FINAL

MCBH CONSTRUCTION BMP FIELD MANUAL

Storm Water Management Program Plan

Marine Corps Base Hawaii, Oahu, Hawaii

NPDES Permit No. HI S000007

Prepared by:

Marine Corps Base Hawaii

July 2022

Table of Contents

This page is intentionally left blank.

List of Acronyms and Abbreviations

AMS	Asset Management System
BAT	Best Available Technology
BCT	Best Conventional Technology
BFM	Bonded Fiber Matrix
BMP	Best Management Practice
C&D	Construction and Demolition
CO	Commanding Officer
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CTB	Cement-Treated Base
CWA	Clean Water Act
CWB	State of Hawaii Department of Health, Clean Water Branch
CWRM	State of Hawaii Department of Land and Natural Resources, Commission on Water Resource Management
DLNR	State of Hawaii Department of Land and Natural Resources
DOE	Department of Education
DOH	State of Hawaii Department of Health
EAL	Environmental Action Level
EC	Erosion Control
ECPD	Environmental Compliance and Protection Division
FEAD	Facilities Engineering and Acquisition Division
GDI	Grated Drop Inlet
GHS	Globally Harmonized System
H:V	Horizontal to Vertical Slope
HAR	Hawaii Administrative Rules
HDOA	State of Hawaii Department of Agriculture
HEER	State of Hawaii Department of Health, Hazard Evaluation and Emergency Response
LBP	Lead-Based Paint
LID	Low Impact Development
L/SD	Length to Settling Depth

LFPE	Logistics Facilities Public Works Engineering
MCBH	Marine Corps Base Hawaii
MCCS	Marine Corps Community Services
MCD	Facilities Engineering Maintenance Control Division
MEP	Maximum Extent Practicable
MRO	Facilities Engineering Maintenance Repair Operations
MS4	Municipal Separate Storm Sewer System
NRCS	United States Department of Agriculture, Natural Resource Conservation Service
NGPC	Notice of General Permit Coverage
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Coast Guard National Response Center
OMC	Ohana Military Communities
OSHA	Occupational Safety and Health Administration
PCBs	Polychlorinated Biphenyls
PCC	Portland Cement Concrete
PM	Project Manager
PPE	Personal Protective Equipment
PPV	Public-Private Venture
RCRA	Resource Conservation and Recovery Act
SC	Sediment Control
SDS	Safety Data Sheet
SHWB	State of Hawaii Department of Health, Solid and Hazardous Waste Branch
SM	Site Management
SPCC	Spill Prevention Control Countermeasures
SSBMP	Site-Specific Best Management Practice
SWPPP	Storm Water Pollution Prevention Plan
USACE	United States Army Corps of Engineers

1 Introduction

1.1 Purpose and Scope

The purpose of this *Marine Corps Base Hawaii (MCBH) Construction Best Management Practice (BMP) Field Manual* is to provide guidance on BMP selection, installation, and maintenance procedures for construction activities to reduce or eliminate the discharge of pollutants from construction sites to State waters to the Maximum Extent Practicable (MEP).

While this manual does not constitute an exhaustive list of all BMPs available, it does provide guidance suitable for use by a wide range of individuals involved in construction site water pollution control. Each user of the manual is responsible for working within their capabilities obtained through training and experience, and for seeking the advice and consultation of appropriate experts at all times. The target audience for this manual includes MCBH personnel, consultants, contractors, and other agencies involved in the planning, design, construction, and maintenance of construction projects at MCBH.

As of the effective date, September 1, 2021, MCBH is required to comply with the conditions of the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit No. HIS000007. In accordance with Part D.1.d.(1) of the MS4 Permit, MCBH is required to develop and implement a Construction BMP Field Manual to establish BMP policy for construction projects. The Construction BMP Field Manual is a key element of the MCBH's Construction Site Runoff Control Program (Construction Program) to protect and restore the water quality of the surrounding surface waters. Refer to Chapter 4 of the Storm Water Management Program (SWMP) Plan for additional information on the objectives of MCBH's Construction Program Plan.

1.2 Water Quality Impacts Related to Construction Activities

Excessive erosion and sedimentation have perhaps the most visible impacts to water quality from construction activities. Erosion is the process by which the soil and rock are removed from the earth's surface by the action of water, wind, and gravity. Most natural erosion occurs at slow rates; however, the rate of erosion increases when land is cleared or altered and left unprotected. Construction sites, if unprotected, can erode at rates more than one hundred times the natural background rate of erosion.

Sedimentation is the movement and settling out of suspended soil particles. Sediment resulting from excessive erosion is a pollutant. Sedimentation occurs when the velocity of water is slowed sufficiently to allow suspended soil particles to settle. Larger particles, such as gravel and sand, settle more rapidly than fine particles such as silt and clay. Other less visible impacts are associated with off-site discharge of pollutants such as metals, nutrients, soil additives, pesticides, construction chemicals, and other construction waste. Proper selection and implementation can reduce or eliminate the impacts of potential pollutants on water quality.

1.3 BMP Selection

Selection and implementation of BMPs is based on the pollution risks associated with the construction activity. BMPS should be implemented to the MEP which includes addressing projects, regardless of size, that have the potential to impact water quality. The effectiveness of a BMP is typically directly related to the maintenance of the BMP and the area around it. BMP maintenance requirements should be considered during BMP selection.

The BMPs included in this manual (Section 7 – Construction BMP Fact Sheets) are organized into BMP categories that focus on the areas of erosion control, sediment control, and site management. Erosion Control (EC) BMPs are devices installed or constructed by the contractor on disturbed soil to protect the ground surface from erosion due to wind, rain, or runoff. Sediment Control (SC) BMPs are measures to intercept and detain sediment-laden runoff prior to discharge off-site or to the storm sewer system. These devices detain runoff to promote infiltration and/or sedimentation. Site Management (SM) BMPs include preventative measures implemented during the planning or construction stage of a project to control potential pollutants at their source.

Table 7-1 lists the commonly used BMPs covered in this manual. BMP Fact Sheets with detailed implementation, operation and maintenance information are included in Section 7 for all BMPs listed in Table 7-1. Continued inspections and maintenance of BMPs are essential to maximizing the effectiveness of the device, application, or procedure.

2 Construction Program Organization and Project Review Process Summary

2.1 Construction Program Organization

As a military installation, MCBH has several different types of construction projects and an agency to handle the oversight of each one. The overseeing agency has the most immediate authority over the day-to-day activities at each construction site. As such, the Construction Program is structured to place responsibility for implementation and enforcement of MCBH's SWMP Plan policies at construction sites on each of these corresponding agencies. The Environmental Compliance and Protection Division (ECPD) is responsible for managing the overall Construction Program, and updating policies as deemed necessary to improve the effectiveness of the program. Although it is typical for any SWMP Plan implementation or non-compliance with the MS4 Permit issues to be resolved at a lower level of authority, the Base Commanding Officer (CO) has the ultimate authority to adjust policies or direct enforcement actions for tenants/agencies subject to the Construction Program.

There are three general categories of construction projects at MCBH: (1) In-house Maintenance and Construction, (2) Military Construction, and (3) Contract Maintenance and Construction. To address the MS4 Permit requirements for construction site runoff of the various types of construction that occur on base at MCBH, the organizational structure displayed in Table 3-1 has been outlined. In Figure 2-1

Construction Program Organizational Chart, the grey boxes indicate the agency responsible for oversight of the project. As indicated above, construction projects at MCBH are categorized as either:

(i) *In-house Maintenance and Construction* – projects are scoped and planned by Facilities Engineering Maintenance Control Division (MCD), and the construction work is completed by Facilities Engineering Maintenance Repair Operations (MRO). Typically, these projects are less than 5,000 sf and/or related to emergency repair work.

(ii) *Military Construction* – These are projects that would typically be handled as in-house construction, but due to limited manpower have been contracted out. These projects are managed by Logistics Facilities Public Works Engineering (LFPE), with all storm water management managed by ECPD.

(iii) *Contract Maintenance and Construction* – These projects are conducted by an outside contractor, but are managed as follows:

- *Naval Facilities Engineering Systems Command (NAVFAC) Construction Projects* are managed by the Facilities Engineering and Acquisition Division (FEAD).
- *Mokapu Elementary School Projects* are managed by the Department of Education (DOE).
- *Public-Private Venture (PPV) Housing Projects* are managed by Ohana Military Communities (OMC)/Hunt Military Communities.
- *Commercial Tenant Projects* are managed by Marine Corps Community Services (MCCS).
- *Various other contract maintenance and construction projects* are managed by MCD.

In-house Maintenance and Construction, Military Construction, and MCD Maintenance and Construction fall into two subcategories, (1) Maintenance 1 Repair 1 (M1R1), or (2) Maintenance 2 Repair 2 (M2R2). M1R1 projects are typically minor in-house construction projects, whereas M2R2 designates major construction projects.

Due to the nature of certain in-house maintenance and construction projects, where the potential risk of storm water pollution is minimal or would compromise public health and safety to uphold, certain projects may be exempt from selected plan review and inspection requirements of the Construction Program. These exceptions will be decided on a case-by-case basis, at the discretion of MCD. Projects that may qualify for exemption include those that involve:

- Routine maintenance to maintain the original hydraulic capacity, or the original purpose of the facility;
- Emergency repair construction activities required to immediately protect public health and safety; and
- Interior remodeling that involves no outside exposure of construction materials/waste to storm water.

These qualifying characteristics are subject to the discretion of the MCD and ECPD and may be revised as determined necessary and/or justifiable. All projects that do not meet these exemption criteria will be referred to herein as *"non-exempt"* construction projects.

2.2 Plan Review and Approval Process

MCBH conducts plan review of all proposed, *non-exempt*, construction projects as required by the MS4 Permit. All applicable plans, including but not limited to, the Storm Water Pollution Prevention Plans (SWPPPs), Erosion and Sediment Control, Grading, Post-construction BMP, and Landscaping Plans, are reviewed in accordance with the requirements of the following:

- Hawaii Administrative Rules (HAR), Chapter 11-55, Appendix C, and any other requirements under the NPDES permit program, as applicable;
- Construction BMP Field Manual;
- Maintenance Activities BMP Field Manual;
- Storm Water Permanent BMP Manual; and
- Implementation of measures to ensure that the discharge of pollutants from the site will be reduced to the appropriate discharge limitations subject to the Best Available Technology Economically Achievable/Best Conventional Pollutant Control Technology (BAT/BCT) discharge requirement, consistent with the Clean Water Act (CWA) and other respective federal and state requirements for such facilities and will not cause or contribute to an exceedance of water quality standards.

2.2.1 Plan Review Checklist

Review of the SWPPP and other supporting documents will be conducted by the agency responsible for overseeing the project, as outlined in Table 3-1. MCBH's "Storm Water Pollution Prevention Plan Content Review Checklist" (see SWMP Plan Appendix 4-1) will be used to guide the plan review process. Plan review is conducted similarly for in-house maintenance and construction, military construction, and contract maintenance and construction projects.

Upon completion and acceptance of a SWPPP review, the reviewing agency will issue a notification to the MCBH project manager (PM) and contractor. If a plan submittal does not meet the requirements outlined by the plan review process, all deficiencies are noted on the project's Plan Review Checklist. The applicant must resubmit the checklist, with comments describing how each deficiency has been addressed. Prior to commencement of construction, the MCBH PM or contractor is responsible for ensuring that necessary approvals, including documentation of any revisions made to satisfy reviewer comments, have been received and updated in the project record.

Any pertinent revisions to the SWPPP and supporting documents following review approval, including but not limited to design or concept changes, shall be resubmitted to the appropriate agency for review. As necessary, ECPD will oversee or provide assistance during the plan review process.

2.2.2 Dig and Connection Permits

Following the review of the project SWPPP and all other pertinent documents, any project requiring a drainage connection to the MS4, discharge of surface storm water runoff associated with construction

activities (private or public), or discharge permit into the MS4 (i.e., hydrotesting, dewatering, etc.) is required to obtain additional approval from MCBH. A dig/connection permit application form is found in Appendix 3-2 of the SWMP Plan. All dig permits are issued by LFPE and are routed for approval through multiple offices on base, including ECPD and MCD. Prior to construction, all project owners must submit a completed Plan Review Checklist, with all other pertinent documents, for review to LFPE. To receive approval in the dig permit process, all documents must demonstrate the following, as applicable:

- All required components of the SWPPP and other planning documents related to pollution prevention, such as Erosion and Sediment Control, Grading, Post-construction BMP and Landscaping Plans, Dewatering Plan, and Hydrotesting Plans are completed.
- Proof of filing a Notice of Intent (NOI) Form C or NPDES application for discharge of storm water associated with construction activities that disturb one (1) acre or more;
- Proof of filing a NOI Form F and/or/ G or NPDES application for the discharge of hydrotesting effluent or construction dewatering effluent; and
- Proof of filing for other NPDES permit coverages, as applicable, for any other non-storm water discharges.

All dig permits are kept on file at LFPE and reference information will be provided to the agency responsible for keeping inventory of the construction site (as listed in Table 4-1). The project owner is required to ensure that reference information for the approved dig permit has been provided to the overseeing agency to facilitate tracking efforts. The LFPE records will be made available to ECPD, upon request, to facilitate additional annual inspections of construction sites with connection permits.

2.2.3 Commencement of Construction

Prior to any construction, a project owner must receive notice of the completion and acceptance of a SWPPP review and revised dig permit, if applicable. All construction activities, for in-house, military or contract projects, will also be prohibited until it is verified that the project has received Notice of General Permit Coverage (NGPC) under HAR, Chapter 11-55, Appendix C, from the State of Hawaii Department of Health (DOH) and Notice of Start, if applicable, and has satisfied all other requirements of the NPDES program.

This page is intentionally left blank.

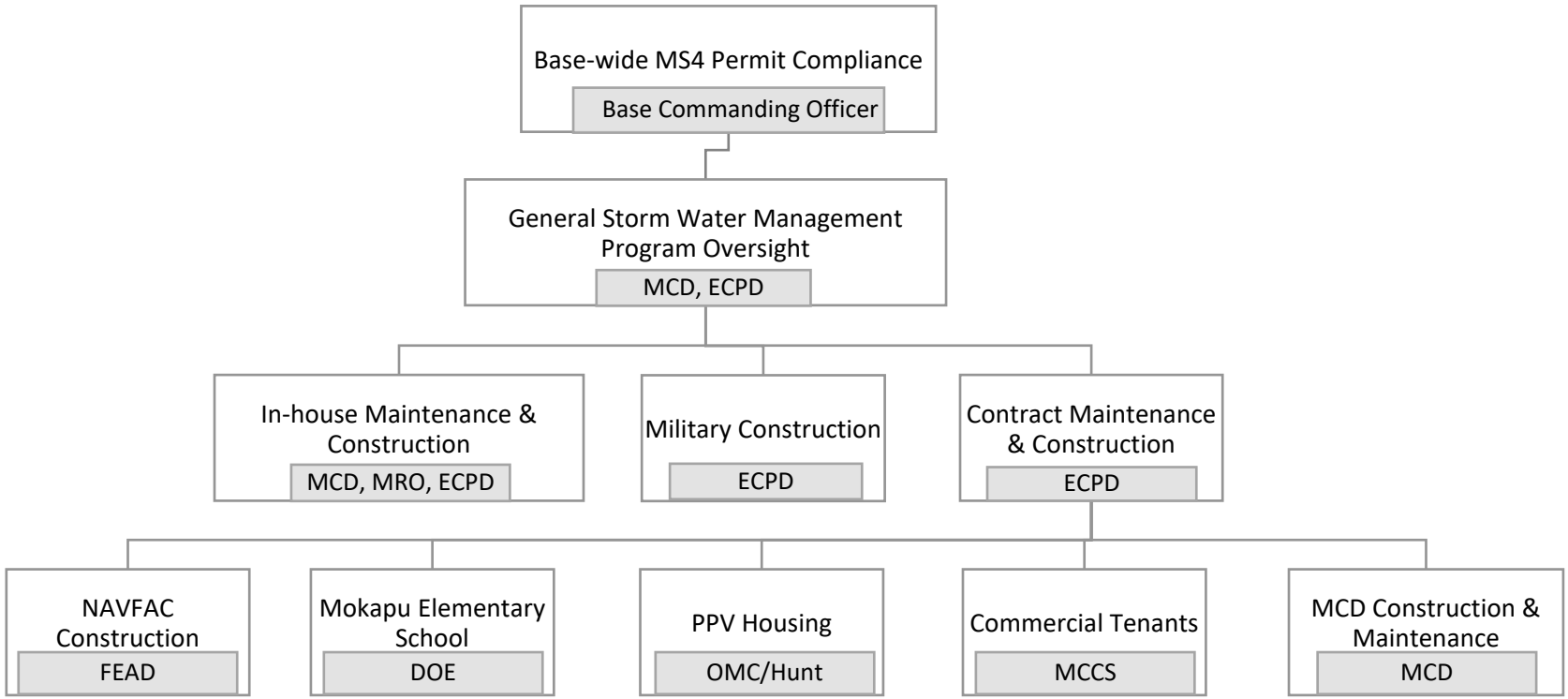


Figure 2-1 Construction Program Organizational Chart

This page is intentionally left blank.

