prevention practices and activities that will be implemented on the site. It includes descriptions of the site and of each major phase of the planned activity, the roles and responsibilities of contractors and subcontractors, procedures that will be implemented to comply with the terms and conditions of the construction general permit and the inspection schedule and logs. It is also a place to document changes and modifications to the construction plans and associated stormwater pollution prevention activities.

Also, SWPPPs are designed to be amended whenever there is a change in design, construction, operation, or maintenance, which has a significant effect on the potential for discharge of pollutants to surface WUS, state or a MS4. The SWPPP is also amended if BMPs prove to be ineffective in managing POCs from sources identified during inspection, or when any new contractor and/or subcontractor will implement any measure of the SWPPP. All amendments are signed, dated, and kept as attachments to the original SWPPP. This ensures that SWPPPs are kept up to date with changes on the construction site.

However, historically many key construction permit applications (including the 404 and 401-water quality certifications) have required that a list of appropriate BMPs proposed for a specific project, along with the required site plan, description, and location of those BMPs be provided. A common issue with this approach is that a construction contractor has not been selected at the time of issuance for these permits. To address this, the project designer provides layout sheets showing the suggested locations of Construction Site BMPs. The purpose of these sheets is to show the contractor the designer's anticipated placement of Construction Site BMPs such as contractor staging areas, approximate location of concrete washouts, approximate locations for storage of materials, and preferred locations for vehicle and equipment maintenance. However, the contractors input into the layout are unavailable during development. Typically, these layouts are not highly detailed drawings and are commonly drawn on l:200 and l:500 scale. Where multiple stages of construction are anticipated, the designer attempts to show the various stages of construction and how the deployment of the BMPs is expected to change over time. These locations and layouts will be, in most cases, subject to the contractor's phasing of the work and timing of operations. As a result, many of the suggested locations are immediately modified by the contractor in the SWPPP/IWPPP as construction phasing is identified.

Contractors and designers need to carefully think through many factors to choose the most appropriate, effective and feasible practice(s) at a construction site that will best

meet Federal, state and local stormwater and water quality objectives. Rather than relying on the suggested temporary BMP locations, and acknowledging the Contractor is ultimately responsible for developing a SWPPP that complies with the Permit, FHWA is attempting to factor in more flexibility into BMP selection.

Proper BMP selection requires that a stormwater manager select those BMPs most able to address an identified pollution source. Selecting an inappropriate BMP for a site could lead to adverse resource impacts, friction with regulators if a BMP does not work as anticipated, misperceptions about stormwater control success, and wasted time and money. Careful selection of BMPs will prevent negative impacts from installing the wrong BMP at the wrong location. .

The number, location and type of applicable BMPs is variable and depends on project design and generally must be determined on a case by-case basis. There is no minimum number of practices that are appropriate to various projects. Following permit approval, it is common that BMPs need to be modified as a contractor develops their methods and means of construction on the project. This commonly requires that BMPs be modified, moved, or substituted to ensure they continue to meet project goals. The SWPPP is a living document and must be developed or amended to address conditions as activities change at the site. The utilization of preferred construction BMPs from six control categories allows improved coordination with the contractor during the development of the SWPPP and adaptive management of BMPs during construction as one preferred construction BMPs is substituted for another in the SWPPP/IWPPP rather than being static.

The goal of the below matrices is to allow a suite of preferred construction BMPs to be identified during the permitting process. Following permit approvals, the PDT including contractors can then use the project design specifications to refine the BMP list in the project site plan of the SWPPP/IWPPP. This approach allows projects to adaptively manage project BMPs as site conditions change, construction phasing changes or construction milestones are reached.

The BMP Matrices in this section cross-reference individual BMPs with the most common construction activities that can release pollutants. Therefore, in Table 4 the horizontal axis of the matrix (across the top) lists typical highway construction activities. The BMPs appropriate for those construction activities are listed on the vertical axis (down the left hand side of the page). This table groups BMPs with major construction operations which will assist with BMP management during construction phasing.

The matrix in Table 5 further refines the construction BMPs by grouping BMPs into BMP categories including: soil stabilization practices, sediment control practices, tracking control practices, and wind erosion control practices, non-storm water controls, waste management and material pollution controls. These BMP categories are cross referenced against typical highway construction activities.

Detailed descriptions and guidance regarding implementation of these BMPs may be found in the Construction BMP Field Manual (Appendix A), CFLHD Design Standards (Appendix E) or the Clear Water Diversion and Isolation Techniques (Chapter 5) which summarizes additional BMPs suitable for construction activities in, over or adjacent to

water or when water diversion and isolation techniques are required to complete the necessary construction activities.

The BMP Matrix includes the best information available to the FHWA and HDOT at this time regarding practices known to be appropriate for transportation projects. It is anticipated that this manual will be revised and supplemented in subsequent reviews of available BMP technologies. The list of BMPs provided in the matrix is not intended to be exhaustive. Rather, it is intended that members of the PDT may select BMPs other than those included in the BMP Matrix, so long as they treat the same POC and are an appropriate BMP for the particular construction activity.

The matrix format in Table 4 and 5 reflects the fact that there are a variety of BMPs that may be appropriate for a given project and that each project's circumstances are unique. The matrix identifies the most likely BMPs appropriate for different types of projects and for different types of pollutant scenarios. It also assists the PDT in determining if a specific BMP is not appropriate to a specific scenario. The individual BMPs designated by an "X" in Table 5 have been identified as applicable to a particular typical construction activity, but will not necessarily be appropriate for all projects involving the noted activity. For example, not all projects will have on-site vehicle fueling and maintenance operations; however, those that do will be required to conduct those operations in a manner consistent with the intent of the BMP description (Appendix A, Appendix E). These tables can assist construction staff to determine if a proposed practice is actually applicable to the desired pollution prevention or environmental protection outcome. It is intended to be a flexible tool.

Table 4. Storm Water BMPs for Construction Operations

Construction Operation	BMP Category	BMPs
Mobilization	Sediment Control	Street Sweeping and Vacuuming
	Tracking Control	Stabilized Construction Entrance/Exit
		Stabilized Construction Roadway
		Entrance/Outlet Tire Wash
	Non-Stormwater Control	Illicit Connection / Illegal Discharge Detection and Reporting
	Waste Management and Materials Pollution Control	Material Delivery and Storage
		Material Use
		Spill Prevention and Control
		Solid Waste Management
		Hazardous Waste Management
		Sanitary/Septic Waste Management
Clearing/Grubbing	Soil Stabilization	Scheduling
		Preservation of Existing Vegetation
		Hydraulic Mulch
		Hydroseeding
		Soil Binders
		Straw Mulch
		Geotextiles, Plastic Covers & Erosion Control Blankets/Mats
		Wood Mulching
		Earth Dikes/Drainage Swales & Lined Ditches
		Outlet Protection/Velocity Dissipation Devices
		Slope Drains
	Sediment Control	Silt Fence
		Desilting Basin
		Sediment Trap/ Filter bags
		Check Dam
		Fiber Rolls
		Gravel Bag Berm
		Street Sweeping and Vacuuming
		Sandbag Barrier
		Straw Bale Barrier
		Storm Drain Inlet Protection
	Wind Erosion Control	Wind Erosion Control
	Non-Stormwater Management	Water Conservation Practices
		Vehicle and Equipment Cleaning
		Vehicle and Equipment Fueling
		Vehicle and Equipment Maintenance
	Waste Management and Materials Pollution Control	Stockpile Management
		Solid Waste Management
		Contaminated Soil Management

Table 4. Storm Water BMPs for Construction Operations

Construction Operation	BMP Category	BMPs
Earthwork	Soil Stabilization	Scheduling
		Preservation of Existing Vegetation
		Hydraulic Mulch
		Hydroseeding
		Soil Binders
		Straw Mulch
		Geotextiles, Plastic Covers & Erosion Control Blankets/Mats
		Wood Mulching
		Earth Dikes/Drainage Swales & Lined Ditches
		Outlet Protection/Velocity Dissipation Devices
		Slope Drains
	Sediment Control	Silt Fence
		Desilting Basin
		Sediment Trap / Filter bags
		Check Dam
		Fiber Rolls
		Gravel Bag Berm
		Street Sweeping and Vacuuming
		Sandbag Barrier
		Straw Bale Barrier
		Storm Drain Inlet Protection
	Tracking Control	Stabilized Construction Entrance/Exit
	Wind Erosion Control	Wind Erosion Control
	Non-Stormwater Management	Temporary Stream Crossing
		Vehicle and Equipment Cleaning
		Vehicle and Equipment Fueling
		Vehicle and Equipment Maintenance
	Waste Management and Materials Pollution Control	Contaminated Soil Management
Portland Cement Concrete and Asphalt / Concrete Operations	Sediment Control	Street Sweeping and Vacuuming
	Tracking Control	Stabilized Construction Entrance/Exit
	Non-Stormwater Management	Paving and Grinding Operations
	Waste Management and Materials Pollution Control	Material Delivery and Storage
		Material Use
		Stockpile Management
		Solid Waste Management
		Concrete Waste Management
Drainage Work	Sediment Control	Desilting Basin
		Sediment Trap / Filter bags
		Check Dam
		Storm Drain Inlet Protection
	Soil Stabilization	Earth Dikes/Drainage Swales & Lined Ditches