3 Construction Site Inspections and Documentation Requirements

To ensure the effectiveness of the Construction Program, the following inspection procedures are in place. These ensure that all non-exempt maintenance and construction sites adhere to the approved SWPPPs and supporting documents for that project, have these documents readily available onsite, and that BMPs are maintained throughout the duration of construction activities. MCBH has prepared standard forms for all applicable maintenance and construction projects (SWMP Plan Appendix 4-1) for required inspections, reporting, and corrective action procedures (SWMP Plan Appendix 4-2).

3.1 Construction Site Inspections:

There are three (3) construction inspection requirements that must be met for all applicable maintenance and construction projects. A summary of these requirements is as follows:

- ***Initial Site Inspection****:*
  - *Purpose*: To ensure that BMPs are correctly installed, in the right locations, and in accordance with all MCBH approved SWPPP related documents.
  - *Inspector*: An engineer or qualified inspector that is familiar with the project and SWPPP related documents.
  - *Frequency*: One-time, after installation of BMPs but prior to any ground disturbing activities.
  - *Documentation*: "Initial BMP Site Inspection Checklist" (SWMP Plan Appendix 4-1)

- ***Monthly Site Inspections*****:**
  - *Purpose*: To ensure the continued performance of BMPs throughout the life of the project, that SWPPP related documents are available to workers onsite, and to make sure that appropriate adjustments are made to BMPs that a found to be deficient. Monthly inspections will be conducted for all projects.
  - *Inspector*: A qualified, independent inspector, with no involvement in the day-to-day planning, design, or implementation of the project.
  - *Frequency*: Begins as monthly, however, the frequency can be reduced to quarterly in accordance with criteria detailed in the SWMP Plan Section 4.5.2.
  - *Documentation*: "BMP Construction Inspection Monthly/Quarterly MCBH Checklist" (SWMP Plan Appendix 4-1)

- ***Dig Permit Inspection:***
  - *Purpose:* This applies to all projects that have been approved, via dig permit, for connections to the MS4, discharge of surface storm water runoff related to construction activities, or discharge of non-storm water to the MS4. The inspection is intended to ensure that any potential construction related discharges to the MS4 have been accurately reported in the dig permit, and any other applicable NPDES permit coverages, and that BMPs have been installed in accordance with the project SWPPP or related documents, as applicable.
  - *Inspector:* A qualified, independent inspector, with no involvement in the day-to-day planning, design, or implementation of the project.
  - *Frequency:* Annual or at least once during the life cycle of the project, whichever is comes first.
  - *Documentation*: "BMP Construction Inspection Monthly/Quarterly MCBH Checklist" (SWMP Plan Appendix 4-1)

All inspections, reporting, and corrective procedures will be conducted in compliance with the MS4 Permit. Table 3-1 provides a general summary of the organization of oversight for MS4 Permit compliance with construction site inspections, corrective actions, and recordkeeping/tracking requirements. Initial site inspections will be conducted by the ECPD Compliance Inspection Team or a qualified inspector contracted by the overseeing agency; familiar with the plans, the project SWPPP, and related documents. For in-house projects, all monthly inspections and dig permit inspections will be conducted by ECPD or a qualified inspector designated or hired by MCD/ECPD. The inspector will not be involved in the day-to-day activities/progress of the project. Any contracted maintenance or construction projects that require monthly inspections and/or dig permit inspections, will have these requirements included as a component within the contract. Contractors will be responsible for hiring a qualified, third-party inspector, who will report to the overseeing agency and to ECPD, as necessary. Additional information regarding inspections is available in the SWMP Plan Section 4.5.

Inspections will also be conducted upon complaints from citizens or concerned groups. Unannounced and follow-up inspections will be conducted as deemed necessary by ECPD. ECPD will coordinate with the overseeing agency if violations/deficiencies are documented. All construction projects are also subject to routine general inspections by the ECPD Compliance Inspection Team. If violations/deficiencies are observed during general inspections, either the tenant or ECPD will be notified. ECPD will direct the issue accordingly. Adjustments to inspection frequency will be made at the discretion of the overseeing agency and ECPD, in accordance with the MS4 Permit requirements.

3.1.1 Deficiency Definitions:

For consistency within the inspection process, MCBH has categorized reportable deficiencies as *(i) critical, (ii) major,* and *(iii) minor*. Refer to the "Enforcement Response Plan" in Appendix 3-4 of the MCBH SWMP Plan for specific examples of deficiencies in these categories.

Critical Deficiency: A deficiency that poses an immediate risk of discharge of pollutants to a storm drain MS4 system, surface waters or State waters.

***Major Deficiency*:** A deficiency that is a significant issue that could result in the discharge of pollutants to the storm drain system, surface waters or State waters.

***Minor Deficiency*:** A deficiency that does not pose a threat of discharge of untreated storm water or pollutants to the storm drain system, surface waters, or State waters, but are not in direct conformance with the SWPPP document.

3.1.2 Reporting and Corrective Action Procedure

MCBH has developed procedures for reporting and corrective actions, based on the severity of any deficiencies observed onsite during any routine site inspection. This procedure is also documented in more detail in the "Enforcement Response Plan" (SWMP Plan Appendix 3-4), and the "Reporting and Corrective Procedures for Construction Storm Water Inspections" (SWMP Plan Appendix 4-2). Generally, outside of its own inspections, ECPD will be notified of MS4 Permit violations detected during routine inspections if:

1. The base inspector identifies a violation during general Base-wide inspections.
2. A MS4 Permit violation is not internally, and promptly resolved by processes in place through construction contracts with the FEAD, MCCS, OMC/Hunt, or DOE.

Once ECPD has been notified, the following procedure will come into effect:

If any critical deficiency is observed, ECPD will immediately provide verbal notification to the responsible tenant/manager and ensure all critical deficiencies are addressed and adequately corrected before the close of business day on the day the deficiency is identified. ECPD will document the issue using the inspection checklist and photograph log and send a written notification to the responsible tenant and MCBH PM. ECPD will immediately notify DOH if work is being completed without appropriate permits or if there is a discharge to State waters that exceeds reportable quantities or exceeds water quality standards.

If any major deficiency is observed, ECPD will immediately provide verbal notification to the responsible tenant/manager. ECPD will document the issue using the inspection checklist and send a written notification with an attached inspection checklist containing photographs to the responsible tenant/manager and MCBH PM explaining the site nonconformities. ECPD will ensure all major deficiencies are addressed or corrected as soon as possible, but in no event later than five (5) calendar days after the deficiency is identified or before the next forecasted rain event, whichever is sooner.

If any minor deficiency is observed, ECPD will document the issue using the approved inspection checklist, photograph log and internal project tracking system. The responsible tenant/manager and MCBH PM will be notified verbally of any non-conformities at the end of the inspection and provided an emailed copy of the inspection form (with attached photographs) within 48 hours of the inspection (two (2) business days). A response from the tenant or PM documenting the corrective action taken to address the identified issues is expected within five (5) calendar days from receiving the verbal notification from ECPD.

Per the permit, an independent qualified construction inspector will conduct follow-up inspections as needed, at least monthly to ensure site deficiencies have been properly addressed and all storm water controls are in proper working order.

For recordkeeping purposes, ECPD will provide the responsible tenant/manager an emailed copy of the inspection form (with attached photographs) with 48 hours of the inspection (two (2) business days). The responsible tenant/manager or MCBH PM is expected to provide a formal written response to ECPD, documenting corrective actions (with photograph verification, maps, etc.), within five (5) calendar days of receiving the inspection form. ECPD will track all inspections using an internal public share drive.

3.2 Enforcement

To ensure compliance with the Construction Program and MS4 Permit requirements, MCBH has developed enforcement procedures for all maintenance and construction projects in its "Enforcement Response Plan," (SWMP Plan Appendix 3-4). Refer to the Enforcement Response Plan for more detailed information of enforcement procedures for this Construction Program.

MCBH is unique from most MS4s in that within its property boundary, it owns the property and almost all of the facilities and provides funding for a majority of work. Due to the nature and internal structure of MCBH, the most effective means for enforcement is escalation of unaddressed violations to the next higher authority.

If an observed deficiency is not addressed by the tenant or contractor within the allotted mitigation period, the issue will be brought to the attention of the ECPD Director. The party in violation will receive a written notice and deadline for compliance. If the issue remains unresolved, it will be escalated to the next higher authority.

Regardless of the type of project, the ultimate penalty for non-compliance of this Construction Program and MS4 Permit regulations, is eviction or discharge of the responsible party from MCBH. This is placed at the discretion of the CO. Although unaddressed violations can be escalated as high as the CO, this has not been an issue in the past due to the inherent threat of discharge or eviction from MCBH.

3.2.1 Referral of Non-compliance and Non-filers to DOH

In the event that MCBH encounters a situation where continued failure to resolve an observed deficiency has resulted in the CO's determination that the contractor or tenant be evicted, ECPD will notify DOH within one (1) week of the decision. A written notification from ECPD, including all relevant information (such as inspection checklists, photographs, notes, and correspondence) is to follow within two (2) weeks of the CO's determination.

In the event that an MCBH inspector identifies that a construction site has not applied for permit coverage under the NPDES permit program, ECPD will provide written notification to DOH within two (2) weeks of the discovery.

All written notifications submitted via email will be directed to:

cleanwaterbranch@doh.hawaii.gov, Attn: Enforcement Section Supervisor

Table 3-1
Organization of MS4 Compliance Oversight

Source of Storm Water Runoff	Required Permits/ Agreements	Responsible for Inspections	Responsible for Corrective Action	Recordkeeping and Tracking
General Base-wide Inspections	None	ECPD Compliance Inspection Team	Varies[1]	Varies[1]
In-house Maintenance & Construction	• Project-specific NPDES Permit or connection/discharge approval through dig permit process (if applicable) *None (If no NPDES permit coverage needed)*	MCD, ECPD	MCD	ECPD
Military Construction	• Project-specific NPDES Permit or connection/discharge approval through dig permit process (if applicable) *None (If no NPDES permit coverage needed)*	MCD, ECPD	MCD	MCD
NAVFAC Construction by Outside Contractor	• Contract documents, including plans & specifications • Project-specific NPDES Permit or connection/discharge approval through dig permit process (if applicable)	FEAD, ECPD	Contractor	FEAD
DOE – Mokapu Elementary School	• Lease Agreement • Project-specific NPDES Permit or connection/discharge permit (if applicable)	DOE, ECPD	DOE (State)	DOE
PPV Housing	• Lease Agreement • Project-specific NPDES Permit or connection/discharge approval through dig permit process (if applicable)	OMC/Hunt, ECPD	Resident (Residential Lots) OMC/Hunt (Common Areas)	OMC/Hunt
MCCS – Commercial Areas	• Lease Agreement • Project-specific NPDES Permit or connection/discharge approval through dig permit process (if applicable)	MCCS, ECPD	Commercial Tenant	MCCS
MCD Contract Maintenance & Construction	• Project-specific NPDES Permit or connection/discharge approval through dig permit process (if applicable) *None (If no NPDES permit coverage needed)*	MCD, ECPD	MCD	MCD

[1] Varies depending on the agency responsible for oversight of the project, in accordance with Figure 2-1.

This page is intentionally left blank.

4 Construction Project Inventory and the Asset Management System

Effective tracking of construction projects from the review stage to project completion ensures that pollutants do not degrade water quality to the MEP. This allows tracking of where pollutants enter the MS4, the schedule and results of inspections, enforcement actions, and the location and maintenance requirement of permanent (post-construction) BMPs. The purpose of the construction project inventory and the Asset Management System (AMS) is to ensure projects maintain compliance with the MCBH MS4 permit and the Stormwater Pollution Prevention Program as outlined in the MCBH SWMP Plan.

4.1 Project Inventory

Effectively managing project information will enable MCBH to be able to easily identify and correct compliance issues and recognize recurring issues within the Construction Program or repeat offenders of its MS4 Permit requirements. The ability to easily identify and address problems will further promote the continual improvement of the Construction Program and facilitate its effectiveness in reducing storm water pollution related to construction sites.

An inventory of applicable construction sites is maintained by the responsible agencies displayed in Table 4-1. All records are kept at the associated agency's office and will be made available, when necessary, upon request by ECPD or DOH.

The inventory of construction sites is made up of project records that contain the following information, as applicable:

- Project title, and permit or file number (*if applicable).*
- Status of plan review and approval process.
- Inspection dates and enforcement action *(if applicable)*. If enforcement action is noted, the record shall include reference information for the associated MCBH BMP Construction Inspection Checklist forms (see Appendix 4-1 of the SWMP Plan), and any follow-up documentation (*if applicable*) as tracked in the ECPD database.
- If the project has filed a NOI for, or received a NGPC for any General Permits under HAR, Chapter 11-55, including, but not limited to:
    - Appendices C and A - NPDES General Permit Authorizing the Discharge of Storm Water Associated with Construction Activity *(for projects disturbing an area of one (1) acre or more);*
    - Appendices F and A - NPDES General Permit Authorizing Discharge of Hydrotesting Waters; or
    - Appendices G and A - NPDES General Permit Authorizing Discharges Associated with Construction Activity Dewatering

or If the project has applied for, or received an individual NPDES permit, or satisfied any other requirement of the NPDES permit program.

In addition to managing the construction project inventory, the specific agency responsible for construction project management (Table 4-1) is responsible for maintaining the project information and inspection/enforcement data in the MCBH Stormwater AMS.

4.1.1 Routine Project Exemption

To prevent overburdening the tracking systems and procedures in place, MCBH is in the process of developing a list of criteria for routine in-house maintenance and construction projects (*exempt* or *non-exempt*) that follow MCBH's standard BMP procedures, and can be reasonably considered to pose a negligible risk for discharging pollutants, via storm water, to its MS4. These criteria will be compiled into a Routine Project Exemption Form, which will be incorporated into Appendix 4-1 of the SWMP Plan once developed.

ECPD is also collaborating with MCD to develop a guidance sheet/booklet to be used by PMs, and staff to further explain required BMP implementation, procedures for meeting exemption criteria, and the importance of this process. For projects that meet these criteria, this Exemption Form will be filled out and signed by the MCBH PM. By signing the Exemption Form, the PM is certifying that the project will meet all exemption criteria until completion. This means that all applicable BMP measures will be implemented and that there is no reasonably foreseeable risk to storm water quality. For tracking purposes, the signed form will be submitted to and kept on file at MCD.

To distinguish between the aforementioned "*exempt"* maintenance/construction projects (i.e., emergency repair projects, interior remodeling, etc.), projects that meet the Exemption Form criteria will be referred to as "*routine exempt*" maintenance/construction.

Routine exempt projects will not require any further Construction Program tracking, asset management, or inspection. It will be the responsibility of the signing PM to ensure that the exemption criteria are met until the project is completed. *Exempt* projects (such as emergency repair projects) will still be considered for tracking if the exemption criteria are not met, because tracking can be instrumental in identifying recurring or resultant issues in the future.

4.2 Asset Management System

In addition to managing the construction project inventory, the specific agency responsible for construction project management (Table 4-1) is responsible for maintaining the project information and inspection/enforcement data in the MCBH Stormwater AMS. This includes data such as:

1. General Project information (including permit or file number, if available);
2. Chapter 11-55, Appendix C NPDES permit status (if applicable);
3. Status of plan review and approval;
4. Inspection dates, reports/photologs; enforcement actions (if applicable).

Table 4-1
Location of Inventory of Construction Sites

Type of Construction Project	Agency Responsible for Site Management	Location of Records (Agency/POC, Building/Address)
In-house Maintenance and Construction	MCD	MCD Building 242
	MRO	MRO Building 201
Military Construction	ECPD	Storm Water Program Manager Building 1360
Contract Construction	MCD	MCD Building 242
▪ NAVFAC	FEAD	FEAD Deputy Director Building 566
▪ Mokapu Elementary School	DOE	School Liaison Officer Mokapu Elementary School
▪ PPV Housing	OMC/Hunt	OMC/Hunt Project Manager 5173 Nimitz Road, Honolulu, HI 96818
	NAVFAC Pacific	PPV Program POC 258 Makalapa Drive, Suite 100, JBPHH, HI 96860
▪ Commercial Tenant	MCCS	Logistics Office Building 140
▪ MCD Construction and Maintenance	MCD	MCD Building 242

BMPs that are intended to provide protection for waterbodies and the MS4 system beyond the scope of a construction project are considered assets that must be properly tracked within the MCBH Stormwater AMS. These BMPs generally include intentionally installed LID assets and proprietary BMP devices but the asset management could also be extended to temporary BMPs that are required to remain intact after construction is complete or in-between working phases of larger scale projects. Refer to SWMP Plan Chapter 5 and the "MCBH Post-Construction BMP Manual" in Appendix 5-3 for more information.

5 References

City and County of Honolulu, Department of Environmental Services, *City and County of Honolulu Storm Water Best Management Practice Manual, New and Redevelopment*, July 2014.

City and County of Honolulu, Department of Planning and Permitting, *Rules Relating to Water Quality*, December 2018.

Department of Environmental Services, City and County of Honolulu in cooperation with The General Contractors Association of Hawaii, *City and County of Honolulu, Storm Water Best Management Practice Manual, Construction*, November 2011.

Marine Corps Base Hawaii Small Municipal Separate Storm Sewer System (Small MS4) and Industrial Facilities, *NPDES Permit No. HIS000007*

State of Hawaii, Department of Health, *Hawaii Administrative Rules (HAR), Title 11, Chapter 55, Appendix A, C, F, and G*, 2019.

State of Hawaii, Department of Transportation, *Hawaii Standard Specifications for Road and Bridge Construction, and Special Provisions*, 2005.

State of Hawaii Department of Transportation, Airports Division, *Construction Activities BMP Field Manual*, 2019.

State of Hawaii Department of Transportation, Highways Division, Oahu District, *Storm Water Permanent Best Management Practices Manual,* 2015.

State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

6 Disclaimer

The information presented in this Construction BMP Field Manual was adopted from available and most recent sources that have locally acceptable BMPs and stormwater runoff control measures. This manual has been prepared as a reference guideline, however, due to site-specific conditions, the selection of the BMPs must be used in conjunction with the best professional judgment and sound engineering principles to assure proper function and performance of the BMPs contained herein. The author does not guarantee the accuracy or completeness of this document and will not assume any liability or responsibility for the use of, or for any damages resulting from the use of any information contained herein. The detail and the wording in this manual will not necessarily result in compliance with NPDES permit requirements or other requirements specific to the user's site or construction contract. Application of BMPs should comply with applicable federal, state, and county regulations.

This page is intentionally left blank

7 Construction BMP Fact Sheets

Table 7-1. Construction BMP Fact Sheets

Section	BMP CATEGORY	BMP NAME	MCBH BMP ID
1	SM	Construction BMP Training	MCBH-SM-01
2	SM	Material Storage and Handling	MCBH-SM-02
3	SM	Stockpile management	MCBH-SM-03
4	SM	Concrete Wash and Waste Management	MCBH-SM-04
5	SM	Asphalt Cement Waste Management	MCBH-SM-05
6	SM	Solid Waste Management	MCBH-SM-06
7	SM	Sanitary Waste Management	MCBH-SM-07
8	SM	Contaminated Soil Management	MCBH-SM-08
9	SM	Hazardous Materials and Waste Management	MCBH-SM-09
10	SM	Spill Prevention and Control	MCBH-SM-10
11	SM	Vehicle and Equipment Cleaning	MCBH-SM-11
12	SM	Vehicle and Equipment Maintenance	MCBH-SM-12
13	SM	Vehicle and Equipment Refueling	MCBH-SM-13
14	SM	Scheduling	MCBH-SM-14
15	SM	Location of Potential Sources of Sediment	MCBH-SM-15
16	SM	Staging Area	MCBH-SM-16
17	SM	Preservation of Existing Vegetation	MCBH-SM-17
18	SM	Dewatering Operations	MCBH-SM-18
19	SM	Dust Control	MCBH-SM-19
20	SM	Paving Operations	MCBH-SM-20
21	SM	Structure Construction and Painting	MCBH-SM-21
22	SM	Topsoil Management	MCBH-SM-22
23	EC	Temporary Stream Crossing	MCBH-EC-01
24	EC	Flared Culvert End Sections	MCBH-EC-02
25	EC	Run-on Diversion	MCBH-EC-03
26	EC	Slope Roughening, Terracing, and Rounding	MCBH-EC-04
27	EC	Earth Dike, Swales, and Ditches	MCBH-EC-05
28	EC	Level Spreader	MCBH-EC-06
29	EC	Slope Drains and Subsurface Drains	MCBH-EC-07
30	EC	Outlet Protection and Velocity Dissipation Devices	MCBH-EC-08
31	EC	Slope Interceptor or Diversion Ditches/Berms	MCBH-EC-09
32	EC	Rip-Rap and Gabion Inflow Protection	MCBH-EC-10
33	EC	Geotextiles and Mats	MCBH-EC-11

Section	BMP CATEGORY	BMP NAME	MCBH BMP ID
34	EC	Seeding and Planting	MCBH-EC-12
35	EC	Hydroseeding	MCBH-EC-13
36	EC	Mulching	MCBH-EC-14
37	EC	Hydromulching	MCBH-EC-15
38	EC	Soil Binders	MCBH-EC-16
39	SC	Storm Drain Inlet Protection	MCBH-SC-01
40	SC	Vegetated Filter Strips and Buffers	MCBH-SC-02
41	SC	Check Dams	MCBH-SC-03
42	SC	Sediment Trap	MCBH-SC-04
43	SC	Sediment Basin	MCBH-SC-05
44	SC	Compost Filter Berm/Sock	MCBH-SC-06
45	SC	Silt Fence or Filter Fabric Fence	MCBH-SC-07
46	SC	Sandbag Barrier	MCBH-SC-08
47	SC	Brush or Rock Filter	MCBH-SC-09
48	SC	Construction Road and Parking Lot Stabilization	MCBH-SC-10
49	SC	Stabilized Construction Entrance/Exit	MCBH-SC-11

Notes:
SM = Site Management
EC = Erosion Control
SC = Sediment Control

1 Construction BMP Training

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

1.1 Description

Training programs that address the proper installation and maintenance of construction best management practices (BMPs)

1.2 Training Objectives

Provide the necessary information for personnel to identify potential pollutant sources on construction projects and implement practicable solutions.

1.3 Applications

Personnel with construction storm water responsibilities, including but not limited to designers, construction engineers, construction and maintenance inspectors, plan reviewers, contractors, and sub-contractors are responsible, as applicable, for the following:

- Designing, installing, maintaining, and/or repairing storm water controls/BMPs (including pollution prevention measures).
- Applying and storing chemicals.
- Vehicle/equipment storage, maintenance, and refueling.
- Conducting inspections.
- Taking and documenting corrective actions.

1.4 Implementation

- Provide training with construction storm water responsibilities, including construction engineers, construction and maintenance inspectors, and plan reviewers.
- Provide relevant educational materials to project applicants, contractors, developers, property owners, and other responsible parties.
- Provide construction BMP training to contractors and sub-contractors responsible for development of the Storm Water Pollution Prevention Plan (SWPPP) and implementation of site-specific BMPs.
- The contractor shall keep training logs updated and readily available.
- Prior to commencement of earth-disturbing activities or pollutant-generating activities, whichever occurs first, at a minimum, personnel must be trained to understand the scope of their job duties, as applicable, as follows:
- Location of all storm water controls on the site, and how they are to be maintained.
- Proper procedures to follow with respect to the project's pollution prevention requirements.
- When and how to conduct inspections, record applicable findings, and take corrective actions.
- Provide storm water training through field office trainings, product demonstrations, an annual storm water conference, videos, newsletters, and/or field demonstrations.

1.5 Training Frequency

- Annual training to staff with construction storm water responsibilities.
- When needed, as new technology, permits, and regulations are created.
- Prior to the commencement of earth-disturbing activities or pollutant-generating activities.
- Provide training to new hires prior to them performing responsibilities related to compliance with applicable permits.
- Site-specific training may be necessary for new construction project

2 Material Storage and Handling

2.1 Description

Practices and procedures to promote proper handling, storage, and use of construction materials in a manner that minimizes or eliminates storm water pollution, groundwater pollution, soil contamination, and injury to workers or visitors.

2.2 Applications

Properly store and handle materials on construction sites based on the general requirements for the materials

- Designate a material storage area.
- Locate stored materials away from inlets, concentrated flows and open waterbodies.
- Provide a cover for stored material.

Table 2-1 Proper storage and handling of materials commonly found on construction sites

Materials Commonly Found on Construction Sites	Proper Storage and Material Handling
• Soil • Fill • Aggregate	• Designate a material storage area. • Locate stored materials away from inlets, concentrated flows and open waterbodies. • Cover stored materials containing fines with an impermeable material to prevent erosion caused by storm water and wind. • Place a compost filter sock, silt fence, or similar sediment barrier device at the base of material stockpiles. • See section 3 Stockpile Management
• Soil stabilizers and binders • Fertilizers • Pesticides and herbicides • Detergents • Plasters	• Designate a material storage area. • Locate stored materials away from inlets, concentrated flows and open waterbodies. • Store materials on proper dunnage, pallet, or similar materials to elevate off the ground. • Cover stored materials with an impermeable material to prevent contact with storm water. • Cover stored materials with an impermeable material to prevent contact with storm water. • Tightly seal container lids when not in use. Do not apply fertilizer or herbicides during or just before a rain event. • Materials shall be in sealed and properly labeled bags or containers. • All liquid materials shall be stored with an appropriately sized secondary containment.
• All metals, including galvanized metal • Rebar	• Rack materials off the ground on proper dunnage, pallet, or similar materials to elevate off the ground. • Cover all metal materials, including galvanized metals and rebar, with an impermeable material to prevent contact with storm water.
• Asphalt • Asphalt products (i.e. cold-patch, tack coat, etc.) • Concrete products (i.e. cold curing compound, form release agents, etc.)	• Designate a material storage area • Locate stored materials away from inlets, concentrated flows and open waterbodies. • Store materials on proper dunnage, pallet, or similar materials to elevate off the ground. • Cover asphalt and concrete • Hazardous materials shall be labeled and stored in their original containers.

Materials Commonly Found on Construction Sites	Proper Storage and Material Handling
	• Provide appropriately sized secondary containment. • Properly dispose of containers only after l the product has been used. • See section 9 Hazardous Materials and Waste Management

2.3 Installation and Implementation

Ensure proper material storage and handling practices are implemented on construction sites.

2.4 Material Storage

- Materials with the potential to contaminate runoff must be stored under some type of impermeable cover and racked off of the ground to prevent contact with storm water. This BMP will greatly decrease the potential of pollutants originating from storage areas.
- Designate an on-site material storage area. This area shall be located away from concentrated flows, inlets, and open waterbodies.
- Maintain accurate and up-to-date records of materials delivered and stored on-site.
- Minimize on-site inventory.
- Retain a complete set of Safety Data Sheets (SDS) on-site.
- Do not store chemicals, drums, and bagged materials directly on the ground. Metal drums or containers must be covered with 10 mil plastic sheeting to prevent contact with rainwater if stored in an uncovered area.
- Secondary containment must be designed, installed, and operated to prevent any migration of wastes or accumulated liquid out of the containment system to the soil, groundwater, or surface water.
- Secondary containment must be able to retain 100% of the volume of the largest container or 10% of the aggregate total of all the containers being stored within the secondary containment, whichever is greater.
- Hazardous chemicals shall be stored in their original containers with manufacturer’s labels and placed in secondary containment.
- All product containers should have Globally Harmonized System (GHS) Labels.
- All containers should be labeled as to their contents.
- Do not stack more than 2 containers on top of each other to avoid tipping over. Containers may be stacked higher (no more than 3) provided they are secured from tipping over through such methods of shrink wrap or other supportive means. There must be enough room in the containment area to contain any tipped containers.
- Fuel containers shall have secondary containment for nozzles/hoses.
- Store soaps, detergents, and solvents under cover or other means to prevent contact with rainwater.
- Materials should not be stored in locations that hinder the effectiveness of other BMPs.
- Do not store materials on erosion and sediment control devices.
- Comply with building and fire code requirements when storing materials.

- Provide appropriate training to all new employees responsible for material storage and handling prior to the commencement of work.

2.4.1 Material Handling

- Use the appropriate amount of materials necessary to complete the construction activity.
- All personnel shall be trained in accordance with hazardous communication standards. Refer to the Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards 29 CFR Section 1910.1200 for more information.
- Minimize the use of hazardous materials. See section EC-9 Hazardous Materials and Waste Management for more information.
- Do not remove the original label. Comply with manufacturer's labels, which include product information regarding uses, protective equipment, flammability, ventilation, mixing of chemicals, and proper disposal.
- Use the entire product before disposing of the container in accordance with all federal, state, and local regulations.
- Restrict amount of herbicide prepared to the quantity necessary for the current application. Comply with the recommended usage instructions. Do not apply fertilizers or herbicides during or just before a rain event.
- Comply with building and fire code requirements when storing materials.
- Maintain an ample supply of cleanup materials that are readily accessible for spills.

2.5 What to Inspect

- Are storage areas clean, organized, and equipped with an adequate supply of cleanup materials?
- Are secondary containment measures being used and are they appropriately sized?
- Do containers have proper labeling?
- Do containers show signs of corrosion and/or evidence of leaks?
- Are materials properly stored and disposed of?
- Are storage areas located away from drainage structures, concentrated flows and open waterbodies?

2.6 Maintenance

- Storage areas shall be clean and well organized.
- Maintain an adequate supply of spill cleanup materials on-site and readily available.
- Any significant residual materials remaining on the ground shall be removed and properly disposed of immediately. If the residual materials contaminate the soil, then the contaminated soil shall also be removed and disposed of properly.
- Maintain covers on any materials that should not come into contact with storm water. All containers must have proper GHS Labels and, if practicable, be in secondary containment.
- Provide periodic training to all employees responsible for material storage and handling.