Table 4. Storm Water BMPs for Construction Operations

Construction Operation	BMP Category	BMPs
		Outlet Protection/Velocity Dissipation Devices
Dewatering Operations	Non-Stormwater Management	Dewatering Operations
Bridge Construction	Non-Stormwater Management	Water Conservation Practices
		Paving and Grinding Operations
		Temporary Stream Crossing
		Clear Water Diversion and Isolation Techniques
		Vehicle and Equipment Cleaning
		Vehicle and Equipment Fueling
		Vehicle and Equipment Maintenance
	Waste Management and Materials Pollution Control	Material Delivery and Storage
		Material Use
		Stockpile Management
		Spill Prevention and Control
		Solid Waste Management
		Hazardous Waste Management
		Concrete Waste Management
		Liquid Waste Management
	Non-Stormwater Control	Paving and Grinding Operations
		Temporary Stream Crossing
		Clear Water Diversion and Isolation Techniques
Roadway Construction	Waste Management and Materials Pollution Control	Material Delivery and Storage
		Material Use
		Stockpile Management
		Solid Waste Management
		Hazardous Waste Management
		Concrete Waste Management
		Liquid Waste Management
Mobile Operations	Sediment Control	Street Sweeping and Vacuuming
		Storm Drain Inlet Protection
	Tracking Control	Stabilized Construction Entrance/Exit
	Non-Stormwater Control	Vehicle and Equipment Cleaning
		Vehicle and Equipment Fueling
		Vehicle and Equipment Maintenance
	Waste Management and Materials Pollution Control	Material Delivery and Storage
		Material Use
		Stockpile Management
		Solid Waste Management
		Hazardous Waste Management
		Concrete Waste Management
Trenching Operations	Sediment Control	Street Sweeping and Vacuuming
		Storm Drain Inlet Protection

Table 4. Storm Water BMPs for Construction Operations

Construction Operation	BMP Category	BMPs
	Waste Management and Materials Pollution Control	Stockpile Management
Erosion Control, Highway Planting and Landscaping	Soil Stabilization	Scheduling
		Preservation of Existing Vegetation
		Hydraulic Mulch
		Hydroseeding
		Soil Binders
		Straw Mulch
		Geotextiles, Plastic Covers & Erosion Control Blankets/Mats
		Wood Mulching
		Earth Dikes/Drainage Swales & Lined Ditches
		Outlet Protection/Velocity Dissipation Devices
	Sediment Control	Silt Fence
		Street Sweeping and Vacuuming
		Sandbag Barrier
		Straw Bale Barrier
		Storm Drain Inlet Protection
	Wind Erosion Control	Wind Erosion Control
	Non-Stormwater Control	Potable Water/Irrigation
		Vehicle and Equipment Cleaning
	Waste Management and Materials Pollution Control	Material Delivery and Storage
		Material Use

Table 5: Construction Site BMPs By Construction Activity

	Typical Highway Construction Activities																											
	Demolish Pavement/Structure	Clear and Grub	Construct Access Roads	Grading (including cut and fill slopes)	Channel Excavation	Channel Paving	Trenching/ Underground Drainage	Underground Drainage Facility Installation	Drainage Inlet Modification	Utility Trenching	Utility Installation	Subgrade Preparation	Base Paving	Asphalt Concrete Paving	Concrete Paving	Saw Cutting	Joint Sealing	Grind/Groove	Structure Excavation	Erect Falsework	Bridge/Structure Construction	Remove Falsework	Striping	Miscellaneous Concrete Work	Sound Walls/Retaining Walls	Planting and Irrigation	Contractor Activities	Treatment BMP Construction
Best Management Practices																												
Temporary Sediment Control																												
Silt Fence	X	X	X	X	X		X			X		X							X		X					X		X
Sandbag Barrier	X	X	X	X	X		X			X		X							X		X					X		X
Straw Bale Barrier	X	X	X	X	X		X			X		X							X		X					X		X
Fiber Rolls	X	X	X	X	X		X			X											X					X		X
Gravel Bag Berm	X	X	X	X	X		X			X											X					X		X
Check Dam	X	X		X	X		X																					X
Desilting Basin	X	X	X	X	X																X					X		X
Sediment Trap / Filter Bags	X	X	X	X	X		X			X		X							X		X					X		X
Sediment Basin		X		X	X																X					X		X
Temporary Soil Stabilization																												
Hydraulic Mulch	X	X		X	X																X					X		X
Hydroseeding	X	X		X	X																X					X		X
Soil Binders	X	X		X	X														X		X					X		X
Straw Mulch	X	X	X	X	X		X	X		X		X							X		X					X		X
Geotextiles, Mats/Plastic Covers and Erosion Control	X	X	X	X	X		X	X		X		X							X		X					X		X

Table 5: Construction Site BMPs By Construction Activity

	Typical Highway Construction Activities																									
	Demolish Pavement/Structure	Clear and Grub	Construct Access Roads	Grading (including cut and fill slopes)	Channel Excavation	Channel Paving	Trenching/ Underground Drainage	Underground Drainage Facility Installation	Drainage Inlet Modification	Utility Trenching	Utility Installation	Subgrade Preparation	Base Paving	Asphalt Concrete Paving	Concrete Paving	Saw Cutting	Joint Sealing	Grind/Groove	Structure Excavation	Erect Falsework	Bridge/Structure Construction	Remove Falsework	Striping	Miscellaneous Concrete Work	Sound Walls/Retaining Walls	Planting and Irrigation	Contractor Activities	Treatment BMP Construction
Best Management Practices																												
Scheduling	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X
Preservation of Existing Vegetation		X	X	X			X	X		X									X	X		X			X			
Temporary Concentrated Flow Conveyance Controls																												
Earth Dikes/Drainage Swales & Lined Ditches		X	X	X																	X							
Outlet Protection/Velocity Dissipation Devices		X	X	X																	X							
Slope Drains				X																	X							
Temporary Stream Crossing			X				X	X		X	X									X	X	X		X				
Clear Water Diversion and Isolation Techniques	X		X		X	X														X	X	X			X			X
Wind Erosion Control		X	X	X	X		X			X		X	X	X	X											X		X
Sediment Tracking Control	X	X	X	X	X		X	X		X	X	X	X	X	X	X		X	X		X				X	X	X	X

Table 5: Construction Site BMPs By Construction Activity

	Typical Highway Construction Activities																											
	Demolish Pavement/Structure	Clear and Grub	Construct Access Roads	Grading (including cut and fill slopes)	Channel Excavation	Channel Paving	Trenching/ Underground Drainage	Underground Drainage Facility Installation	Drainage Inlet Modification	Utility Trenching	Utility Installation	Subgrade Preparation	Base Paving	Asphalt Concrete Paving	Concrete Paving	Saw Cutting	Joint Sealing	Grind/Groove	Structure Excavation	Erect Falsework	Bridge/Structure Construction	Remove Falsework	Striping	Miscellaneous Concrete Work	Sound Walls/Retaining Walls	Planting and Irrigation	Contractor Activities	Treatment BMP Construction
Best Management Practices																												
Street Sweeping and Vacuuming	X	X	X	X	X		X	X		X	X	X	X	X	X	X		X	X		X				X	X	X	X
Stabilized Construction Roadway		X	X	X																								
Entrance/Outlet Tire Wash		X	X	X																						X	X	
Waste Management																												
Spill Prevention and Control	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Solid Waste Management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hazardous Waste Management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Contaminated Soil Management	X	X		X			X	X		X	X									X								
Concrete Waste Management	X		X			X		X			X		X		X	X		X	X		X			X	X	X	X	X
Sanitary/Septic Waste Management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Liquid Waste Management														X		X	X		X		X		X				X	X

Table 5: Construction Site BMPs By Construction Activity

	Typical Highway Construction Activities																									
	Demolish Pavement/Structure	Clear and Grub	Construct Access Roads	Grading (including cut and fill slopes)	Channel Excavation	Channel Paving	Trenching/ Underground Drainage	Underground Drainage Facility Installation	Drainage Inlet Modification	Utility Trenching	Utility Installation	Subgrade Preparation	Base Paving	Asphalt Concrete Paving	Concrete Paving	Saw Cutting	Joint Sealing	Grind/Groove	Structure Excavation	Erect Falsework	Bridge/Structure Construction	Remove Falsework	Striping	Miscellaneous Concrete Work	Sound Walls/Retaining Walls	Planting and Irrigation	Contractor Activities	Treatment BMP Construction
Best Management Practices																												
Materials Handling																												
Material Delivery, and Storage	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Material Use	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Vehicle and Equipment Operations																												
Vehicle and Equipment Cleaning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Vehicle and Equipment Fueling	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Vehicle and Equipment Maintenance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Paving Operations			X			X			X				X	X	X	X	X	X			X							
Stockpile Management	X		X					X		X	X		X	X	X			X										
Water Conservation Practices	X	X	X	X	X	X	X	X	X	X		X				X	X	X	X		X			X		X	X	X

Table 5: Construction Site BMPs By Construction Activity

	Typical Highway Construction Activities																										
	Demolish Pavement/Structure	Clear and Grub	Construct Access Roads	Grading (including cut and fill slopes)	Channel Excavation	Channel Paving	Trenching/ Underground Drainage	Underground Drainage Facility Installation	Drainage Inlet Modification	Utility Trenching	Utility Installation	Subgrade Preparation	Base Paving	Asphalt Concrete Paving	Concrete Paving	Saw Cutting	Joint Sealing	Grind/Groove	Structure Excavation	Erect Falsework	Bridge/Structure Construction	Remove Falsework	Striping	Miscellaneous Concrete Work	Sound Walls/Retaining Walls	Planting and Irrigation	Contractor Activities	Treatment BMP Construction
Best Management Practices																											
Potable Water/Irrigation																											
Dewatering Operations	X			X	X	X	X	X	X	X	X								X		X			X	X	X		X
Illicit Connection/Illegal Discharge Detection and																											
Storm Drain Inlet Protection	X	X	X	X	X		X	X	X	X		X	X			X	X	X	X								X	X
Stabilized Construction Entrance/Exit		X	X	X																						X		X

X BMP may be applicable to activity

4.2 CONSTRUCTION BMPS

Specifications for construction BMPs can be found in FHWA FP 14 Standard Specifications and HDOT Construction BMP Field Manual (Appendix A) and CFLHD Standard Details (Appendix E).