3 Stockpile Management

3.1 Description

Stockpile protection measures to reduce the potential for air and water pollution originating from stockpiles of construction materials and spoil piles. Stockpiled materials may include soil, Portland cement concrete (PCC), asphalt concrete, cold mix asphalt, and aggregate. Spoil piles may include materials excavated from a trench, tunnel, shaft or other excavation activity.

3.2 Applications

Provide proper protection of stockpiles on construction sites. Table 3-1 provides a list of materials commonly stockpiled on construction sites and examples of BMPs for stockpile protection, depending on what material is being stored and the associated risk it poses.

Table 3-1 Common Stockpiled materials and example BMPs

Common Stockpile Material	Examples of BMPs
• Soil • Topsoil • Excavated material • Imported material • Spoil piles	• Cover stockpile with either: • 10 mil plastic sheeting or comparable impermeable material. • soil stabilization measures (i.e., hydromulch, tackifier). • Protect stockpile with a temporary perimeter sediment barrier.
• PCC • Rubble • Crushed • Hardened • Saw cut	• Cover with 10 mil plastic sheeting or comparable impermeable material (applicable if fines are present). • Protect stockpile with a temporary perimeter sediment barrier.
• Asphalt • Hot mix asphalt • Asphalt cement (cold mix) • Rubble • Reclaimed asphalt pavement	• Cover with 10 mil plastic sheeting or comparable impermeable material. • Protect stockpile with a temporary perimeter sediment barrier. • Asphalt (cold mix and hot mix) must be stored on an impervious material.
• Aggregate • Base • Sub-base etc.)	• Cover with 10 mil plastic sheeting or comparable impermeable material. • Protect stockpile with a temporary perimeter sediment barrier.
• Treated wood • Creosote telephone poles	• Cover with 10 mil plastic sheeting or comparable impermeable material at all times. • Rack materials off the ground or place on top of impermeable material.

3.3 Installation and Implementation

- Locate stockpiles a minimum of 50 feet, or as far as practicable, from concentrated runoff, waterbodies, and inlets. If impracticable, additional precautions should be taken to protect storm drain inlets, open drainage facilities, and waterbodies.
- Place bagged materials on pallets and under cover.
- Provide physical diversion to protect stockpiles from concentrated runoff.
- Cover stockpiles with 10 mil plastic sheeting or comparable impermeable material.
- Cover may be removed while adding to or removing from the stockpile. Replace the cover when not in use.
- Cover should be weighted down to prevent it from blowing off.
- Geotextile filter fabric is an acceptable cover for mulch stockpiles or other heat producing materials.
- Stockpiles of paving materials must not be placed directly on the ground. Place on 10 mil plastic sheeting or similar impermeable material or dispose of it properly off-site at the end of the day.
- Soil stabilization measures may be used if soil stockpiles will be inactive for an extended amount of time. Hydroseeding, hydromulching, and tackifiers may be accepted as adequate soil stabilization measures. See sections EC-13 Hydroseeding, EC-15 Hydromulching, and EC-16 Soil Binders for more information. Place silt fence, compost filter socks, or other accepted perimeter controls approximately 1 to 2 feet from the base of the stockpile.
- Stockpiles consisting of aggregate may need to be covered depending on the amount of fines present.
- Stockpiling topsoil for extended periods of time can reduce the biotic benefits of the existing soil. Topsoil stockpiles should be stored for as little time as possible.
- Stockpiles must be covered at the end of each work day and before each anticipated rain event.
- Minimize compaction of soil stockpiles.
- Ensure stockpile heights can be managed and should be no taller than surrounding structures.

3.4 Considerations

- Stockpiles are only applicable for temporary storage of material.
- Perimeter controls for the project limits are not considered stockpile protection.
- Stockpiles cannot be located in any natural buffer area.

3.5 What to Inspect

- Are stockpiles completely covered?
- Is perimeter control installed at the base of the stockpile?
- Are there tears/rips in the stockpile cover?
- Is there evidence of water or wind erosion?
- Are stockpiles located away from concentrated flows, open waterbodies, and inlets?
- Does the stockpiled material have fines and need to be covered?
- Is the stockpile taller than surrounding structures?

3.6 Maintenance

- Replace/repair damaged stockpile cover, as needed.
- Ensure the plastic cover is in contact with the ground around the entire pile and properly anchored.
- Replace/repair damaged temporary perimeter sediment barrier.
- Stockpiles removed from the project site shall be disposed of at an approved solid waste permitted facility. Stockpiles shall not be taken to an intermediary site such as a contractor's baseyard unless the contractor's baseyard has been issued the appropriate permit from the Department of Health.
- Revegetate any disturbed areas under removed stockpiles, if applicable.
- Reapply temporary stabilization (i.e., hydromulch, tackifier, etc.), if needed.

4 Concrete Wash and Waste Management

4.1 Description

Practices and procedures to manage concrete/cementitious products, washout, and waste to prevent discharges to the ground, the drainage system, or adjacent waterbodies.

4.2 Applications

- Projects involving the use of concrete/cementitious products as construction materials.
- Demolition activities generating dust and debris.
- On-site wash areas used for concrete-coated vehicles or equipment.
- Activities such as sawcutting and grinding which result in the formation of slurries containing Portland cement.
- Activities generating fines from sawcutting, grinding, and demolition.
- Commonly Used Cementitious Products
- Concrete
- Mortar
- Plaster
- Stucco
- Grout
- Cement-Treated Base (CTB)

4.3 Installation and Implementation

- Properly store cement-based materials under cover to prevent contact with storm water. The materials can be classified as waste if improperly stored.
- Designate areas for concrete waste and washout a minimum of 50 feet away, if practicable, from storm drain inlets, open drainage facilities, and waterbodies. If impracticable, per Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Appendix C, 5.1.2.1.1.2, other measures, such as double sediment control (e.g., double perimeter control), must be employed to prevent wash water/waste concrete from reaching the storm drain inlets, open drainage facilities, and waterbodies.
- Avoid mixing excess concrete, if possible. Discard excess concrete in the designated area.
- Disposal of concrete washout via percolation is prohibited. Wash concrete-coated vehicles or equipment in the designated wash area or off-site.
- The designated concrete washout area shall be a temporary pit (below grade), a level bermed area (above grade), or a commercially available system approved to capture concrete wash water.
- The washout should be sufficiently sized so that no overflow can occur due to inadequate sizing or precipitation.
- The washout area shall be lined with an impermeable material (i.e., plastic sheeting, Visqueen, polypropylene, etc.) to prevent seepage of washout into the ground. If plastic is used, it must be a minimum of 10 mil thick. The lining shall be seamless.
- Allow wash water to evaporate or contain the washout in an approved concrete washout system. Provide a minimum freeboard (height above the water mark) of 4 inches for concrete washouts to account for rain events. Washouts must be changed or not used after reaching 75% capacity or 4-inch freeboard, whichever is more stringent.
- If secondary containment is placed under the washout (recommended), it should be bermed under the plastic sheeting to create a secondary pooling area to catch any leaks or splashes.
- Waste concrete shall not be allowed to harden on the bare ground and shall be removed while wet.
- Materials from the contractor's spill kit can be used to clean up waste concrete.
- Break up and store hardened concrete in the designated area.
- Saw cut slurry shall be removed from the site by vacuuming.
- Provide storm drain inlet protection during sawcutting operations.
- When placing concrete in water environments or tremie pours and drill shafts, any water which is displaced or in contact with wet concrete, mortar, or grout is considered contaminated/concrete impacted.
- Remove concrete impacted water to a sealed containment area where it cannot contact or percolate into the ground. Holding tanks can be used where water is treated pending release/removal and concrete waste collected for disposal. If a pit is used, it must be sealed against possible leaks to the ground until the water evaporates. Overlapped plastic sheeting in the pit is not permitted.
- Concrete placement in drill shafts often result in water displacement and requires an over pour of concrete in the shaft. Displaced water must be considered contaminated/concrete impacted and treated as you would above. Any over pour of concrete in contact with the ground must be cleaned up while wet and placed in containment. Plastic sheeting lined pit areas at the drill shaft may also be constructed to catch over pour if adhered to the drill shaft.

- Do not allow concrete liquid wastes onto the ground, into the storm drainage systems, or into waterbodies.
- Collect and properly dispose of all concrete waste material at an approved solid waste permitted facility. Dispose of liquid and solid concrete wastes in accordance with solid waste regulations as well as other applicable federal, state, and local regulations.
- Provide concrete waste management training for employees and contractors.

4.4 Considerations

- Off-site concrete wash areas may be impracticable.
- Locating concrete washout areas a minimum of 50 feet away from drainage systems and open waterbodies may not be practicable.
- May need to allow washout to evaporate.
- Constructing washout areas may not be practicable. Manufactured concrete washout bins may be the only option.
- Rainwater can cause uncovered washout pits and containers to overflow.

4.5 What to Inspect

- Has the concrete washout been damaged?
- Is liner a continuous and seamless piece?
- Is the concrete washout area exceeding 75% capacity limits or minimum freeboard of 4 inches?
- Are leaks observed from the designated concrete washout area?
- Is there evidence of concrete waste on ground?
- Are contractors implementing proper concrete waste management measures?

4.6 Maintenance

- Regularly remove and dispose of hardened concrete in accordance with solid waste regulations.
- Remove accumulated concrete washout materials when it reaches 75% capacity or exceeds the minimum 4-inch freeboard requirement.
- Cover temporary concrete washout, when not in use and at the end of the work day, to avoid overflow.
- Inspect concrete washout facilities daily and after heavy rains. Replace lining if damaged (i.e., torn, brittle, UV-degraded) before use.
- Immediately clean up concrete waste on bare ground or paved areas before it hardens.
- Vacuum concrete dust and slurry during and immediately after sawcutting activities with proper equipment to prevent/minimize concrete stains. Hosing or washing the area is not allowed.
- Sweep up debris when concrete work is completed for the day.

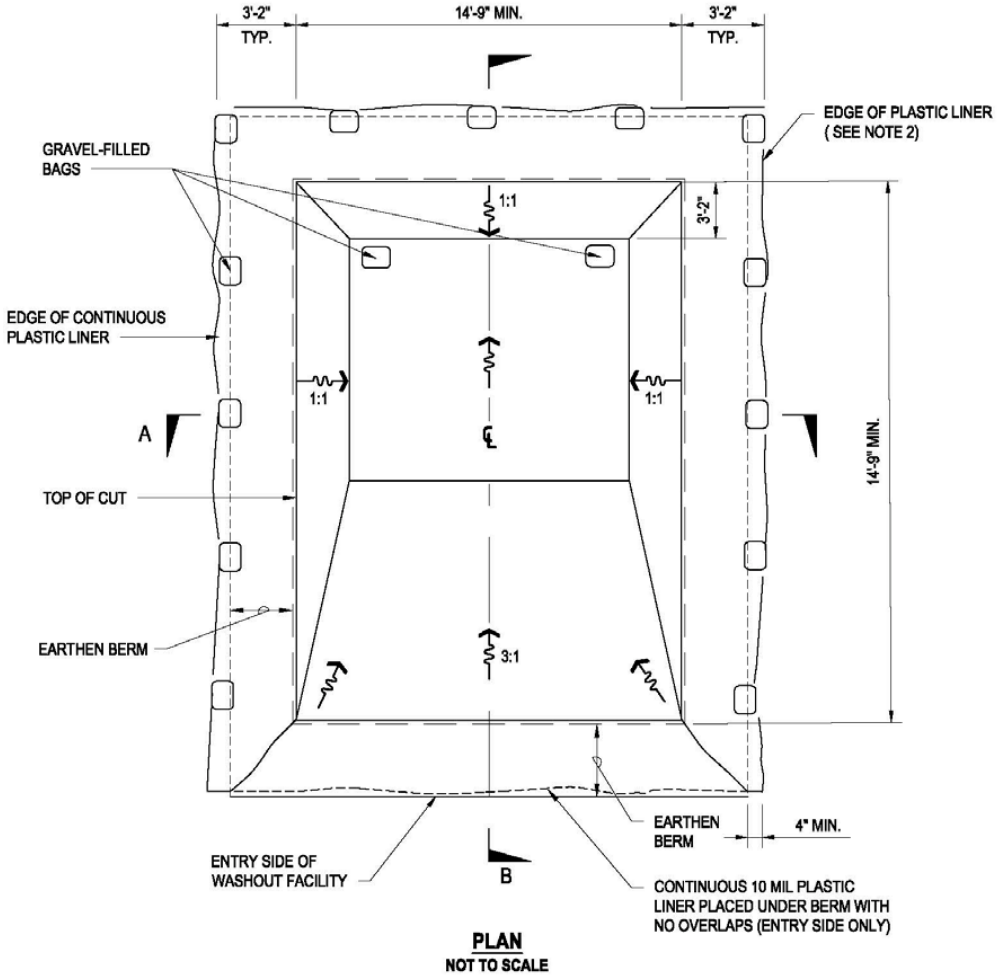


Figure 4-1. Example of a Below Grade Concrete Washout

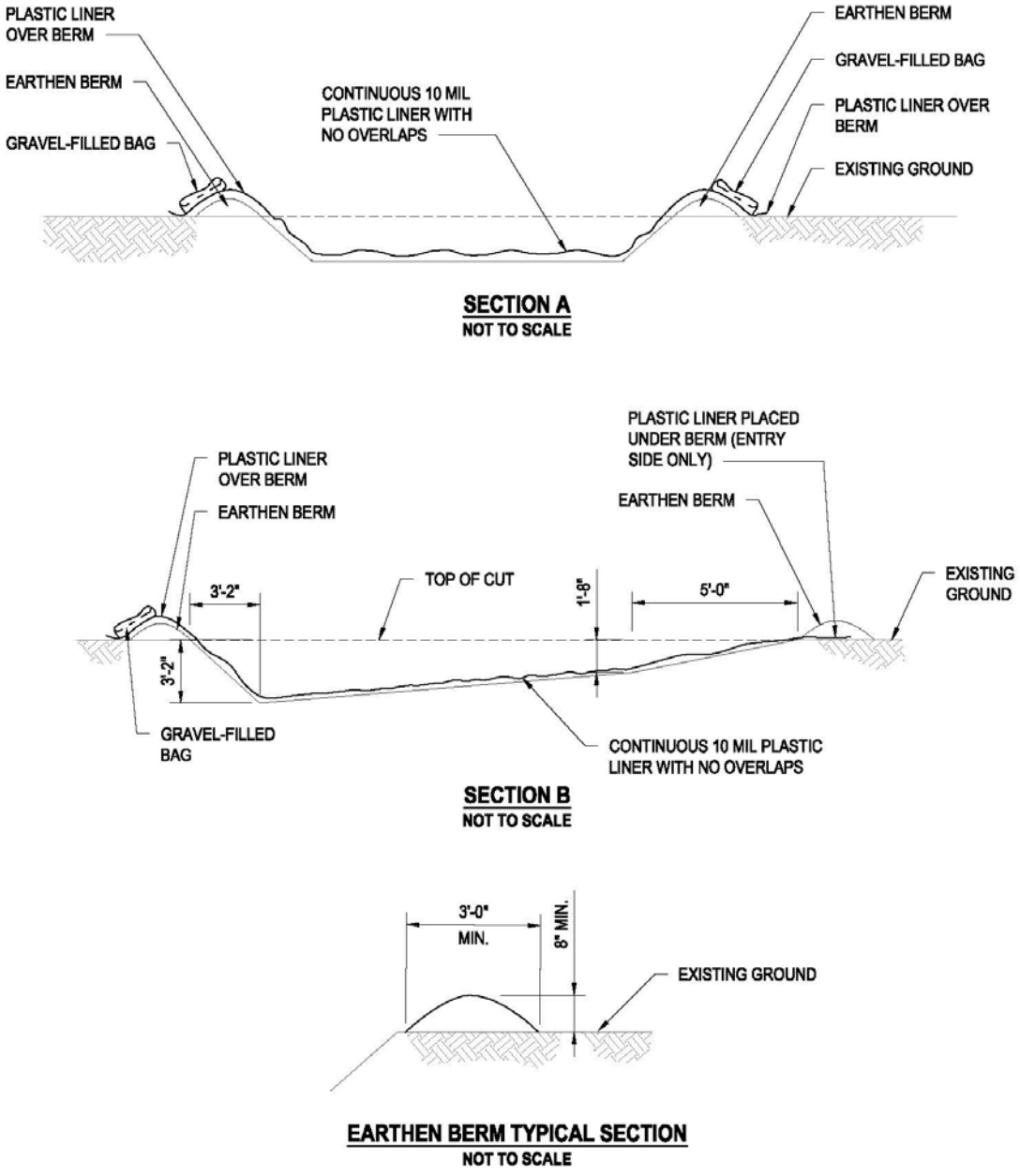


Figure 4-2. Example of an Earthen Berm Section

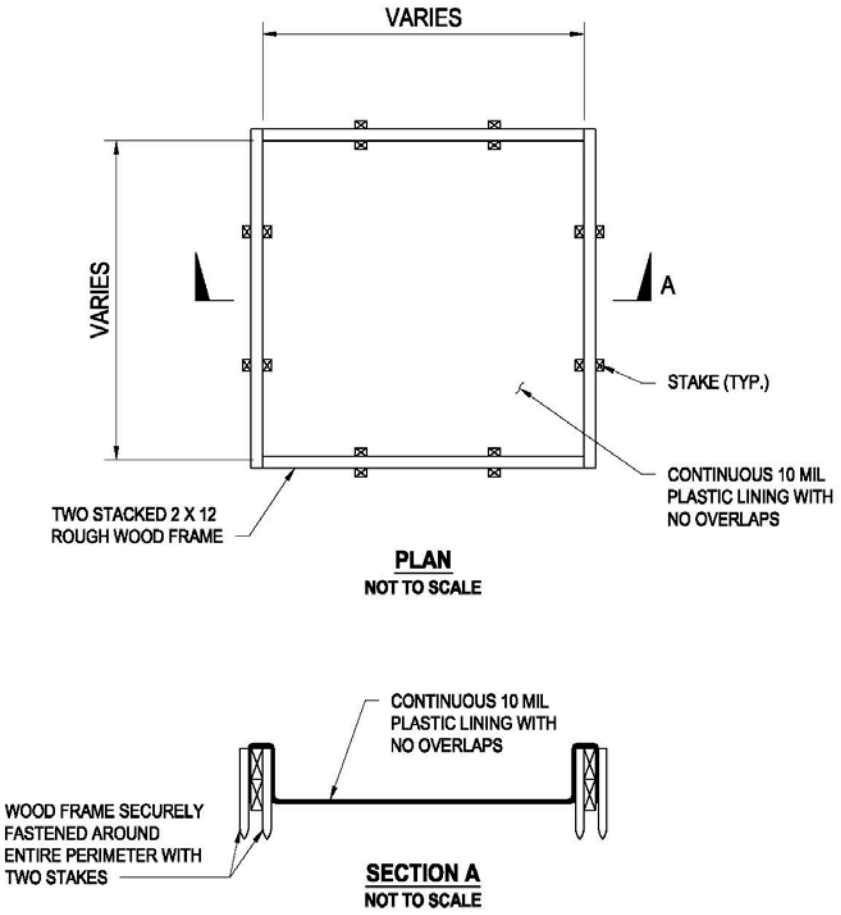


Figure 4-3. Example of an Above Grade Concrete Washout

5 Asphalt Cement Waste Management

5.1 Description

Practices and procedures to prevent asphalt cement millings and waste from discharging into the drainage system or adjacent waterbodies.

5.2 Applications

- Paving operations.
- Milling road and highway surfaces that generate dust and debris.
- Asphalt cement pavement patching and repair.

5.3 Installation and Implementation

- Ensure all inlets at risk of receiving pollutants are protected with inlet protection during milling operations. See section 39 Storm Drain Inlet Protection for more information.
- Place temporary cold patch spoil piles or waste asphalt piles on impervious material, cover with impermeable material, and surround with full perimeter control.
- Store paving vehicles and equipment in an approved staging area and fully park on a layer of geotextile filter fabric on top of 10 mil plastic sheeting. See section 16 Staging Area for more information.
- Seed pervious areas disturbed by paving operations within 14 days (7 days if runoff drains to impaired waters) of completing paving to initiate stabilization per Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Appendix C, section 5.2 or per project specifications.
- Clean roads of loose debris by the end of the work day by sweeping or vacuuming.

- Remove waste asphalt from site, including contaminated soil that may be mixed in material, and dispose of properly based on applicable federal, state, and local regulations. See section 8 Contaminated Soil Management for more information.

5.4 Considerations

- Staging area may have limited amount of space to store milling and paving vehicles/equipment.
- Contractors may need to implement dust control measures during milling operations.
- Storm water can cause fines from milling to enter into storm drains and open bodies of water.

5.5 Maintenance

- Storage areas shall be clean and well organized.
- Remove any significant residual materials remaining on the ground and properly dispose of immediately. If the residual materials contaminate the soil, then the contaminated soil shall also be removed and disposed of properly.
- Maintain an adequate supply of spill cleanup materials on-site and readily available.
- Maintain covers on any materials that should not come into contact with storm water. All containers must have proper Globally Harmonized System (GHS) Labels, including secondary containers.
- Provide periodic training to all employees responsible for material storage and handling.

6 Solid Waste Management

6.1 Description

Practices and procedures to reduce the discharge of pollutants from construction and demolition (C&D) waste from entering the drainage system or adjacent waterbodies.

6.2 Applications

- Construction projects generating non-hazardous solid wastes from C&D activities. These wastes include C&D waste, inert fill material, litter and recycle/reuse material.
- C&D wastes include materials originating from the construction, demolition, and repair of roads, buildings, or other structures.
- Inert fill materials are defined as earth, soils, rocks, rock-like material, such as cured asphalt, brick, and clean concrete less than 8 inches in diameter, except as specified by a licensed Engineer with no exposed steel reinforced rod. The inert fill material shall not contain vegetation, organic material, or other solid waste. It shall not be contaminated with asbestos or lead-based paint. In addition, inert fill materials do not decompose or produce leachate or products harmful to the environment.

6.3 Installation and Implementation

- Separate contaminated cleanup materials from C&D wastes. Contamination may be from hazardous substances, friable asbestos, waste paint, solvents, sealers, or adhesives.
- Dispose of waste in designated waste containers.
- Solid waste bins must be watertight and placed away from drainage facilities and open bodies of water.

- Most C&D wastes can be reused or salvaged for recycling. Inert fill materials shall not be mixed with other C&D waste.
- Solid waste is generally any material that leaves a project that is no longer usable on the project. If any material is intended to be characterized as inert fill or soil for reuse, the material shall be tested and determined clean.
- Ensure inert fill material does not contain vegetation, organic material, or other solid waste.
- The Department of Health, Hazard Evaluation and Emergency Response Office (HEER) refers to Guidance for Soil Stockpile Characterization and Evaluation of Imported and Exported Fill Material, to define "acceptable fill material" as:
- Natural materials consisting of soil, clay, sand, volcanic cinder and ash, and rock; or a mixture/combination of such materials.
- C&D materials exclusive of soil that are known or tested to be free of hazardous substances.
- The fill determination process, defined by HEER, is to determine if proposed fill material meets the definition of acceptable fill material. Options to complete the fill determination process include:
- An environmental due diligence review of the fill source property that concludes there is no evidence of past releases that could pose an environmental hazard or contain chemical contaminants above applicable State of Hawaii Department of Health (DOH) Tier 1 Environmental Action Levels (EALs).
- A fill material characterization report that summarizes representative analytical data for the proposed fill material from the fill source operator, fill importer, or fill exporter.
- Provide waste containers of sufficient size and number to contain construction and domestic waste. Dumpsters must be watertight and securely lidded. Roll off containers must be watertight and have a cover to keep rain out and prevent loss of waste during windy conditions.
- It is highly recommended to cover waste containers with 10 mil plastic sheeting, tarpaulin, manufactured lid, or other impermeable material.
- Waste containers shall meet all local and state solid waste management regulations.
- Littering on-site is prohibited.
- Ensure construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Any site not contiguous with the project site may need a permit to receive solid waste. This includes any site or facility that receives solid waste, landowners who want to accept and process solid waste, and contractors who have to take solid waste to their baseyard.
- The contractor's supervisory personnel shall be instructed regarding the correct practices for waste disposal. Post notices detailing these practices in the office trailer. The contractor shall ensure that these practices are followed.
- Follow all contract requirements regarding handling and disposal of solid waste.
- Do not allow containers to overflow. Plan for waste and recyclable materials to be collected weekly or when containers are two-thirds full, whichever is sooner.
- Minimize production of solid waste materials wherever possible.
- It is highly recommended to reuse C&D waste when possible. For criteria for reuse, refer to DOH Tier 1 EALs for unrestricted land use. Refer to DOH Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater for more information on EALs.
- Consideration of soil that exceeds Tier 1 EALs for unrestricted land use, but meets the DOH environmental action levels for commercial use (Refer to DOH Evaluation of Environmental Hazards at Sites with Contaminated Soil and Groundwater, Appendix 1, Table I-2) for off-site

reuse at such sites must be approved by HEER in consultation with the State of Hawaii Department of Health, Solid and Hazardous Waste Branch (SHWB).

- Notify the Resident/Construction Engineer of any illegal connections, illicit discharges, or illegal dumping not generated by the contractor.

6.4 Considerations

- Must sort waste material accordingly.
- Some types of solid waste can easily be washed away by storm water if not properly disposed.
- The Engineer may reject imported fill from sources known to contain hazardous material.
- The import of fill material from a source that has not been evaluated could inadvertently recontaminate a remediated property, and may be considered illegal dumping. Contaminated fill material can also pose direct exposure hazards to workers and the public.
- Understanding the source of the fill material and the potential for contamination is very important.
- Construction vehicles may be necessary to put C&D waste in the correct bin.
- Construction personnel should not hose out containers on-site. Leave dumpster cleaning to the trash hauling contractor.

6.5 What to Inspect

- Are waste containers properly covered?
- Do waste containers exceed two-thirds capacity?
- Is there evidence of leaks or spills around waste containers?
- Is site neat and free of litter?
- Is waste being separated and placed in the appropriate bin?
- Are waste bins located away from drainage facilities, inlets, and open bodies of water?
- Is there evidence of illegal dumping on-site?
- Is trash removed regularly?

6.6 Maintenance

- Schedule solid waste collection regularly.
- Empty waste containers when they are two-thirds full.
- Schedule recycling activities based on construction/demolition phases.
- Do not allow containers to overflow.
- Repair/replace leaking or damaged dumpsters.
- Clean up site and dispose of waste in designated waste containers by the end of each work day.

7 Sanitary Waste Management

7.1 Description

Practices and procedures to reduce or prevent the discharge of sanitary wastes from construction sites into the storm drain system or adjacent waterbodies.

7.2 Applications

Construction sites containing temporary or portable sanitary waste systems.

7.3 Installation and Implementation

- Locate sanitary facilities in a convenient place away from drainage facilities.
- Wastewater shall not be discharged to the ground and open waterbodies, or buried.
- Position sanitary facilities where they are secured and will not be tipped over or knocked down.
- Straps, rebar stakes, or similar devices should be used to secure sanitary facilities.
- Sanitary systems discharging to the sanitary sewer shall comply with the local wastewater treatment plant requirements.
- A licensed service provider shall maintain sanitary facilities in good working order.
- Schedule regular waste collection by a licensed transporter at least once a week or as required.
- If a spill occurs, immediately contain and determine if contents have reached an inlet or open waterbody. The area shall be properly disinfected after cleanup of the spill has been completed.
- All spills regardless of size must be reported to the Emergency Spill Response Coordinator. See section 10 Spill Prevention and Control for more information.

7.4 What to Inspect

- Are portable toilets secured from tipping over? Place portable toilets on a dry, level surface against a sturdy structure (i.e., brick wall or building).
- Are contents leaking from septic facility?
- Are portable toilets located away from the drainage systems, concentrated flows and waterbodies?

7.5 Maintenance

- Maintain facilities regularly.
- Schedule regular waste collection by a licensed transporter at least once a week or as required.
- Prevent illicit discharges.
- Resecure portable toilets, if needed.

8 Contaminated Soil Management

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

8.1 Description

Practices and procedures to identify and prevent the discharge of pollutants from contaminated soil to the drainage system and adjacent waterbodies.

8.2 Applications

Projects in urbanized or industrial areas where previous site usage, undetected spills or leaks, illicit discharges, or underground storage tank leaks may have contributed to soil contamination.

8.3 Installation and Implementation

- Abide by all federal, state, and local regulations when dealing with contaminated soil.
- A site assessment should be conducted prior to ground-disturbing activity to identify contaminated soil or other hazardous pollutants.
- Research records of previous site uses and activities.
- Identify soil discoloration, odors, soil property differences, abandoned underground tanks or pipes, or buried debris to determine possible soil contamination.
- If contaminated soil or other hazardous pollutants are found on-site, stop work in the area immediately and notify the State of Hawaii Department of Health, Hazard Evaluation & Emergency Response (HEER) office (808-586-4249), as well as the Project Engineer.
- Contaminated soil shall be placed on an impermeable liner or device, such as 20-mil plastic sheeting, surrounded with impermeable lined berms and covered with impermeable sheeting.
- Soil suspected of being contaminated should be isolated from other stockpiles until test results return. If the suspected contaminated soil has evidence of contamination (odor, sheen, color, etc.), then it should be handled and stored as contaminated until testing determines otherwise. Known contaminated soil must be segregated from uncontaminated soil.
- Soil testing is the only option to know if soil is contaminated. Sampling of the soil shall follow DOH guidelines and requirements. Test soil at a certified laboratory if soil is suspected of

contamination. Multi Increment testing should be conducted if soil is contaminated with lead because it is commonly unevenly distributed.

- The contractor shall propose the testing protocols for the Engineer's approval.
- Contaminated soil stockpiles must remain on-site and cannot be transported or stored off-site without prior authorization.
- Temporary stockpiles of contaminated material must have signage designating material as contaminated.
- Identify area to temporarily store contaminated soil away from drainage facilities, waterbodies and conveyance systems.
- Construction vehicles leaving the excavation area must be clean of contaminated soil. All contaminated soil and wash water from vehicle cleaning must be properly contained, collected, and disposed of.
- Contaminated soil disposal options:
- Re-use on-site (not grossly contaminated)
- Off-site reuse (Refer to DOH Guidance for Soil Stockpile Characterization and Evaluation of Imported and Exported Fill Material)
- Landfill disposal (check with landfill)

8.4 Considerations

- Dispose of contaminated soils at DOH-permitted facilities. Transfer contaminated soils via DOH-approved transporter.
- This manual does not explain environmental laws and regulations. Therefore, a contracting firm that is experienced in handling contaminated and hazardous materials should be consulted when dealing with contaminated soil.
- Site-specific conditions may require the use of additional personal protective equipment (PPE). Gloves and safety glasses must be worn when dealing with contaminated soil.
- A removal action may be conducted either as a stand-alone response action, or as an interim response action to be followed by further removal or remedial action at a later date. In addition, a removal action may result in long-term management of contamination on site. Each of these different types of removal actions has implications for site closure.