4.2.1 SOIL STABILIZATION BMPS

Examples of Temporary Soil Stabilization BMPs include:

- Scheduling;
- Preservation of Existing Vegetation;
- Hydraulic Mulch;
- Hydroseeding;
- Soil Binders;
- Straw Mulch;
- Geotextiles, Plastic Covers and Erosion Control Blankets;
- Wood Mulching;
- Earth Dikes/Drainage Swales and Ditches;
- Outlet Protection/Velocity Dissipation Devices; and
- Slope Drains.

Provided on Table 5 are selection criteria information and ratings for temporary soil stabilization BMPs. The BMPs are described in detail following Table 6.

Table 6: Temporary Soil Stabilization Criteria Matrix

CLASS	TYPE	TEMPORARY SOIL STABILIZATION CONTROL CRITERIA													
		Antecedent Moisture	Availability	Ease of Clean-Up	Installed Cost Per Ha	EC Effectiveness (%)	Degradability	Length of Drying Time (hrs)	Time to Effectiveness (days)	Longevity	Mode of Application	Residual Impact	Native	Runoff Effect	Water Quality Impact
CATEGORY: STANDARD BIODEGRADABLE MULCHES (SBM)															
Straw Mulch	Wheat Straw	D	S	H	$5,200	90-95	B	0	1	M	L/M	M		+	M
	Rice Straw	D	S	H	$5,200	90-95	B	0	1	M	L/M	M		+	L
Wood Fiber Mulch	Wood Fiber	D	S	H	$2,200	50-60	B	0-4	1	M	H	L		+	M
Recycled Paper Mulch	Cellulose Fiber	D	S	H	$2,100	50-60	B	0-4	1	S	H	L		+	L
Bonded Fiber Matrix	Biodegradable	D	S	H	$13,600	90-95	B	12-18	1	M	H	M		+	H
CATEGORY: ROLLED EROSION CONTROL PRODUCTS (RECP)															
Biodegradable	Jute Mesh	D	S	H	$16,000	65-70	B		1	M	L	M		+	UNK
	Curled Wood Fiber	D	S	H	$26,000	85-90	P/B		1	M	L	M		+	L
	Straw	D	S	H	$22,000	85-90	P/B		1	M	L	M		+	H
	Wood Fiber	D	S	H	$22,000	85-90	P/B		1	M	L	M		+	L
	Coconut Fiber	D	S	H	$32,000	90-95	P/B		1	L	L	M		+	L
	Coconut Fiber Mesh	D	S	H	$77,000	85-90	B		1	L	L	M		+	UNK
	Straw Coconut Fiber	D	S	H	$27,000	90-95	P/B		1	L	L	M		+	M
Non-Biodegradable	Plastic Netting	D	M	H	$5,000	<50	P		1	L	L	H		+	UNK
	Plastic Mesh	D	M	H	$8,000	75-80	P		1	L	L	H		+	UNK
	Synthetic Fiber with Netting	D	M	H	$86,000	90-95	P		1	L	L	H		+	UNK
	Bonded Synthetic Fibers	D	M	H	$121,000	90-95	P		1	L	L	H		+	UNK
	Combination with Biodegradable	D	M	H	$79,000	85-90	P		1	L	L	H		+	UNK
CATEGORY: TEMPORARY SEEDING (TS)															
High-Density	Ornamentals		S-M	H	$1000 - $4000	50-60			28	M-L	H	L-M	N/E	+	UNK

	Turf species		S	H	$900	50-60			28	L	H	M-H	N/E	+	UNK
	Bunch grasses		S-M	H	$750 - $3200	50-60			28	L	H	L-M	N	+	UNK
Fast-Growing	Annual		S	H	$900 - $1,600	50-60			28	L	H	L-H	N/E	+	UNK
	Perennial		S	H	$800 - $2000	50-60			28	L	H	M	N/E	+	UNK
Non-Competing	Native		S-M	H	$700 - $4000	50-60			28	L	H	L-M	N	+	UNK
	Non-Native		S-M	H	$1000 - $1200	50-60			28	L	H	L-H	E	+	UNK
Sterile	Cereal Grain		S	H	$1,200	50-60			28	L	H	L	E	+	UNK
CATEGORY: IMPERVIOUS COVERS (IC)																
Plastic	Rolled Plastic Sheeting		S		$17,000	100	P		1	M	L	H		-	UNK
	Geotextile (Woven)		S		$14,800	90-95	P		1	M	L	H		-	UNK
CATEGORY: HYDRAULIC SOIL STABILIZERS (HSS)																
(PBS) Plant Material Based- Short Lived	Guar	D	S	H	$1,000	80-85	B	12-18	Same as Length of	S	B	L		0/+	M/L
	Psyllium	P	S	H	$1,000	25-35	B	12-18		M	B	L		0	L/H
	Starches	D	S	H	$1,000	25-30	B	9-12		S	H	L		0	L
(PBL) Plant Material Based- Long Lived	Pitch/ Rosin Emulsion	D	S	M	$3,000	60-75	B	19-24		M	B	M		-	H
(PEB) Polymeric Emulsion Blends	Acrylic polymers and copolymers	D	S	M	$3,000	35-70	P/C	19-24		L	B	M		+/-	L/M
	Methacrylates and acrylates	D	M	M	$1,000	35-40	P/C	12-18		S	W	L		0/+	L
	Sodium acrylates and acrylamides	D	M	M	$1,000	20-70	P/C	12-18		S	H	L		+/-	L/M
	Polyacrylamide	D	M	M	$1,000	55-65	P/C	4-8		M	H	L		0/+	L
	Hydro-colloid polymers	D	M	H	$1,000	25-40	P/C	0-4		M	H	L		0/+	L/M
(PRB) Petroleum/ Resin-Based Emulsions	Emulsified Petroleum Resin	D	M	L	$3,000	10-50	P/C	0-4		M	B	M		0/-	H
(CBB) Cementitious Based Binders	Gypsum	D	S	M	$2,000	75-85	P/C	4-8		M	H	L		-	M/H

Antecedent Moisture	D P	Soil should be relatively dry before application Soil should be pre-wetted before application
Availability	S M	A short turn-around time between order and delivery, usually 3-5 days A moderate turnaround time, between 1-2 weeks
Ease of Clean-Up	L M H	Require pressure washing, a strong alkali solution, or solvent to clean up Requires cleanup with water while wet; more difficult to clean up once dry May be easily removed from equipment and overspray areas by a strong stream of water
Installed Cost		Dollars per hectare
Degradability	C P B	Chemically degradable Photodegradable Biodegradable
Length of Drying Time		Estimated hours
Time to Effectiveness		Estimated days
Erosion Control Effectiveness		Percent reduction in soil loss over bare soil condition.
Longevity	S M L	1 - 3 months 3 – 12 months > than 12 months

Application Mode	L W H B M	Applied by hand labor Applied by water truck Applied by hydraulic mulcher Applied by either water truck or hydraulic mulcher Applied by a mechanical method other than those listed above (e.g., straw blower)
Residual Impact	L M H	Projected to have a low impact on future construction activities Projected to have a moderate impact on future construction activities Projected to have a significant impact on future construction activities
Native	N E	Plant or plant material native to the State of Hawaii Exotic plant not native to the State of Hawaii
Runoff Effect	+ 0 -	Runoff is decreased over baseline (bare soil) No change in runoff from baseline Runoff is increased over baseline
Water Quality Impact	L M H	Low potential to impact water quality Moderate potential to impact water quality Higher potential to impact water quality

4.2.1.1 Scheduling

This BMP involves developing, for every project, a schedule that includes sequencing of construction activities with the implementation of Construction Site BMPs such as temporary soil stabilization (erosion control) and temporary sediment control measures. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

4.2.1.2 Preservation of Existing Vegetation

Preservation of existing vegetation is the identification and protection of desirable vegetation that provides erosion and sediment control benefits. Whenever practical, existing vegetation should be preserved. Plants and trees act as effective soil stabilization and sediment control devices, particularly around the perimeter of construction sites. Areas that will not be disturbed as part of construction activities should be clearly marked on plans and protected in the field with fencing prior to clearing and grubbing. Access limitations should also be shown on the plans and described in the Special Contract Requirements (SCR). Any damage to preservation areas should be repaired immediately.

Items to consider when preserving existing vegetation include:

- Preserve existing vegetation to provide effective erosion control;
- Consider the age, life expectancy, health, aesthetic value, and habitat benefits of vegetation to be preserved;
- Areas containing vegetation to be preserved must be shown on the plans; and
- Preserve native plants on the site wherever possible.

4.2.1.3 Hydraulic Mulch

Hydraulic mulch consists of applying a water-based mixture of wood or paper fiber and stabilizing emulsion with hydro-mulching equipment. This will protect disturbed soil from erosion by raindrop impact or wind.

4.2.1.3.1 Type: Wood Fiber

Wood fiber mulch is generally used as a component of hydraulic applications. It is usually used in combination with seed, fertilizer and other materials, and is typically applied at the rate of 2,250 to 4,500 kilograms per hectare (kg/ha).

Wood fiber mulch can be specified with or without a tackifier. Data shows that wood fiber mulches with tackifiers have better erosion control performance.

4.2.1.3.2 Type: Recycled Paper

Recycled paper mulch is generally used in hydraulic applications. It is usually used in combination with seed and fertilizer and is typically applied at the rate of 2,250 to 4,500 kg/ha.

4.2.1.3.3 Type: Cellulose Fiber

Cellulose fiber mulch contains fibers of shorter length than wood fiber mulches and is typically made from recycled newsprint, magazine, or other waste paper sources. It can be specified with or without a tackifier.

4.2.1.3.4 Type: Bonded Fiber Matrix

A bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion-resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 3,400 to 4,500 kg/ha based on the manufacturer's recommendation.

The biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall so that the matrix will have an opportunity to dry for 24 hours after application.

4.2.1.4 Hydro seeding

Hydro seeding consists of applying a water-based mixture of wood or paper fiber, stabilizing emulsion, and seed with hydro-mulching equipment. This is usually a multi-step process with a layer of straw. Often fertilizer and compost are added to the hydraulic mixture. This will protect disturbed soil from erosion by raindrop impact or wind. Hydraulic mulches are typically combined with a seed mixture for achieving longer term temporary soil stabilization than by hydraulic mulching alone. The selection of plant materials to be included in the seed mixture can be based, in part, on the length of time temporary stabilization is required.

4.2.1.5 Soil Binders

Soil binders, also known as soil stabilizers, are adhesives that stabilize soil by binding soil particles together. This will protect disturbed soil from erosion by raindrop impact or wind. Soil binders can also be used in combination with hydraulic mulches to improve their erosion control effectiveness.

There are five types of soil binders:

- Plant Material-Based (Short-Term);

- Plant Material-Based (Long-Term);
- Polymeric Emulsion Blends;
- Petroleum or Resin-Based Emulsions; and
- Cementitious-Based Binders.

4.2.1.5.1 Type: Plant-Material Based (Short-Term)

4.2.1.5.1.1 Guar

Guar is a non-toxic, biodegradable, natural galactomannan-based hydrocolloid treated with dispersant agents for easy field mixing. It should be applied at the rate of 1.2 to 1.8 kg per 1,000 liters of water, depending on application machine capacity. Recommended minimum application rates are as follows:

Application Rates for Guar Soil Stabilizer

Slope (V:H):	Flat	1:4	1:3	1:2	1:1
Kg/ha:	45	50	56	67	78

4.2.1.5.1.2 Psyllium

Psyllium is composed of the finely ground muciloid coating of plantago seeds that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but re-wettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates are generally 90 to 225 kg/ha, with enough water in solution to allow for a uniform slurry flow.

4.2.1.5.1.3 Starch

Starch is non-ionic, cold-water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 170 kg/ha. Approximate drying time is 9 to 12 hours.

4.2.1.5.2 Type: Plant-Material Based (Long-Term)

4.2.1.5.2.1 Pitch and Rosin Emulsion

Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water-dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted as follows:

- For clayey soil: 5 parts water to 1 part emulsion
- For sandy soil:10 parts water to 1 part emulsion

Application can be by water truck or hydraulic seeder with the emulsion/product mixture applied at the rate specified by the manufacturer.

4.2.1.5.3 Type: Polymeric Emulsion Blends

4.2.1.5.3.1 Acrylic Copolymers and Polymers

Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain an anti-foaming

agent. The polymeric emulsion should have a minimum shelf life of one year. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should not re-emulsify when cured. The applied compound should air cure within a maximum of 36 to 48 hours. Liquid copolymer should be diluted at a rate of 10 parts water to 1 part polymer and applied to soil at a rate of 11,000 liters/hectare.

4.2.1.5.3.2 Liquid Polymers of Methacrylates and Acrylates

This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization applications, it is diluted with water and applied with a hydraulic seeder at the rate of 190 liters per hectare. Drying time is 12 to 18 hours after application.

4.2.1.5.3.3 Copolymers of Sodium Acrylates and Acrylamides

These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

Slope Gradient (V:H)	**Kg/ha**
Flat to 1:5	3.4 – 5.6
1:5 to 1:3	5.6 – 11.2
1:2 to 1:1	11.2 – 22.4

4.2.1.5.3.4 Poly-Acrylamide and Copolymer of Acrylamide

Linear copolymer poly-acrylamide is packaged as a dry-flowable solid. When used as a stand-alone stabilizer, it is diluted at a rate of 1.2 kg/1,000 liters of water and applied at the rate of 5.6 kg/ha.

4.2.1.5.3.5 Hydro-Colloid Polymers

Hydro-colloid polymers are various combinations of dry-flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 60 to 70 kg/ha. Drying times are 0 to 4 hours.

4.2.1.5.4 Type: Petroleum or Resin-Based Emulsions

4.2.1.5.4.1 Emulsified Petroleum Resin

This material is a concentrated petroleum hydrocarbon emulsion that is mixed with water and applied to the soil surface at a rate of 23,000 liters per hectare. Dilution rates vary with the type of soil and other site conditions, and should be provided by the manufacturer. They typically range from 12:1 to 20:1 parts water to emulsion.

4.2.1.5.5 Type: Cementitious-Based Binders

4.2.1.5.5.1 Gypsum

This is a formulated gypsum-based product that readily mixes with water and mulch

to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86

percent. It is mixed in a hydraulic seeder and applied at rates 4,500 to 13,500 kg/ha. Drying time is 4 to 8 hours.

4.2.1.6 Straw Mulch

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller, or anchoring it with a tackifier. Straw mulch is used for soil stabilization, as a temporary surface cover, on disturbed areas until soils can be prepared for re-vegetation. It is also used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Loose straw is the most common mulch material used in conjunction with direct seeding of soil. Straw mulching is generally the second part of multi-step process where seed and fertilizer are first applied, then straw mulch is applied as the second step. The final step of the process involves holding the loose straw in place by a) using netting, b) applying a liquid tackifier, or c) punching it into the soil by a process known as "crimping" or "incorporating."

4.2.1.6.1 Type: Wheat or Rice Straw

Straw can be hand applied or machine applied. The fiber length of the straw should be typically greater than 150 millimeters (mm) (6 inches [in]).

4.2.1.7 Geotextiles, Mats/Plastic Covers and Erosion Control Blankets

This BMP involves the placement of geotextiles, plastic covers, or erosion control blankets/mats to stabilize DSAs and protect soil from erosion by wind or water. These measures are typically used when DSAs are particularly difficult to stabilize, around Environmentally Sensitive Areas (ESAs), and as a temporary quick stopgap measure.

4.2.1.7.1 Type: Biodegradable Rolled Erosion Control Products

Biodegradable Rolled Erosion Control Products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. For an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that hold the biodegradable mulch fibers together must also be biodegradable.

4.2.1.7.1.1 Jute Mesh

Jute is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.1.2 Curled Wood Fiber

Excelsior (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80% of the fiber 150 mm (6 in) or longer. The excelsior blanket should be of consistent thickness. The wood fiber should be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and shall be non-toxic and non-injurious to plant and animal life. Excelsior blanket should be furnished in rolled strips, a minimum of 1,220 mm (48 in) wide, and should have an average weight of 0.5 kilograms per square meter (Kg/m2), +/-10 percent, at the time of manufacture. Excelsior blankets should be secured in place with wire staples. Staples should be made of 3.05-mm (0.12 in) steel wire and should be U-shaped with 200-mm (7.9 in) legs and 50-mm (2 in) crown.

4.2.1.7.1.3 Straw

Straw blanket should be machine-produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket.

The straw blanket should be furnished in rolled strips a minimum of 2 meters (m) (6.6 feet [ft]) wide, a minimum of 25 m (82 ft) long and a minimum of 0.27 kg/m2. Straw blankets should be secured in place with wire staples. Staples should be made of 3.05-mm (0.12 in) steel wire and should be U-shaped with 200-mm (7.9 in) legs and 50-mm (2 in) crown.

4.2.1.7.1.4 Wood Fiber

Wood fiber blanket is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance revegetation. The material is furnished in rolled strips, which should be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.1.5 Coconut Fiber

The coconut fiber blanket should be machine-produced mats of 100% coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. The coconut fiber blanket should be furnished in rolled strips with a minimum of 2 m (6.6 ft) wide, a minimum of 25 m (82 ft) long and a minimum of 0.27-kg/m2. Coconut fiber blankets should be secured in place with wire staples. Staples should be made of 3.05-mm (0.12 in) steel wire and should be U-shaped with 200-mm (7.9 in) legs and 50-mm (2 in) crown.

4.2.1.7.1.6 Coconut Fiber Mesh

Coconut fiber mesh is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which should be secured to the soil with U- shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.1.7 Straw Coconut Fiber

The straw coconut fiber blanket should be machine-produced mats of 70% straw and 30% coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. The straw coconut fiber blanket should be furnished in rolled strips a minimum of 2 m (6.6 in) wide, a minimum of 25 m (82 ft) long and a minimum of 0.27 kg/m2. Straw coconut fiber blankets should be secured in place with wire staples. Staples should be made of 3.05-mm (0.12 in) steel wire and should be U-shaped with 200-mm (7.9 in) legs and 50-mm (2 in) crown.

4.2.1.7.2 Type: Non-Biodegradable Rolled Erosion Control Products

Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

4.2.1.7.2.1 Plastic Netting

Plastic netting is a lightweight biaxially-oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.2.2 Plastic Mesh

Plastic mesh is an open-weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than 0.5 centimeters (cm) (0.2 in). It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.2.3 Synthetic Fiber with Netting

Synthetic fiber with netting is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three-dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.2.4 Bonded Synthetic Fibers

This type of product consists of a three-dimensional, geomatrix nylon (or other synthetic) matting. Typically it has more than 90% open area, which facilitates root growth. It's tough root-reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.2.5 Combination Synthetic and Biodegradable

Combination synthetic and biodegradable RECPs consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high-strength continuous-filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

4.2.1.7.2.6 Rolled Plastic Sheeting

Plastic sheeting should have a minimum thickness of 6 mm (0.24 in), and should be firmly held in place with sandbags or other weights placed no more than 3 m (9.8 ft) apart. Seams are typically taped or weighted down their entire length, and there should be at least a 300 mm (12 in) to 600 mm (24 in) overlap of all seams. Edges should be embedded a minimum of 150 mm (6 in) in native soil.

All sheeting should be inspected periodically after installation and after significant rainstorms to check for erosion and undermining. Any failures shall be repaired immediately. If washout or breakages occurs, the material should be re-installed after repairing the damage to the slope.