8.5 What to Inspect

- Are stockpiles of contaminated soil stored on an impermeable liner or device, surrounded by an impermeable lined berm, and completely covered with impermeable material?
- Are the BMP measures installed properly and maintained?
- Has the contaminated soil been properly tested, per DOH guidelines and requirements?
- Is the contaminated soil in contact with non-contaminated bare soil?
- Has the contaminated soil come into contact with rainwater?
- Is the contaminated soil stockpile isolated from other stockpiles?
- How long has the contaminated stockpile remained onsite?

8.6 Maintenance

- Prevent leaks and spills by implementing spill prevention and control practices and procedures. See section 10 Spill Prevention and Control for more information.
- Repair tears and rips to the impermeable berm and cover to ensure erosion is prevented.
- Damaged perimeter control devices must be repaired/replaced when the device is not functioning as designed.
- Repair/replace barriers that no longer prevent contaminated soil from coming into contact with bare soils.

9 Hazardous Materials and Waste Management

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

9.1 Description

Practices and procedures to prevent hazardous material and waste from discharging into the storm drain system or adjacent waterbodies.

9.2 Applications

Handling and storing procedures on construction sites involving the following hazardous materials and waste:

9.3 Installation and Implementation

- It is preferred to store hazardous material under a covered facility. If a covered facility is not applicable, materials must be placed in secondary containment and covered with impermeable material to prevent storm water from coming in contact with materials.
- Secondary containment must be able to retain 100% of the volume of the largest container or 10% of the aggregate total of all the containers being stored within the secondary containment, whichever is greater.
- Metal containers shall be covered by an impermeable material so they are not exposed to rainwater, which can cause rusting and potential leaks.
- Secondary containment is required for storing hazardous materials and must be impervious to the materials stored.
- All spills, free products, or storm water captured in a secondary containment shall be immediately removed and properly disposed of.
- Incompatible materials, such as chlorine and ammonia, shall not be stored in the same temporary containment facility.
- Immediately clean up hazardous waste that spills or leaks on the ground. Do not hose down or bury spills.

- Maintain an ample supply of cleanup materials that are readily accessible for spills. All employees shall be informed of the location of the cleanup material and trained in their proper use.
- Hazardous waste must not accumulate on the ground.
- A licensed hazardous waste transporter shall dispose of hazardous waste at an authorized disposal facility. For more information regarding licensed transporters, refer to the State of Hawaii Department of Health (DOH) Hazardous Waste Section at website – http://health.hawaii.gov/shwb/hazwaste/.

9.4 Typical Hazardous Materials and Wastes

Typical hazardous materials and wastes from commercial construction and demolition (C&D) sites include:

- Oil-based paint, stains, and varnishes
- Acids and bases (e.g., muriatic acid, etc.)
- Ignitable waste (gasoline and diesel)
- Used batteries
- Waste vehicle lubricants (e.g., used motor oil, etc.)
- Latex paint with mercury
- Thinners and painting solvents
- Spent sand blast material from paint removal operations
- Weatherproofing/insulation solvents
- Finishing and flooring adhesives and sealants
- Mechanical/electrical waste
- Absorbent materials used to clean up spills
- All petroleum-based products
- Concrete curing/repair compounds and related concrete work products
- Contaminated rags
- Waste mercury or acrylic mercury paint
- Non-empty aerosol cans

9.5 Typical Hazardous Materials and Waste from Existing Structures

- Sandblasted material such as grit or chips containing lead, cadmium, or chromium- based paints
- Asbestos
- Polychlorinated Biphenyls (PCBs)
- Older transformers are a common source of PCBs.

9.6 Potentially Hazardous Waste Recognition

- Review product label and shipping papers.
- Identify key words such as flammable or ignitable (able to catch fire); carcinogenic (causes cancer); toxic or poisonous (injures or harms people or animals); and hazardous, danger, caustic or corrosive (burns through chemical action). Hawaii Administrative Rules (HAR) Title 11, Chapter 261 includes a list of hazardous waste and criteria. Review Safety Data Sheets (SDS) from the manufacturer and supplier of the product.

9.7 Hazardous Materials Handling and Storage

- Hazardous material should remain in the original container. Do not transfer material into another storing device unless it is considered waste.
- Keep the original product label on the container because it includes important safety and disposal information. Keep all SDS at a designated location. Inform all personnel of the location of the SDS.
- Restrict amount of herbicide and fertilizer prepared to the quantity necessary for the current application. Comply with the recommended usage instructions. Do not apply herbicides and fertilizers during or just before a rain event.
- The MCBH Hazardous Material Minimization (HAZMIN) Center was established to consolidate hazardous material base-wide and improve inventory control. Unused or excess reusable hazardous material can be turned into the HAZMIN Center and reissued to other MCBH work centers. The HAZMIN Center is located in Building 6407.

9.7.1 Disposal of Hazardous Waste from Construction Activities

- Ensure the site has adequate space for hazardous waste storage volume.
- Waste storage areas must be located away from drain inlets, watercourses, and moving vehicles.
- Minimize hazardous waste stored on-site.
- Waste shall not be mixed and drums used for waste shall not be overfilled.
- Label all waste containers with the type of waste being stored and the date of accumulation.
- Store hazardous waste separate from non- hazardous waste to prevent mixing in case of a spill. Do not mix wastes.
- Remove as much paint from brushes on painted surface. Do not clean or rinse water-based paint brushes in soil, streets, gutters, storm drains, or streams. Rinse from water-based paints shall be discharged into the sanitary sewer system. Filter and reuse solvents and thinners.
- Dispose of oil-based paints and residue as a hazardous waste.
- Place hazardous waste in a sealable container suitable for the material.
- Rainwater that mixes with hazardous waste due to spills or leaks shall be treated as hazardous waste and must be placed in drums.
- Dispose of container only after all of the product has been used in accordance with federal, state, and local regulations.
- Hazardous waste that will not be recycled/reused must be disposed of off-site within 90 days of being generated, or as directed by the Resident/Construction Engineer.

9.7.2 Waste Recycling and Disposal of Hazardous Waste

- Designate areas for collection of hazardous wastes.
- Store hazardous materials and wastes in covered containers and label according to applicable Resource Conservation and Recovery Act (RCRA) requirements.
- Provide secondary containment for hazardous waste containers to prevent contact with storm water runoff.
- Keep wastes separate to prevent chemical reactions which make recycling and disposal difficult.
- Recycle useful materials such as oil- or water-based paint.
- Do not dispose of toxic liquid wastes (solvents, used oils, and paints) or chemicals (additives, acids, and curing compounds) in dumpsters allocated for construction debris.
- Schedule periodic waste collection to prevent overflow of containers.
- Ensure collection, removal, and disposal of hazardous waste complies with regulations.
- Clean up spills immediately. Do not clean spills or surfaces by hosing the area down. Use the appropriate tools in the spill prevention kit to mitigate spills from leaching into the receiving waters or entering a storm drainage system.
- Eliminate the source of the spill to prevent a discharge or a continuation of an ongoing discharge.

9.8 Considerations

- Hazardous waste that cannot be reused or recycled shall be disposed of by a licensed hazardous waste hauler.
- Nothing in this section relieves the contractor's responsibility of compliance with federal and state laws.

9.9 What to Inspect

- Is hazardous material in secondary containment and covered with an impermeable material?
- Are containers completely empty before being thrown into the waste bin?
- Is plastic cover ripped or torn?
- Are metal containers containing hazardous material rusting or leaking?
- Are original labels on all containers containing hazardous material.
- Are containers completely sealed?
- Is hazardous material in its original container?
- Is there evidence of leaks or spills on ground?
- Is hazardous waste being stored properly and regularly disposed of by a licensed transporter?
- Is there an ample supply of cleanup material readily accessible?
- Is hazardous waste being mixed?

9.10 Maintenance

- Schedule regular hazardous waste collection.
- Replace/repair secondary containment if there are signs of leaking.
- Replace plastic cover that has rips and tears.
- Immediately clean up spills of hazardous material and dispose of waste properly.
- Maintain areas where hazardous material and waste must be kept clean and well organized.

10 Spill Prevention and Control

10.1 Description

Proper spill prevention practices and procedures to aid in preventing spills and leaks from discharging into the storm drain system or adjacent waterbodies.

10.2 Applications

Construction projects involving the storage and use of chemicals or hazardous substances.

10.3 Installation And Implementation

- Maintain an ample supply of cleanup materials that are readily accessible for spills.
- Train employees on proper spill prevention and cleanup.
- Review spill response requirements at all applicable work sites.
- Install perimeter control, such as a dike or berm, around areas of concern to prevent spills or leaks from exiting the contained area.
- Eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge.

10.4 Cleanup Requirements and Procedures

- Immediately clean up leaks and spills.
- Use minimal water to clean up spills on paved surfaces. For small spills, use a rag. For general cleanup, use a damp mop. For larger spills, use absorbent materials.
- Properly dispose of materials used to clean up hazardous materials.
- Do not hose down or bury dry material spills.
- Ensure all personnel who are affected by the spill or will be responsible for its cleanup have all appropriate personal protective equipment (PPE).
- If possible, prevent or minimize the amount of the spill that may discharge into the drainage system.

10.4.1 Small Spills

- Small spills must be taken care of immediately by the first responder.
- Use a rag or any type of absorbent material to soak up the chemical spill. Do not hose down or bury the spill.
- Use a broom or shovel to clean up dry chemical spills.
- Prompt and effective response is the best way to prevent pollutants from coming into contact with storm water.
- Notify the Engineer.

10.4.2 Medium-Sized Spills

- Semi-significant/medium-sized spills can be cleaned up by the first responder with help from construction personnel on-site, but the spill will be too large to soak up with a rag.
- Isolate and contain the chemical spill with the appropriate BMPs and use materials in the spill prevention kit to immediately clean up the spill. Do not let the chemical liquid spread into drainage systems or state waterways.
- Immediately notify the Resident/Construction Engineer.

10.4.3 Significant Hazardous Spill Occurrence

Should a spill occur that cannot be cleaned up/handled by on site personnel see the following guide:

- Immediately notify the Resident/Construction Engineer followed by completing a written report of the incident.
- Immediately stop work in the vicinity of the spill. Remove and keep all non-essential employees away from the spill. Never subject yourself or other personnel to unreasonable risk of illness or injury.
- Call 911 immediately for spills that pose an immediate threat or danger to the public or property.

10.5 Reporting On-Site Spill Occurrence

- Where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302 occurs during a 24-hour period, the permittee shall notify:
- U.S. Coast Guard National Response Center (NRC) at 800-424-8802,
- The State of Hawaii Department of Health, Clean Water Branch (CWB) during regular business hours,
- The Hawaii State Hospital Operator during non-business hours at 247-2191, and
- The CWB via email at cleanwaterbranch@doh.hawaii.gov during non-business hours as soon as the permittee has knowledge of the discharge.
- To report a spill to the State of Hawaii Department of Health Hazard Evaluation and Emergency Response (HEER) office outside of normal business hours, call (808) 236- 8200.
- It is expected that HEER is notified via telephone or in-person within 20 minutes of discovery of the release. A follow-up written notification form will also need to be completed and post-marked to HEER no later than 30 days after the initial discovery of a release. (The notification form can be found at https://health.hawaii.gov/heer/how-to-report-a-release-spill/).
- Immediately report spills that are 25 gallons or more of petroleum product, such as oil and gasoline, or any spill of any volume that is not contained and remediated within 72 hours to HEER.
- The contractor shall provide to the Engineer, within 7 calendar days of knowledge of the release, the circumstances leading to the release, and the date of the release. The Engineer shall provide this information the CWB.
- For any spills that discharge into the drain system or receiving state waters, immediately notify the CWB. Within 7 calendar days of discovering the occurrence of discharge into the drain system or receiving state waters, submit a discharge report of the following to the CWB:
- Any follow-up actions taken to review the design, installation, and maintenance of storm water controls, including the dates such actions occurred.
- A summary of storm water control modifications taken or to be taken, including a schedule of activities necessary to implement changes, and the date the modifications are completed or expected to be completed.
- Notice of whether Storm Water Pollution Prevention Plan (SWPPP) modifications are required as a result of the condition identified or corrective action.

10.6 Vehicle and Equipment Maintenance Activities

- Use off-site repair and maintenance shops as much as possible. These repair and maintenance shops are better equipped to handle vehicle fluids and spills properly.
- If on-site repair is necessary, use a designated area and/or secondary containment for on-site repair or maintenance activities. These areas shall be located away from drainage courses, inlets, and open waterbodies.
- Conduct regular inspections of on-site vehicles and equipment, including delivery trucks and employee vehicles, for leaks. Do not allow vehicles or equipment with leaks on-site.
- Secondary containment devices such as drop cloths and drain pans shall be used to catch leaks or spills while staging or changing fluids from vehicles or equipment.
- Drip pans can be used to catch potential leaks from idle vehicles and equipment.
- Place drip protection/pads with absorbent and impermeable materials under all vehicles and equipment with the potential to leak/spill when not in use.

- Use absorbent materials on small spills. Do not hose down or bury spills. Remove and properly dispose of cleanup materials.
- Minimize the movement of drums and containers filled with hazardous material.
- Immediately transfer used fluids to the appropriate waste or recycling containers. Avoid leaving drip pans and open containers with hazardous material on-site. Large- diameter funnels must be used to transfer liquids into drums.
- Drain excess oil from oil filters prior to disposal by placing filter in a funnel over a waste oil recycling drum. Recycle oil filters if this service is available.
- Store all cracked batteries in a non-leaking secondary container even if the acid appears to have drained out. Handle dropped batteries as cracked batteries until assured it is not leaking.

10.7 Vehicle and Equipment Fueling Activities

- Use off-site fueling stations as much as possible.
- If on-site fueling is necessary, use designated areas for required on-site fueling. Fueling areas shall be located away from drainage courses, inlets, and waterbodies.
- Avoid “topping off” of fuel tanks.
- Use secondary containment devices such as drain pans to catch spills or leaks while fueling.

10.8 Considerations

- Use of a private spill cleanup company may be necessary.
- This BMP only applies to spills caused on-site by the contractor, sub-contractors, and their vendors.
- Only respond to spills if you can do so safely.

10.9 What to Inspect

- Are drip pans and/or absorbent material placed under construction vehicles and equipment?
- Is there an ample amount of spill cleanup material on-site and easily accessible?
- Are spills/leaks evident around construction vehicles, equipment, stored materials, drain inlets or open bodies of water?
- Are there tears/rips in plastic sheeting or geotextile covers?
- Is plastic cover or other impermeable material overlapped and secured.
- Are perimeter controls in good condition and able to operate properly, in case of a spill?
- Are facilities away from waterbodies and drainage systems?
- Do facilities have sufficient spill containment areas?
- Are facilities located on impervious surfaces?
- Does sufficient containment volume exist?
- Do locations for storing hazardous materials and chemicals exist?
- Are hazardous material drums/containers properly labeled?
- Are hazardous and chemical materials/waste stored in secondary containment?
- Are hazardous and chemical materials/waste covered by an impermeable material?

10.10 Maintenance

- Update spill prevention and control plans and stock necessary cleanup materials as the chemicals used or stored on-site change.

- Locate an ample supply of materials for spill control and cleanup on-site near maintenance and material storage or unloading areas.
- Replace/repair impermeable material/plastic covers that have rips or tears.
- Realign perimeter control devices, when necessary, to ensure proper function.
- Immediately clean up spills.

Table 10-1 Emergency Spill Contacts

Emergency Spill Contacts	Phone Numbers
Federal Fire Department (FedFire)	(808) 471-7117
Honolulu Fire Department; Honolulu Police Departments (call will be transferred to FedFire)	911
State of Hawaii Department of Health, Hazard Evaluation and Emergency Response Office	(808) 586-4249 or (808) 236-8200 during non-business hours
State of Hawaii Department of Health, Clean Water Branch – Oahu	(808) 586-4309 or (808) 247-2191 during non-business hours
Honolulu Local Emergency Planning Committee	(808) 723-8960
U.S. Coast Guard	(808) 842-2970
Hawaii National Guard	(808) 733-4228
State of Hawaii Department of Health, Solid Waste & Hazardous Waste Branch	(808) 586-4226
U.S. Coast Guard National Response Center	(800) 424-8802

11 Vehicle and Equipment Cleaning

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

11.1 Description

Practices and procedures to prevent the discharge of pollutants from equipment and vehicle cleaning activities from entering the drainage system or adjacent waterbodies.

11.2 Applications

Construction or maintenance activities involving cleaning of vehicles and equipment.

11.3 Installation and Implementation

- Use off-site vehicle wash racks or commercial washing facilities when practical. Off-site cleaning facilities may be better equipped to properly handle and dispose of wash waters. Use of MCBH wash racks and oil/water separators is prohibited unless permission is granted.
- If on-site cleaning is necessary, designate a paved surface and bermed wash area for cleaning activities. The wash area may be sloped to facilitate collection of wash water and evaporative drying.
- Water must be contained in the bermed wash area.
- Use a positive shutoff valve when cleaning vehicles and equipment to minimize water usage.
- Removal of sediment or soil from vehicles and equipment, except for contaminated media, can be done on pervious areas as long as they are cleaned through dry cleanup measures (e.g., tire sweeping, vacuuming, etc.) only.
- Do not allow wash water to enter the storm drainage system or open waterbodies.
- Minimize the amount of water being used to clean vehicles and equipment.
- Vehicle and equipment cleaning using soaps, solvents, or detergents are only allowed in an impervious area where water can be captured and either treated (i.e., oil/water separator) or disposed of properly (off-site).

- Properly store soaps, detergents, and solvents. See section 2 Material Storage and Handling for more information.
- Only use phosphate-free, biodegradable soaps.
- Do not discharge wash water directly into the storm drainage system or open waterbodies.
- Minimize water use to avoid the need for erosion and sediment controls for the wash area.
- If vehicles and equipment are cleaned off in the field, ensure waste is collected and disposed of properly.
- Do not store hazardous material in the wash area.
- Cover the wash area when it is not in use to prevent contact with storm water.
- Train employees on pollution prevention measures.
- Do not wash personal vehicles on-site.
- Steam cleaning shall not occur in uncontained areas. Significant pollutant concentrations may be generated from steam cleaning.
- Remove the wash area and stabilize disturbed areas once the project is complete.

11.4 What to Inspect

- Are pollution prevention controls (i.e., berms, sumps, oil/water separators, etc.) properly functioning?
- Are soaps, detergents, and solvents properly stored?
- Are there traces of soap and solvents in pervious wash areas?
- Is there a presence of pollutants (i.e., concrete, oils, etc.) observed in the wash area?
- Are all wash areas located in impervious areas?
- Is wash water being captured?
- Is there evidence of prohibited discharge?

11.5 Maintenance

- Is there evidence of prohibited discharge?
- Any sediment or other potential pollutants removed from vehicles and equipment during cleaning activities should be managed and/or disposed of appropriately.
- Any sediment or other potential pollutants removed from vehicles and equipment during cleaning activities should be managed and/or disposed of appropriately.
- Repair/replace pollution prevention controls (i.e., berm, sump, etc.) if not operating per design.
- Wash water containing soaps, detergents, and solvents should be routinely disposed of.

12 Vehicle and Equipment Maintenance

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

12.1 Description

Practices and procedures to prevent or reduce the discharge of pollutants from vehicle and equipment maintenance. When vehicles and equipment need maintenance, the best option is to perform these activities off-site to avoid spills and leaks on-site. If on-site maintenance activities are necessary, they should be conducted in an approved designated area.

12.2 Applications

- Construction sites with vehicle and equipment maintenance areas.
- Construction sites where vehicle and equipment are stored when not in use.
- Construction sites where vehicle and equipment are idle, but intermittent use is occurring.

12.3 Installation and Implementation

- Prevent excessive accumulation of oil and grease by keeping vehicles and equipment clean.
- Use off-site repair and maintenance facilities where practical.
- Repair oil and fluid leaks immediately.
- Place a drip pan or drip pad under the vehicle in the most probable location of a spill while necessary repairs are being conducted.
- Designate a leveled maintenance area away from drainage courses and inlets to prevent pollutants from entering the drainage system.
- Store vehicles and equipment that need maintenance on a layer of geotextile filter fabric on top of 10 mil plastic sheeting before conducting maintenance activities. Perimeter controls must be placed along the perimeter of the maintenance area and underneath the impermeable material, to create a berm able to contain any possible spills and/or leaks.
- Have an ample supply of readily accessible spill cleanup materials on-site, at all times.

- Use absorbent materials on small spills. Promptly remove and properly dispose of absorbent materials. Do not hose down or bury small spills. See section 10 Spill Prevention and Control for more information.
- Check vehicles and equipment regularly for leaks. Leaking vehicles and equipment shall not be allowed on-site.
- Keep maintenance areas clean and orderly to minimize oil and grease buildup.
- Segregate and recycle wastes from vehicle/equipment Maintenance activities such as used oil, oil filters, greases, hydraulic and transmission fluids, cleaning solutions, antifreeze, and automotive batteries.
- Oil, fuels, fluids and lubricants should be recycled whenever possible. Do not dump on the ground or pour into storm drains.
- Properly dispose of wastes generated by vehicle/equipment maintenance activities.
- Provide employee training on proper maintenance and spill cleanup practices and procedures.

12.4 Considerations

- Off-site Maintenance facility may not be easily accessible.
- Vehicle and equipment Maintenance should only be used when off-site maintenance is impractical.

12.5 What to Inspect

- Are leaks and/or spills coming from vehicles and/or equipment?
- Is there evidence of oil, grease, fluids, lubricants, etc. on the ground?
- Are spill cleanup materials available on-site?
- Are vehicles and equipment properly stored on a layer of geotextile filter fabric on top of 10 mil plastic sheeting?
- Are berms properly aligned along the perimeter of the maintenance area?
- Is the maintenance area on leveled ground away from drainage courses?
- Are maintenance areas kept clean and orderly?
- Are vehicles being taken off-site for maintenance?

12.6 Maintenance

- Maintain an adequate supply of spill cleanup materials on-site.
- Remove used oils, antifreeze, grease, lubricants, etc. routinely.
- Do not allow used oils to accumulate on-site.
- Maintain adequate supplies of spill cleanup materials on-site.
- Leaking vehicles and equipment shall be repaired promptly.
- Leaks and spills shall be cleaned up immediately.
- Maintain impermeable material/plastic sheeting, geotextile filter fabric, and perimeter control to ensure proper effectiveness.

13 Vehicle and Equipment Refueling

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

13.1 Description

Practices and procedures to prevent or reduce the discharge of pollutants to storm water from vehicle and equipment fuel leaks or spills.

13.2 Applications

Construction or Maintenance activities involving fueling of vehicles or equipment.

13.3 Installation and Implementation

- Use off-site fueling sites when practical. Off-site fueling sites may be better equipped to service and handle spills due to multiple vehicles or pieces of equipment.
- If on-site fueling is necessary, locate designated fuel areas away from storm water run-on and runoff, and locate fueling areas at least 50 feet, or as far as practicable, from downstream drainage facilities and watercourses to prevent contamination of storm water. If impracticable, consider implementing additional BMPs or secondary containment when fueling.
- Avoid “topping-off” of fuel tanks.
- Drip pans or absorbent pads shall be used to absorb leaks or spills during fueling.
- Fueling must be performed on a leveled area.
- Protect fueling areas with berms and dikes to prevent run-on, runoff, and to contain spills.
- Have absorbent spill cleanup materials located in fueling areas.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Promptly remove and properly dispose the absorbent materials. See section 10 Spill Prevention and Control for more information.

- Clean up spills or contaminated surfaces immediately, using dry cleanup measures where possible, and eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge. Store hazardous materials and fluids under cover and in secondary containment. See section 9 Hazardous Materials and Waste Management for more information.
- Minimize mobile fueling of construction equipment by transporting equipment to designated areas for fueling.
- Train employees on proper fueling and cleanup procedures.
- Put fuel pods and hoses in secondary containment to prevent hoses/nozzles from leaking.
- Store diesel fuel, oil, hydraulic fluid, or other petroleum products or other chemicals in watertight containers and provide cover or secondary containment. If container is metal, cover is required.
- Containers shall be properly labeled.
- Comply with federal and state requirements regarding stationary, above ground storage tanks.
- Comply with the Spill Prevention Control Countermeasures (SPCC) requirements in 40 CFR 112 and section 311 of the Clean Water Act (CWA).

13.4 What to Inspect

- Is there evidence of fuel spills or leaks on the ground?
- Are any vehicles and/or equipment leaking fuel?
- Are hoses/nozzles in secondary containment?
- Are berms and absorbent pads well-maintained and effective?
- Is there an ample amount of spill cleanup materials on-site?
- Are hazardous fluids properly stored?

13.5 Maintenance

- Keep an ample supply of materials for fuel spill control and cleanup located on-site near fueling areas available at all times.
- Properly dispose of absorbent pads, hazardous material and contaminated soil.

14 Scheduling

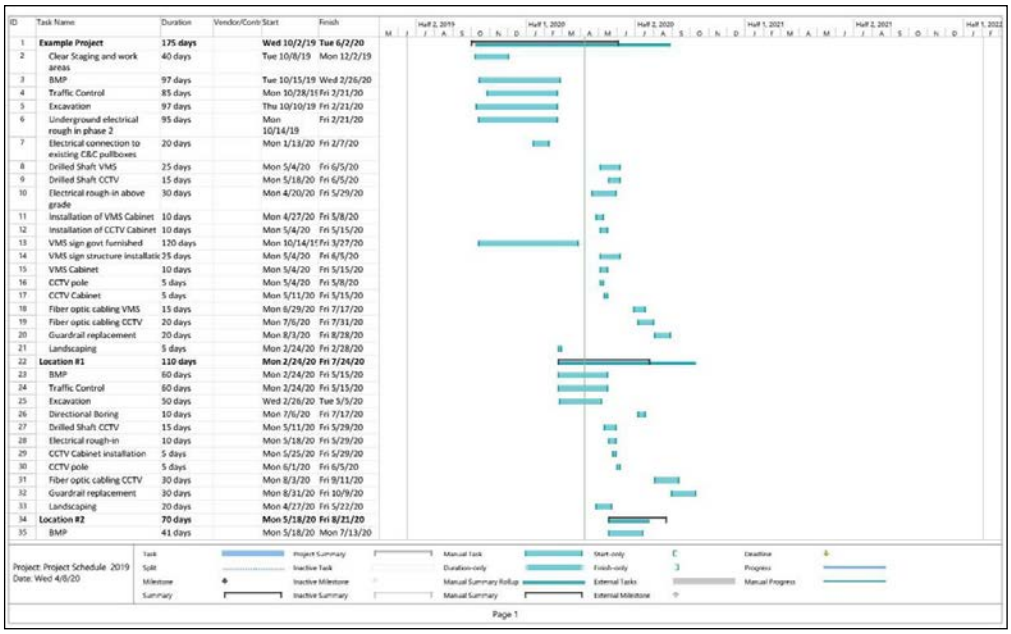


Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

14.1 Description

Developing a schedule that includes sequencing of construction activities with the implementation of construction site BMPs to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking as well as ensure construction activities and control practices are performed in accordance with the planned schedule.

14.2 Applications

The Storm Water Pollution Prevention Plan (SWPPP) must include a description of the intended sequence of construction activities, including a schedule of the estimated start dates and the duration of the activity, for the following activities:

14.3 Installation and Implementation

- Installation of storm water control measures, and when they will be operational, including an explanation of the sequence and schedule for installation of storm water control measures.
- Commencement and duration of earth-disturbing activities, including clearing and grubbing, mass grading, site preparation (i.e., excavating, cutting, and filling), final grading, and creation of soil and vegetation stockpiles requiring stabilization.
- Cessation, temporarily or permanently, of construction activities on-site, or in designated portions of the site.
- The dates for final or temporary stabilization of areas of exposed soil.

- Removal of temporary storm water conveyances/channels and other storm water control measures, removal of construction equipment and vehicles, and cessation of any pollutant generating activities.
- Minimize the area of active construction. Limit maximum surface area of earth material exposed at any time to 300,000 square feet. Do not expose or disturb surface area of earth material until BMP measures are installed and accepted in writing by the Engineer.
- Inspect the site prior to initiation of ground-disturbing activities to verify BMPs, as required by the approved BMP Plan and/or other documents, have been installed correctly per the manufacturer's specifications and in the correct location.
- Date and sign the Site-Specific BMP Plan (SSBMP) or SWPPP, keeping an approved copy of the plan on-site or at an accessible location so that it can be made available at the time of an on-site inspection or upon request by the Engineer, per 2005 Hawaii Standard Specifications for Road and Bridge Construction, Special Provisions Section 209.03(A)(h).
- After the SSBMP Plan or SWPPP is accepted in writing, schedule a water pollution, dust, and erosion control meeting with the Engineer a minimum of 7 calendar days prior to the start work date.
- Minimize work involving soil-disturbing activities during rain and forecasted events.
- Schedule disturbed areas to be stabilized prior to additional grading of other areas.
- Minimize duration of time trenches remain open. Schedule trenching activities to ensure trenches are closed prior to excavating new trenches.
- Periodically review the schedule for upcoming tasks. Prior to any new activity or new area opened for work, review the SWPPP to ensure BMP measures are appropriate to the site and/or means and methods of work. If not, a SWPPP amendment should be proposed by the Contractor and certified by MCBH prior to any change to the SWPPP. An approved/signed amendment must be in place prior to the start of work.
- Immediately initiate stabilization of exposed soil areas upon completion of earth- disturbing activities for areas permanently or temporarily ceased on any portion of the site. Stabilization must be completed no later than 14 calendar days after the initiation of stabilization measures.
- All BMPs must be in place at the start of construction unless stipulated otherwise in the SWPPP.
- Refer to Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Appendix C or project specifications for information on inspection and maintenance scheduling requirements.

14.4 Considerations

- Adherence to schedule.

14.5 What to Inspect

- Does the schedule reflect actual construction activities?
- Is there new work starting on-site?
- Does the SWPPP need to be amended?
- Are amendments approved prior to the start of work?

14.6 Maintenance

- Monitor progress of construction activities relative to construction schedule. Implement remedial measures if progress deviates from schedule.
- Revise the schedule, as necessary.

15 Location of Potential Sources of Sediment

15.1 Description

Practices and procedures to identify potential sources of sediment to reduce sediment discharge from construction sites.

15.2 Applications

Any potential source of sediment on all projects.

15.3 Installation and Implementation

- Configure construction site to ensure vegetated areas buffer haul roads, stockpiles, and adjacent waterbodies. Vegetation provides an effective means of reducing sediment and pollutants discharged off-site.
- Place stockpiles away from waterways, drains and low spots.
- Direct off-site runoff away from bare ground.
- Maintain vegetation in swales and natural drainage ways.
- Designate naturally level areas for parking and equipment staging during construction.
- Inspect the construction site during or immediately following a rain event to identify the storm water's natural path to locate where sediment leaves the site. This will assist in Storm Water Pollution Prevention Plan (SWPPP) design and BMP placement.

15.4 What to Inspect

- Where are the exposed areas on the construction site?
- Is there evidence of run-on and/or runoff?

15.5 Maintenance

- Install, repair, or replace BMPs to cover exposed areas or redirect off-site runoff.