4.2.1.7.2.7 Geotextile (Woven)

Woven geotextile material should be a woven polypropylene fabric with a minimum thickness of 15 mm (0.6 in), a minimum of 3.7 m (12ft) wide and should have a minimum tensile strength of 0.67 KN (warp) 0.36 KN (fill) in conformance with the requirements in American Society of Testing and Materials (ASTM) Designation: D 4632. The permittivity of the fabric shall be approximately 0.07 sec –1 in conformance with the requirements in ASTM Designation: D 4491. The fabric should have an ultraviolet (UV) stability of 70% in conformance with the requirements in ASTM designation: D 4355. Geotextile blankets should be secured in place with wire staples or sandbags and by keying into tops of slopes and edges to prevent infiltration of surface waters under geotextile. Staples should be made of 3.05-mm (0.12 in) steel wire and shall be U-shaped with 200-mm (7.9 in) legs and 50-mm (2 in) crown.

4.2.1.7.2.8 Geotextile (Non-Woven)

Non-woven geotextile shall be manufactured from polyester, nylon, or polypropylene material, or any combination thereof. The fabric shall be permeable, non-woven, shall not act as a wicking agent. The fabric shall weigh a minimum of 135 grams per square meter (per ASTM Designation: D 3776), have a minimum grab tensile strength of 0.22 KN in each direction (per ASTM Designation: D 4632), have a minimum elongation at break of 10% (per ASTM Designation: D 4632), have a minimum toughness of 13 KN (percent elongation x grab tensile strength), and a minimum permittivity of 0.5 sec-1 (per ASTM Designation: D 4491).

4.2.1.8 Wood Mulching

Wood mulching consists of applying shredded wood, bark, or green material. The primary function of wood mulching is to reduce erosion by protecting bare soil from raindrop impact and reducing runoff. Use is limited to slopes that are less than 1:3 and depth of the mulch blanket is typically 8 to 10 cm (3 – 4 inches). The material is typically spread by hand, although pneumatic methods are available. Wood mulching is primarily applicable for landscape projects.

4.2.1.9 Earth Dikes/Drainage Swales and Ditches

The primary function of earth dikes, drainage swales and ditches is to prevent erosion and reduce pollutant loading. They are structures that intercept, divert, and convey surface runoff in a controlled, non-erosive manner. Top, toe, and mid-slope diversion ditches, berms, dikes, and swales should be used to intercept runoff and direct it away from critical slopes without allowing it to reach the roadway.

Typically, mid-slope diversion ditches should have a cross-slope of at least 2%, and should be concrete or rock-lined. Top of slope diversions should be paved along cut slopes where the slope length above the cut is greater than 12.2 m (40 ft). Earthen diversion ditches, berms, dikes, and swales channelize flow and should be stabilized with vegetation or other materials to prevent erosion.

Alternatively, drop structures can be placed along the diversion to maintain a grade sufficiently mild to prevent erosive velocities, or a paved chute can be placed down the side of the fill before the accumulated runoff in the diversion is sufficient to cause erosive velocities.

Design guidelines include:

- Select design flow and safety factor based on careful evaluation of the risk due to erosion of the measure, over topping, flow backups, or wash out;

- Examine the site for run-on from off-site sources. These off-site flows should be diverted from the right-of-way;
- Select flow velocity limit of unlined conveyance systems based on soil types and drainage flow patterns for each project site. Establish a maximum flow velocity for using earth dikes and swales, above which a lined ditch must be used. Consider use of rip-rap, engineering fabric, vegetation or concrete lining;
- Consider outlet protection where localized scour is anticipated;
- Consider order of work provisions early in the construction process to effectively install and use the permanent ditches, berms, dikes, and swales; and
- A sediment-trapping device should be used in conjunction with conveyances where sediment-laden water is expected.

4.2.1.10 Outlet Protection/Velocity Dissipation Devices

Outlet protection/velocity dissipation devices are rock, riprap, or other materials placed at pipe outlets to reduce flow velocity and the energy of exiting storm water flows and to prevent scour. They are used where localized scouring is anticipated, such as outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels. They are also used where lined channels or ditches discharge to unlined conveyances.

Appropriate applications include:

- Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels;
- Outlets located at the bottom of mild to steep slopes;
- Discharge outlets that carry continuous flows of water;
- Outlets subject to short, intense flows of water, such as from flash floods; and
- Where lined conveyances discharge to unlined conveyances.

4.2.1.11 Slope Drains

A slope drain is a pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area. Slope drains are used with lined ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

Slope drains should be sized to convey large, infrequent storms down or around the slope. Design the top and toe of slope diversion ditches/berms/dikes/swales to direct flow into the drain. Provide for outlet protection/velocity dissipation devices at the outlet of the drain, as needed

4.2.2 Sediment Control Practices

Sediment control is required along the site perimeter at all operational internal inlets and at all times during the rainy season.

Sediment control devices function by:

- Slowing water velocities, thereby allowing soil particles to settle out; and

- Attenuating the flood peak by detaining flow and releasing water at a slower rate.

All sediment control devices require continued maintenance to function properly. Excess sediment not removed reduces capacity and efficiency.

Examples of sediment control practices include:

- Silt Fence
- Desilting Basin
- Sediment Trap / Filter Bags
- Check Dam
- Fiber Rolls
- Gravel Bag Berm
- Street Sweeping and Vacuuming
- Sand Bag Barrier
- Straw Bale Barrier
- Storm Drain Inlet Protection

4.2.2.1 Silt Fence

A silt fence is a temporary linear sediment barrier of permeable fabric designed to intercept and slow the flow of sediment-laden sheet flow runoff. Silt fences allow sediment to settle from runoff before water leaves the construction site.

Silt fences are placed below the toe of exposed and erodible slopes, downslope of exposed soil areas, around temporary stockpiles and along streams and channels. Silt fences should not be used to divert flow or in streams, channels or anywhere flow is concentrated.

4.2.2.2 De-silting Basin

A de-silting basin is a temporary basin formed by excavation and/or constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

De-silting basins shall be considered for use:

- On construction projects with disturbed areas during the rainy season;
- Where sediment-laden water may enter the drainage system or water courses; and
- At outlets of disturbed soil areas between 2 ha and 4 ha (5 acres and 10 acres).

4.2.2.3 Sediment Trap / Filter Bags

A sediment trap is a temporary basin with a controlled release structure, formed by excavating or constructing an earthen embankment across a waterway or low drainage area. As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Sediment traps may be used on construction projects during the rainy season when the contributing drainage area is less than 2 ha (5 acres). Traps would be placed where sediment laden storm water may enter a storm drain or watercourse, and around and/or up-slope from storm drain inlet protection measures.

Filter bags may be used in place of sediment traps. Sediment filter bags consist of a non-woven geotextile fabric that can catch and contain sediment during dewatering and pumping operations.

4.2.2.4 Check Dam

A check dam is a small device constructed of rock, sand bags, or fiber rolls, placed across a natural or man-made channel or drainage ditch. Check dams reduce scour and channel erosion by reducing flow velocity and encouraging sediment dropout.

Check dams may be installed:

- In small open channels that drain 4 ha (10 acres) or less;
- In steep channels where storm water runoff velocities exceed 1.5 meters per second (m/s) (5 feet per second [ft/s]);
- During the establishment of grass linings in drainage ditches or channels; and
- In temporary ditches where a short length of services does not warrant establishment of erosion-resistant linings.

4.2.2.5 Fiber Rolls

A fiber roll consists of straw, flax or other similar materials inserted into a tube of netting. Fiber rolls are placed on the face of slopes at regular intervals and/or at the toe of slopes to intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide some removal of sediment from the runoff. Fiber rolls may be used along the top, face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

4.2.2.6 Gravel Bag Berm

A gravel bag berm consists of a single row of gravel bags that are installed end-to-end to form a barrier across a slope to intercept runoff, reduce runoff velocity, release runoff as sheet flow and provide some sediment removal. The gravel bag berm should be installed along a level contour with the bags tightly abutted.

4.2.2.7 Street Sweeping and Vacuuming

Street sweeping and vacuuming are practices to remove tracked soil particles from paved roads to prevent the sediment from entering a storm drain or watercourse. Street sweeping and vacuuming are implemented anywhere sediment is tracked from the project site onto public or private paved roads, typically at points of egress.

4.2.2.8 Sand Bag Barrier

A sand bag barrier is a temporary linear sediment barrier consisting of stacked sand bags, designed to intercept and slow the flow of sediment-laden sheet flow runoff. Sand bag barriers allow sediment to settle from runoff before water leaves the construction site.

Sand bags can also be used:

- Where flows are moderately concentrated to divert and/or detain flows;
- Along the perimeter of a site;
- Along streams and channels;
- Below the toe of exposed and erodible slopes; and
- Around stockpiles.

4.2.2.9 Straw Bale Barrier

A straw bale barrier is a temporary linear sediment barrier consisting of straw bales, designed to intercept and slow sediment-laden sheet flow runoff. Straw bale barriers allow sediment to settle from runoff before water leaves the construction site.

Typical applications for straw bale barriers include:

- Along the perimeter of a site;
- Along streams and channels;
- Below the toe of exposed and erodible slopes;
- Downslope of exposed soil areas; and
- Around stockpiles.

4.2.2.10 Storm Drain Inlet Protection

Storm drain inlet protection is a practice to reduce sediment from storm water runoff discharging from the construction site prior to entering the storm drainage system. Effective storm drain inlet protection allows sediment to settle out of water or filters sediment from the water before it enters the drain inlet. Storm drain inlet protection is the last line of sediment control defense prior to storm water leaving the construction site.

Storm drain inlet protection is used:

- Where ponding will not encroach into highway traffic;
- Where sediment-laden surface runoff may enter an inlet;
- Where disturbed drainage areas have not yet been permanently stabilized; and
- Where the drainage area is 0.4 ha (1 acre) or less.

4.2.3 Tracking Control Practices

Tracking control practices prevent or reduce off-site tracking of sediment by vehicles. Tracking is a common source of complaints, and can result the discharge of sediment to storm drains or watercourses. These measures include:

- Stabilized Construction Entrance;
- Stabilized Construction Roadway; and
- Entrance/Outlet Tire Wash.

Tracking controls shall be implemented, as needed, to reduce the tracking of sediment and debris from the construction site. At a minimum, entrances and exits shall be inspected daily, and controls implemented as needed.

4.2.3.1 Stabilized Construction Entrance

A stabilized construction entrance is a designated point of access (ingress and egress) to a construction site that is stabilized to reduce tracking of sediment (mud and dirt) onto public roads by construction vehicles. Stabilized construction entrances are an effective method to limit the migration of sediment from the construction site, especially when combined with

street sweeping and vacuuming. The stabilized entrance is typically composed of a crushed aggregate layer over a geotextile fabric or constructed of steel plates with ribs.

4.2.3.2 Stabilized Construction Roadway

A stabilized construction roadway is a temporary access road connecting existing public roads to a remote construction area. It is designed for the control of a dust and erosion created by vehicular traffic. A stabilized construction roadway may be constructed of aggregate, asphalt concrete, or concrete based on the desired longevity.

4.2.3.3 Entrance/Outlet Tire Wash

A tire wash is an area located at stabilized construction access points to remove sediment from tires and undercarriages, and to prevent tracking of sediment onto public roads. The tire wash typically includes a wash rack on a pad of coarse aggregate. The runoff water from the wash area must be conveyed to a sediment trap or basin.

4.2.4 Wind Erosion Control

Wind erosion controls shall be considered for all disturbed soil areas on the project site that are subject to wind erosion and when significant wind and dry conditions are anticipated during construction of the project. Wind erosion control consists of applying water or other dust palliatives as necessary to prevent or alleviate wind-blown dust. Dust control must be applied in accordance with FHWA/HDOT standard practices. Water or dust palliatives should be applied so no runoff occurs.

The Hawaii General Construction Permit (Appendix D) requires that special attention be paid to stockpiles. Stockpiles may be covered with plastic, mats, blankets, mulches, or sprayed with water or soil binders. It may also be prudent to surround the base of a stockpile with a row of fiber rolls, silt fence, or other sediment barrier.

Another means to reduce the potential for wind erosion of stockpiles is to keep the height of stockpiles low, and to adjust the shape and orientation of the stockpiles to reduce the area of exposure to the prevailing wind.

4.2.5 Non-Storm Water Controls

The objective of the construction site management (non-stormwater and waste management and materials pollution controls) is to reduce the discharge of materials other than stormwater to the stormwater drainage system or to receiving waters. These controls shall be implemented year-round for all applicable activities, material usage, and site conditions.

The National Pollutant Discharge Elimination System (NPDES) storm water regulations for construction sites also require that BMPs be included in the project plans for control of non-storm water discharges. Non-storm water management measures are source controls that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with storm water. These BMPs are also known as "good housekeeping practices." These BMPs must be in place throughout the grading and construction phases. The measures include:

- Water Conservation Practices
- Dewatering Operations
- Illicit Connection/Illegal Discharge Detection and Reporting
- Potable Water/Irrigation

- Paving and Grinding Operations
- Temporary Stream Crossing
- Clear Water Diversion
- Vehicle and Equipment Cleaning
- Vehicle and Equipment Fueling
- Vehicle and Equipment Maintenance

During preparation of the project plans, it is not always possible to know where a contractor will be performing certain activities. To provide the contractor with flexibility, but to assure that proper control measures are implemented, it is appropriate to identify in the project plans that specific BMPs will be implemented for certain activities regardless of where on the site those activities are performed.

4.2.5.1 Water Conservation Practices

Water conservation practices are activities that use water during the construction of a project in a manner that avoids erosion caused by runoff and the transport of pollutants off the site. If less water is used, the potential for erosion decreases and the transport of construction-related pollutants off site is less likely. Water conservation practices must be implemented on all construction sites wherever water is used. It includes preventing water leaks, avoid vehicle washing on site, sweeping in lieu of hosing areas, and applying water for dust control to minimize runoff.

4.2.5.2 Dewatering Operations

This BMP is intended to prevent the discharge of pollutants from construction site dewatering operations associated with storm water (accumulated rain) and non-storm water (groundwater, water from a diversion or cofferdam, etc.). Dewatering effluent that is discharged from the construction site to a storm drain or receiving water is subject to the requirements of the applicable NPDES permit.

4.2.5.3 Paving and Grinding Operations

Procedures that minimize pollution of storm water runoff during paving operations include new paving and preparation of existing paved surfaces for overlays. Paving and grinding operations include handling materials, wastes and equipment associated with pavement removal, paving, surfacing, resurfacing, pavement preparation, thermoplastic striping and placing pavement markers.

4.2.5.4 Temporary Stream Crossing (Discussed further in Chapter 5)

A temporary stream crossing is a structure placed across a waterway that allows vehicles to cross the waterway during construction without contacting the water, thus reducing erosion and the transport of pollutants into the waterway. Temporary stream crossings are typically conditions of regulatory permits for work near live streams. Installation may require dewatering or temporary diversion of the stream. Types of temporary stream crossings include culverts, fords, and bridges. Their design requires knowledge of stream flows, soils, and wildlife.

4.2.5.5 Clear Water Diversion (Discussed further in Chapter 5)

Clear water diversion consists of a system of structures and measures that intercept clear surface water runoff upstream of a construction site, transport it around the site, and discharge it downstream with minimal water quality impact. A common example is a temporary creek diversion system that consists of a sandbag cofferdam and a flexible plastic pipe to divert the water around the construction site. Structures commonly used as part of this system include diversion ditches, berms, dikes, slope drains, drainage, and interceptor swales.

4.2.5.6 Illicit Connection/Illegal Discharge Detection and Reporting

These procedures and practices are designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents to the Project Engineer (PE).

4.2.5.7 Potable Water/Irrigation

Potable water/irrigation consists of practices and procedures to reduce the discharge of potential pollutants generated from irrigation water lines, landscape irrigation, lawn or garden watering, potable water sources, water line flushing, and hydrant flushing. These practices include reusing discharges for landscaping, automatic shut-off valves, prevention of impacts to downstream drainage systems, leak detection, inspection of equipment and lines, and repair of broken pipes.

4.2.5.8 Vehicle and Equipment Cleaning

This BMP consists of procedures and practices used to minimize or eliminate the discharge of pollutants from vehicle and equipment cleaning operations to storm drains or watercourses. On most construction sites, vehicle and equipment cleaning on site should be discouraged.

If vehicle or equipment cleaning is allowed, then soap, solvents, or steam shall not be used unless approved by the PE. Vehicle and equipment wash water must be contained for percolation or evaporation, and must not be discharged off site.

4.2.5.9 Vehicle and Equipment Fueling

This BMP consists of measures and practices to minimize or eliminate the discharge of fuel spills and leaks into the storm drain system or to watercourses. These measures include containment of fueling areas, spill prevention and control, drip pans or absorbent pads, automatic shut-off nozzles, vapor recovery nozzles, topping off restrictions, and leak inspection and repair.

4.2.5.10 Vehicle and Equipment Maintenance

This BMP consists of procedures and practices to minimize or eliminate the discharge of pollutants to the storm drain system or to watercourses from vehicle and equipment maintenance procedures. Practices include drip pans or absorbent pads, spill kits, dedicated maintenance areas, proper waste disposal, leak repair, and secondary containment.

4.2.5.11 Pile Driving Operations

The construction of bridges and retaining walls often includes driving piles for foundation support. Piles are typically constructed of cast in place concrete, steel, or timber. Driven sheet piles are also used for shoring and cofferdam construction. Proper control and use of equipment, materials, and waste products from pile driving operations will reduce the discharge of potential pollutants to the storm drain system or watercourses. These procedures apply to all construction sites where permanent and temporary pile driving operations take place.

4.2.5.12 Concrete Curing

This BMP consists of procedures that minimize pollution of storm water runoff during concrete curing. Concrete curing includes the use of both chemical and water methods. Concrete curing is used for the construction of structures such as bridges, retaining walls, and pump houses. Any element of the structure (i.e., footings, columns, abutments, stem and soffit, decks) may be subject to curing requirements.

4.2.5.13 Material and Equipment Use Over Water (Discussed Further in Chapter 5)

This BMP consists of procedures for the proper use, storage, and disposal of materials and equipment on barges, boats, temporary construction pads, or similar locations that minimize or eliminate the discharge of potential pollutants to a watercourse. These procedures shall be implemented for construction materials and wastes (solid and liquid), soil or dredging materials, or any other materials that may be detrimental if released and apply where equipment is used over or adjacent to a watercourse.

4.2.5.14 Concrete Finishing

This BMP consists of procedures to minimize the impact that concrete finishing methods may have on storm water runoff. Methods include sand blasting, lead shot blasting, grinding, or high pressure water blasting. Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances.

4.2.5.15 Structure Demolition/Removal Over Water (Discussed Further in Section ////)

This BMP consists of procedures to protect water bodies from debris and wastes associated with structure demolition or removal over or adjacent to watercourses. These procedures shall be implemented for full bridge demolition and removal, partial bridge removal (i.e., barrier rail, edge of deck) associated with bridge widening projects, concrete channel removal, or any other structure removal that could potentially affect water quality.

4.2.6 Waste Management and Materials Pollution Control

The NPDES storm water regulations for construction sites also require that BMPs be included in the project plans for waste management and materials pollution control. These are source control BMPs that prevent pollution by reducing pollutants at their source, and require a clean, well-kept site. The measures include:

- Material Delivery and Storage
- Material Use
- Stockpile Management
- Spill Prevention and Control
- Solid Waste Management
- Hazardous Waste Management
- Contaminated Soil Management
- Concrete Waster Management
- Sanitary/Septic Waste Management
- Liquid Waste Management

As with the non-storm water management measures, it is important to provide the contractor with flexibility, but to identify that in the plans, that specific BMPs will be implemented for certain activities regardless of where on the site those activities are performed.

4.2.6.1 Material Delivery and Storage

This BMP consists of procedures and practices for the proper handling and storage of materials in a manner that minimizes or eliminates the discharge of these materials to the storm drain system or to watercourses. These procedures include secondary containment, spill prevention and control, product labeling, quantity reduction, proper storage, material covering, training, and inventory control.

4.2.6.2 Material Use

This BMP consists of procedures and practices for use of construction material in a manner that minimizes or eliminates the discharge of these materials to the storm drain system or watercourses. These procedures include proper waste disposal, product labeling, proper

cleaning techniques, recycling materials, reducing quantities, and application rates, spill prevention and control, training, and reduction of exposure to storm water.

4.2.6.3 Stockpile Management

This BMP consists of procedures and practices to eliminate pollution of storm water from stockpiles of soil and paving materials (such as concrete rubble, aggregate, and asphalt concrete). These procedures include locating stockpiles away from drainages, providing perimeter sediment barriers, and wind erosion control measures.

4.2.6.4 Spill Prevention and Control

This BMP consists of procedures and practices implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to storm drain systems or watercourses. Spill prevention and prompt appropriate spill response reduce the potential for polluting receiving waters with spilled contaminants. Spills of concern include chemicals and hazardous wastes such as soil stabilizers/binders, dust palliatives, herbicides, growth inhibitors, fertilizers, de-icing products, fuels, lubricants, paints, and solvents. Spill prevention practices include education as well as cleanup and storage procedures that address small spills, semi- significant spills, and significant/hazardous spills. A Spill Prevention Control and Countermeasure (SPCC) Plan may be required to document the anticipated procedures and protocols to be implemented on the project.

4.2.6.5 Solid Waste Management

This BMP consists of procedures and practices to minimize or eliminate the discharge of pollutants to storm drain systems or watercourses as a result of the creation, stockpiling or removal of construction site wastes. Solid wastes include such items as used brick, mortar, timber, steel, vegetation/landscaping waste, empty material containers, and litter. Measures include education as well as collection, storage, and disposal practices.

4.2.6.6 Hazardous Waste Management

This BMP consists of procedures and practices to minimize or eliminate the discharge of pollutants from construction site hazardous waste to the storm drain system or watercourses. Hazardous wastes should be collected, stored, and disposed of using practices that prevent contact with storm water. The following types of wastes are considered hazardous; petroleum products, concrete curing compounds, palliatives, septic wastes, paints, stains, wood preservatives, asphalt products, pesticides, acids, solvents, and roofing tar. There may be additional wastes on the project that are considered hazardous. It is also possible that non-hazardous waste could come into contact with these hazardous wastes, such that they become contaminated and are therefore considered hazardous waste. Measures include education, storage procedures, and disposal procedures.

4.2.6.7 Contaminated Soil Management

This BMP consists of procedures and practices to minimize or eliminate the discharge of pollutants to the storm drain system or watercourses from contaminated soil. Typical soil contamination is due to spills, illicit discharges, and underground storage tank leaks, or aerially deposited lead (ADL). Contaminated soils tend to occur on projects in urban or industrial areas. Soil contaminants and locations are often identified in the project plans and specifications. Measures include identifying contaminated areas, education, handling procedures for material with ADL, handling procedures for contaminated soils, procedures for underground storage tank removals, and water control.

4.2.6.8 Concrete Waste Management

This BMP consists of procedures and practices that are implemented to minimize or eliminate the discharge of concrete waste materials to the storm drain system or to watercourses. These measures include education, concrete slurry waste handling procedures, on-site concrete washout facility, transit truck washout procedures, and procedures for removal of temporary concrete washout facilities.

4.2.6.9 Sanitary/Septic Waste Management

This BMP consists of procedures and practices to minimize or eliminate the discharge of construction site toilet facilities to the storm drain system or watercourse. Measures include education, and storage and disposal procedures.

4.2.6.10 Liquid Waste Management

This BMP includes procedures to prevent pollutants related to non-hazardous liquid wastes from entering storm drains or receiving waters. Liquid wastes include drilling slurries, drilling fluids, wastewater that is free from grease and oil, dredging's, and other non-storm water liquid discharges not covered by separate permits. This BMP does not apply to the following:

- Dewatering operations;
- Solid wastes;
- Hazardous wastes ;
- Concrete slurries;
- Liquid wastes covered by specific laws or permits; and
- Non-storm water discharges permitted by any FHWA/HDOT NPDES permit unless FHWA/HDOT determines that the discharge contains pollutants.

4.3 Monitoring and Inspection Program

The Project Engineer (PE) or Resident Engineer (RE) is responsible for ensuring that construction personnel monitor the contractor's water pollution control practices and maintain compliance with the approved project SWPPP. This includes reviewing the contractor's SWPPP, reviewing written inspection reports, and conducting field inspections. All construction personnel should also be aware of the water pollution control requirements and participate in the monitoring program. Key steps to a successful monitoring and inspection program are summarized below.

Step 1. Do your Homework

a. Review the Current FHWA and HDOT Storm Water Quality Handbooks included in Appendix A, B and E of this manual.

   Construction personnel with storm water responsibilities should familiarize themselves with BMP requirements. In particular, become familiar with (1) the rainy season dates for your geographical area, (2) the definitions of DSA, active DSA, and non-active DSA, and (3) the requirements for soil stabilization and sediment control BMPs for the season and specific Rainfall Area.

b. Review the Project Plans.

Review the Project Plans in the context of storm water pollution control. Visualize storm water run-on and runoff flow patterns when reviewing the plans. Review the general layout and existing drainage courses. Identify potential problem areas where storm water may run onto the site or discharge off site.

Identify the locations where structures are being constructed or modified. Be familiar with the right-of-way and easement limits. Determine the limits of clearing and grubbing activities (i.e. Construction Limits). Identify the project phase or stage. Try to determine DSAs and Environmentally Sensitive Areas (ESAs). Is the next phase going to include soil-disturbing activities and is it scheduled within the rainy season? Do the DSAs have provisions in the plans for permanent erosion control? Determine if permanent erosion control can be placed when activity in the DSA is complete.

c. Review the SCRs

Review the SCRs for site-specific water pollution control requirements such as:

(1) permits for the construction project, (2) limits on active DSAs, (3) rainy season dates and requirements, (4) minimum BMP requirements, (5) BMP maintenance and inspection requirements, and (6) final erosion control requirements. Final erosion control requirements include (1) required products, (2) application process, (3) application rate, (4) seeding window, and (5) planting requirements.

The SCRs also include a section on water pollution control permits or requirements imposed on the project by other agencies. Typical agencies include the USACE, DOH-CWB, USFWS, NMFS, local flood control agencies, and others. There may be special requirements for water bodies or ESAs that need special water pollution control consideration.

Review the SCRs bid items related to water pollution control. There may be lump sums or unit prices for water pollution control items including SWPPP/WPCP preparation, permanent erosion control, and temporary erosion and sediment controls.

Review the section of the SCRs for site-specific activities such as: (1) dewatering, (2) sampling and analysis, (3) BMP maintenance cost allocation between FHWA/HDOT and the contractor, and (4) sanctions against the contractor in the event of non- compliance with the water pollution control requirements.

d. Review the SWPPP/IWPPP.

The SWPPP or IWPPP for the project is the contractor's plan to ensure conformance with FHWA/HDOT water pollution control requirements on the construction site. The SWPPP/IWPPP contains conceptual details about the BMPs to be used on the site, their locations, implementation timeframes, and inspection and maintenance schedules. The contractor must comply with the approved SWPPP/WPCP. If conditions change on the construction site that impact storm water pollution controls, the contractor must amend the SWPPP/IWPPP.

The SWPPP/IWPPP contains the approval signature, lists any amendments, describes unique features of the construction site, and contains the construction and water pollution control schedules. It also identifies the BMPs selected for soil stabilization, sediment control, non-storm water controls, waste management, and materials disposal controls and references locations on the vicinity map and water pollution control drawings.

e. Review the Schedule.

The accepted Baseline schedule as well as the monthly updates and three-week "look-ahead" schedules are important references to better anticipate which BMPs will be implemented or needed. A project schedule is required in both SWPPPs and must show how the rainy season relates to soil-disturbing and re-stabilization activities and must also show major activities sequenced with implementation of BMPs.

Step 2. Establish an Inspection Schedule

a. Prior to the rainy season, inspect the site to ensure that the contractor has the necessary materials to stabilize required DSAs and to implement the necessary sediment controls.

b. Year round, inspect the construction site prior to a forecast storm, after a rain event that causes runoff from the construction site, and at 24-hour intervals during an extended rain event. Refer to Section 4.4, Rain Event Action Plan.

c. Conduct inspections at other frequencies as required by the Special Provisions.

d. Work with the PE, and Inspectors during site inspections and to receive assistance when necessary.

Step 3. Conduct the Inspection

a. Document the Inspection in a Construction Site Inspection Checklist.

b. Encourage the contractor to participate in the inspection. This provides the opportunity for verbal feedback and discussion.

c. If the project involves significant structures work, encourage the Structures representative or inspector to participate in the inspection. Take a copy of the most current and approved site plan(s) and SWPPP on the inspection for identification of site features and for taking notes at specific areas.

d. Fill out the Inspection Checklist and add findings in writing. Use clear and concise language and give specific locations where problems were observed.

e. Take photographs during the inspection to document the existing conditions. This is especially important if the contractor does not attend the inspection. When photos of problem areas are taken, try to follow up with photos showing corrections.

f. Inspect the entire site, including the perimeter, especially where there is potential for run-on or discharge from the site. Look for areas of potential concentrated flows and for adjacent water bodies or drainage facilities that may be affected by discharges from the site. Start the inspection at the lowest point, or the area with

the highest potential for discharge. Inspect all potential discharge points. The SWPPP should identify discharge points; however, there may be areas with discharge potential that were not identified in the SWPPP.

g. Inspect the contractor's yard(s), where required.

h. Look for changes in construction or site conditions that may require an amendment to the SWPPP.

i. Inspect for proper implementation of non-storm water management BMPs and waste management and materials pollution control BMPs.

j. For inspections during the rainy season, evaluate active and non-active DSAs. (The PE or RE should periodically evaluate the classification of construction areas as active DSAs or non-active DSAs.) Determine the total area of DSA and compare it to the limit for DSAs in the Special Provisions. If the existing DSA exceeds the limit, identify areas that can be stabilized to reduce the amount. Active DSAs require protection prior to the onset of rain. Evaluate erosion and sediment control BMPs based on the requirements related to Rainfall Area, season and active/non-active status as defined in the SWPPP and BMP Manual. Be sure to inspect the entire site during a rain event, especially when run-off from the site occurs.

k. During the non-rainy season, identify the active and non-active DSAs. Depending on the Rainfall Area, DSAs may continue to require erosion and sediment control BMPs during the non- rainy season.

l. For individual BMPs, note if the BMP is properly installed. Also note if the BMP is in need of repair or maintenance.

Step 4. Report the Inspection Results

a. If the PE or RE did not attend the inspection, communicate the results to the Resident Engineer.

b. Ideally, observations should be discussed with the contractor during the inspection.

c. Missing BMPs and non-compliance issues must be communicated to the contractor. Refer to the contractor's SWPPP/IWPPP for required BMPs.

Step 5. Follow-up with Corrective Measures

The contractor must install missing BMPs and correct improperly installed or damaged BMPs immediately or by a date and time as approved in writing by the Project Engineer or Resident Engineer. In any event, corrections must be made prior to the next rain event.

Corrective actions will be implemented within 72 hours for deficiencies identified during inspections. SWPPP amendments will be prepared by a qualified SWPPP practitioner if warranted by the problem encountered and corrective action required.

At a minimum, erosion and sediment controls will be cleaned, repaired, or replaced under these conditions:

- In advance of the rainy season and prior to a storm event
- When sediment or other debris has accumulated to greater than one-third the height of the barrier
- When sediment accumulation reaches one-third of the trap capacity
- When more than one-third of the cross section of a conveyance structure, such as a drainage swale or ditch, is plugged or blocked

Table 7 provides a BMP implementation and maintenance schedule. The selection of BMPs can potentially change during Project construction, and Table 7 will be amended accordingly.

Table 7 - BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Silt fence	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Replace torn sections; repair up-rooted sections; clean out collected sediment when greater than 1/3 height of fence
Fiber rolls; coir logs; compost socks; biofilter bags	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Replace crushed sections; replace rotted sections; clean out collected sediment when greater than 1/3 height of roll
Sediment basin; Sediment trap	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair damage and remove obstructions as needed; stabilize eroded areas; clean out collected sediment when 1/2 of designated storage volume of basin or 1/3 of trap capacity; dewater within 72 hours

Table 7 - BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Check dams; velocity dissipation devices	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Replace degraded or missing rock, bags, etc.; clean out when collected soil greater than 1/3 of barrier height
Dikes and drainage swales; slope drains	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during	Repair as needed
Non-stormwater and materials management	Planned prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Dispose of waste materials weekly; contract with outside vendors as needed; keep material storage areas clean and orderly; train all employees on correct use of materials and spill response
Erosion control blankets (geotextiles); non-vegetative stabilization; compost blankets	In sequence with construction activities; prior to forecasted rain event	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair eroded areas; replace and repair geotextiles and mats as needed
Sandbags	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair, reshape, replace bags as necessary; replace bags exposed to sunlight every 2 to 3 months; clean out collected sediment when greater than 1/3 barrier height

Table 7 - BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Gravel bags	Prior to construction and in sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair, reshape, replace bags as necessary; replace bags exposed to sunlight every 2 to 3 months; clean out collected sediment when greater than 1/3 barrier height
Storm drain inlet protection	Prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Clean and repair filters or fabric fence as needed; clean out collected sediment when greater than 1/3 barrier height
Hydraulic mulch	In sequence with construction activities; prior to forecasted rain event	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair eroded areas; reapply on bare areas as needed
Mulch (straw, wood, organic); soil binders	In sequence with construction activities; prior to forecasted rain event	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair eroded areas; reapply on bare areas as needed

Table 7 - BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Hydroseeding; seeding (if applicable)	As soon as possible after disturbance has permanently or temporarily ceased, but in no case more than 14 days after the construction activity in an area has ceased (except when construction activity will resume on that portion of the site within 21 days)	Inspect before and after storm events (and once each 24-hour period during extended storm events), weekly; monitored every May for the first 3 years following Project completion	Reseed areas that do not meet revegetation criteria
Streambank stabilization	In sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair eroded areas; replace BMP measure as needed
Straw bale barrier	In sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Replace rotted sections; clean out collected sediment when greater than 1/3 height of barrier
Active treatment system	In sequence with construction activities	Follow guidelines of the Construction General Permit	Follow guidelines of the Construction General Permit
Concrete washout	In sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Clean out, or construct new facility, once the washout is 75 percent full

Table 7 - BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Aggregate surfacing	Completion of grading activities	Weekly	Keep all temporary roadway ditches clear; periodically apply additional aggregate as needed
Stabilized construction entrance/exit	Prior to grading/earth disturbance	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Remove aggregate, separate and dispose of sediment when construction entrance/exit is clogged with sediment; keep all temporary roadway ditches clear; check for damage and repair as needed; replace gravel material when surface voids are visible
Stabilized construction roadway	Prior to start of associated construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Keep all temporary roadway ditches clear; periodically apply additional aggregate on gravel roads
Stockpile management	In sequence with construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Repair or replace perimeter controls and covers as needed

Table 7 - BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Street sweeping and vacuuming	Start of construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); when actively in use, inspect points of ingress and egress daily, otherwise weekly	Remove tracked or spilled sediment outside the construction limits at a minimum daily
Tire wash	Prior to start of associated construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events); weekly	Remove accumulated sediment in wash rack to maintain system performance; repair as needed

4.4 Rain Event Action Plans

The Rain Event Action Plans (REAP) is written document designed to be used as a planning tool by a qualified stormwater professional (QSP) to protect disturbed portions of the construction site and to ensure that adequate materials and staff are available to implement erosion and sediment control measures. It is the responsibility of the QSP to be aware of precipitation forecast and to obtain and print copies of forecasted precipitation from NOAA's National Weather Service Forecast Office (http://www.prh.noaa.gov/hnl/).

A REAP template for each applicable project phase can be found in Appendix F. The QSP shall customize these templates for each rain event and project phase when the project is under construction. The QSP shall maintain a paper copy of completed REAPs in compliance with the record retention requirements of the SWPPP/ IWPPP. Completed REAPs shall be maintained on the project site with the SWPPP/IWPPP throughout the duration of construction.

The QSP will develop the event-specific REAP 48 hours prior to precipitation event forecast to have a 50% or greater chance of producing precipitation in the project area. The REAP will be maintained onsite and be implemented 24 hours in advance of the predicted precipitation event.

At a minimum, the REAP will include the following site and phase-specific information:

- Site Address;
- Site Stormwater Manager Information including the name, company and 24-hour emergency telephone number;
- Erosion and Sediment Control Provider information including the name, company and 24-hour emergency telephone number;
- Stormwater Sampling/Inspector Agent information including the name, company, and 24-hour emergency telephone number;
- Activities associated with each construction phase;
- Trades active on the construction site during each construction phase;
- Trade Contractor information; and
- Recommended actions for each project phase.

4.4.1 Rain Event Triggered Observations and Inspections

Visual observations of the site and inspections of BMPs are required prior to a qualifying rain event, following a qualifying rain event, and every 24-hour period during a qualifying rain event. Pre-rain inspections will be conducted after consulting NOAA and determining that a precipitation event with a 50% or greater probability of precipitation has been predicted.

4.4.2 Visual Observations Prior to a Forecasted Qualifying Rain Event

The REAP must be available onsite at least 48-hours prior to a qualifying forecast storm event. A stormwater visual monitoring site inspection and observations shall be conducted at the following locations:

- Potential pollutant sources are properly stored (i.e. sorted in covered areas, elevated off ground surfaces, etc.);
- Stormwater drainage areas to identify any spills, leaks, or uncontrolled pollutant sources;
- BMPs to identify if they have been properly implemented or require maintenance;
- Any stormwater storage and containment areas to detect leaks and ensure maintenance of adequate freeboard.

4.4.3 BMP Inspections During an Extended Storm Event

During an extended rain event BMP inspections will be conducted every 24 hours during normal business hours to identify and record:

- Stormwater drainage areas to identify any spills, leaks, or uncontrolled pollutant sources;
- Evidence of any spills, leaks, or uncontrolled pollutant sources that may have migrated offsite;
- BMPs that are properly installed;
- BMPs that need maintenance to operate effectively;

- BMPs that have failed; or
- BMPs that could fail to operate as intended.

If the construction site is not accessible during the rain event, the visual inspections shall be performed at all relevant outfalls, discharge points, and downstream locations. The inspections should record any projected maintenance activities.

4.4.4 Visual Observations Following a Qualifying Rain Event

Within 48 hours following a qualifying rain event (½ inch of rain) a stormwater visual monitoring site inspection is required to observe:

- Evidence of any spills, leaks, or uncontrolled pollutant sources that may have migrated offsite;
- BMPs to identify if they have been properly designed, implemented, and effective;
- Need for additional BMPs or BMP maintenance;
- Any stormwater storage and containment areas to detect leaks and ensure maintenance of adequate freeboard; and
- Discharge of stored or contained rain water.

If the QSP or the Project Engineer (PE) identifies a deficiency in the implementation of the accepted SWPPP/IWPPP, the deficiency must be corrected immediately unless the PE authorizes an agreed date for correction. The correction must occur before the onset of precipitation.

If failure to correct the deficiency by the scheduled date or by the onset of precipitation occurs, the project may correct the deficiency and deduct the cost of correcting the deficiency from payment. Failure to comply with the corrective action may result in the suspension of work by the PE until the project complies with the requirements of the SWPPP/IWPPP.