16 Staging Area

16.1 Description

An approved location, designated in the Storm Water Pollution Prevention Plan (SWPPP), where construction equipment, vehicles, materials, and other construction-related materials are stored. Staging areas can be a significant point source for pollution, so BMPs are necessary to ensure no contaminated storm water exits the site.

16.2 Applications

Sites that include flat areas with ample space for equipment and materials to be stored, paved areas, and/or land already disturbed within project boundaries.

16.3 Installation and Implementation

- Staging areas must be defined in the plans of the project's SWPPP and approved prior to using the area. The approved locations and layout/detailing of the staging area must be included in the SWPPP or included by amendment process. In the case of roadside staging areas for paving equipment, a generic layout may be provided for multiple roadsides identified locations. The approved staging area plan shall designate the locations of the equipment/material to be stored within the staging area, as well as, any BMPs to be implemented for the staging area.
- BMPs must be in place prior to using the staging area.
- Drip pans can be used to catch potential leaks from idle vehicles and equipment.
- Place drip protection/pads with absorbent and impermeable materials under all vehicles and equipment with the potential to leak/spill when not in use.
- Perimeter controls must be placed along the perimeter of the staging area and underneath the impermeable material, to create a berm able to contain any possible spills and/or leaks.

- Perimeter control devices installed along the perimeter of the staging area diverts storm water run-on and runoff. For sloping areas where storm water can run onto the project site, consider installing a diversion to prevent off-site storm water from entering the project site.
- Do not store materials or equipment on perimeter controls. Material and equipment must be stored away from the perimeter controls to allow access for inspection and maintenance of the controls.
- Consider phasing construction staging areas to minimize the duration of exposed soil. Dust control must be used on all exposed soils or any construction activity generating soil. See section 19 Dust Control for more information.
- When a phase of the project is complete and the staging area for the site is no longer required, immediately initiate stabilization at the disturbed areas. Once the area is deemed stabilized, the BMP devices can be removed. See section EC-12 Seeding and Planting for more information.
- Install a stabilized construction entrance/exit at the entrance of the staging area to prevent tracking onto adjacent paved roads and sidewalks. See section 49 Stabilized Construction Entrance/Exit for more information.
- All storm drain inlets that may intercept sediment-laden runoff from staging areas must be protected. See section 39 Storm Drain Inlet Protection for more information.
- Place drip pans or drop cloths under vehicles and equipment to absorb spills or leaks. See sections 10 Spill Prevention and Control and 12 Vehicle and Equipment Maintenance for more information.
- Store paving equipment and vehicles that are idle in a designated staging area on a layer of geotextile filter fabric on top of 10 mil plastic sheeting. Place drip pads/pans under paving equipment to contain leaks and spills. Use drip protection under asphalt hopper and roller assembly. See section 20 Paving Operations for more information.
- Ensure that construction vehicles and equipment are not stored under tree drip lines or on top of existing tree roots. See section 17 Preservation of Existing Vegetation for more information.
- Metal (galvanized and ungalvanized) and rebar must be stored off of the ground on proper dunnage, pallet, or similar material and covered with 10 mil plastic sheeting to prevent material from coming into contact with storm water. See section 2 Material Storage and Handling for more information.
- Locate stockpiles a minimum of 50 feet, or as far as practicable, from concentrated runoff, drainage systems, or open waterbodies. Stockpiles must be entirely covered with an impermeable material and surrounded by a perimeter control device installed around the base of the pile. Staging area perimeter protection cannot be used as perimeter protection for stock/spoil piles. See section 3 Stockpile Management for more information.
- Sanitary facilities must be secured and located away from drainage systems and open waterbodies. See section 7 Sanitary Waste Management for more information.
- Waste bins must be covered by the end of each work day and emptied when they reach two-thirds capacity. See section 6 Solid Waste Management for more information.
- Hazardous materials and waste such as: creosote pipes, waste asphalt, contaminated soil and transite pipes must be properly stored and covered. See section 9 Hazardous Materials and Waste Management for more information.
- Concrete wash areas must be lined with an impervious material and disposed of in compliance with federal, state, and local standards. See section4 Concrete Wash and Waste Management for more information.
- For shared staging areas, responsibilities must be clearly defined. If the staging area is divided by well-defined boundaries for each project, each area can be covered under its respective Notice

of General Permit Coverage (NGPC)/National Pollutant Discharge Elimination System (NPDES) permit. If a staging area is share in its entirety, a separate NGPC/NPDES permit may be obtained for the staging area.
- All areas within a shared staging area must be accounted for and there should be no overlapping areas for which responsibilities are shared by more than 1 contractor. Consult with the Engineer for review/approval.
- Off-site staging areas need to be included in the project's SWPPP and are subject to NPDES requirements.

16.4 Considerations

- Staging area may have a limited amount of space to store vehicles and equipment due to local traffic and existing vegetation.
- Storm water run-on from a point source upgradient becomes the contractor's responsibility to manage if it enters the staging area.
- Contractor may need to implement dust control measures if staging area is not stabilized.
- Runoff flows increase on paved and graded areas. Special attention will be needed during heavier rain events. Staging areas need to be secured prior to a severe storm event.
- Staging areas must be approved before storing materials and equipment in the area.
- Additional staging areas added to the project, outside of the project limits, may require a separate NPDES permit.

Commonly used BMPs which include:

- Silt fences
- Compost filter socks or berms
- Berms

16.5 What to Inspect

- Are approved staging areas identified in the project's SWPPP?
- Are BMPs installed prior to vehicles and equipment being stored in the staging area?
- Are there leaks and/or spills evident around construction vehicles, equipment or materials?
- Is the correct size aggregate being used in staging area for construction roads and entrances?
- Are waste bins covered when not in use?
- Area portable toilets secured to prevent tipping or knocking over?
- Is rebar and steel under cover/covered with 10 mil plastic sheeting and properly stored on dunnage, pallet, or similar material?
- Are construction vehicles stored under existing tree drip lines or on top of tree roots?
- Are vehicles tracking sediment onto public roads?
- Are there traces of run-on or runoff around the perimeter of the staging area?
- Has the contractor-initiated stabilization in disturbed areas no longer required for staging?

16.6 Maintenance

- Immediately clean up spills using dry cleanup methods where possible, and dispose of used materials properly.
- Clean up leaks and spills with an absorbent material. Do not clean surfaces or spills by hosing the area down.
- Provide an ample supply of readily available spill cleanup materials.
- Repair/replace plastic sheeting and/or geotextile filter fabric when torn or ripped.

- Replenish surface and construction entrance aggregate periodically.
- Repair/replace perimeter control devices that are tampered with and not functioning as designed.
- Place drip pans under idle construction vehicles.
- Adjust, repair, and/or reinstall inlet protection devices that are damaged, out of position, or not fully functional according to manufacturer's specifications.
- Regularly dispose of garbage and waste material.
- Amend the project's SWPPP when additional staging areas are needed or existing staging areas are no longer required.

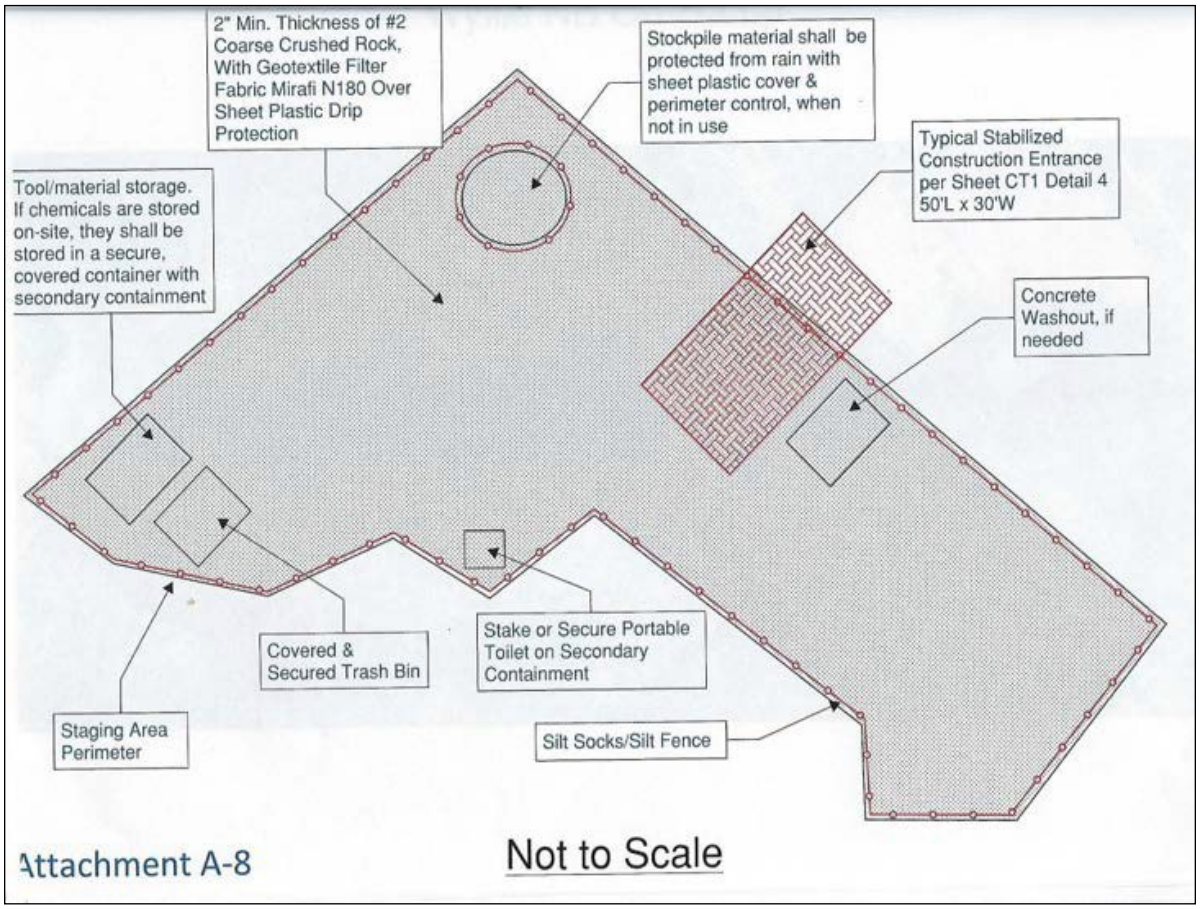


Figure 16-1. Example of a typical staging area

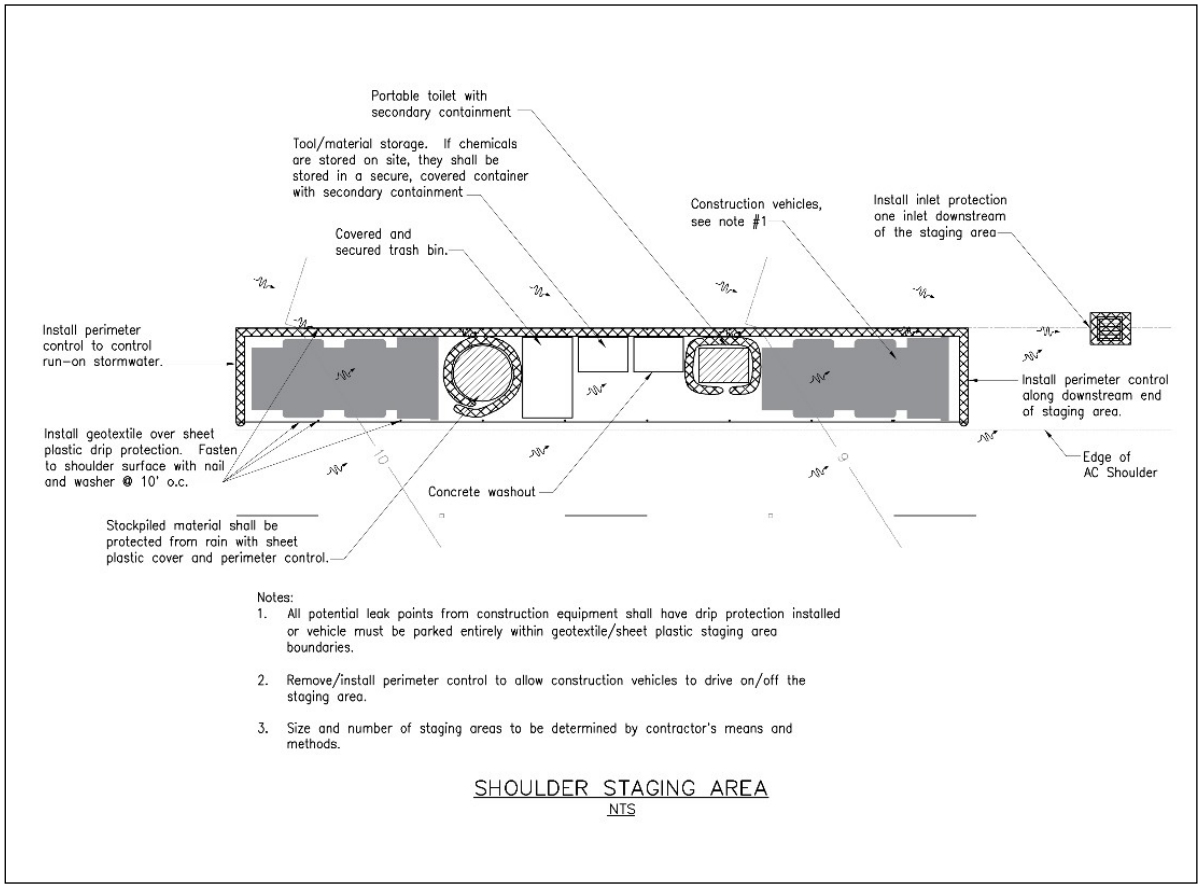


Figure 16-2. Example of a typical shoulder staging area

17 Preservation of Existing Vegetation

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

17.1 Description

Practices and procedures to provide erosion and sediment control to preserve existing vegetation on a site with future land-disturbing activities.

17.2 Applications

- Areas on-site where no construction activity occurs or will occur at a later date.
- Areas where the existing vegetation should be preserved such as steep slopes, watercourses, and building sites in wooded areas.
- Natural resources or environmental protection areas requiring preservation by federal, state, and local governments such as wetlands and marshes.

17.3 Installation and Implementation

- Incorporate existing vegetation into landscaping plans when possible. Proper care of this vegetation before and after construction is required.
- Consider aesthetic and environmental values, tree/plant health, life span, sun exposure limitations, and space requirements when determining which vegetation to preserve.
- Avoid using vegetation which competes with the existing vegetation when preparing the landscaping plans
- Phase construction activity to minimize the total amount of disturbed area to preserve existing vegetation.
- Clearly identify land to be disturbed to avoid damaging existing vegetation that is not meant to be disturbed.
- Establish setback distances defined by devices such as berms, fencing, or signs. Setback distances are based on vegetation species, location, size, and age. Consider the type of

construction activity in the vicinity of the vegetation. Construction activities are not permitted within the setback.
- Consult with a licensed arborist to develop a plan if it is not possible, due to construction requirements, to provide a setback to the limits of the root system (tree drip line). This plan should include setback limits and other mitigation methods to provide protection for the subject tree or other vegetation.
- Do not park equipment on tree roots or near endangered species of vegetation.
- Consult with the appropriate agencies to approve any setbacks established if endangered species of vegetation are found within or adjacent to the project limits.

17.3.1 Methods for Protecting Existing Vegetation

Methods include but are not limited to the following:

- Mark, flag, or fence areas of vegetation to be preserved.
- Designate limits of root system (tree drip line).
- Identify tree wells and retaining walls which are large enough to protect the root system.
- Limit grading to within 1 foot of the tree drip lines, if grading under the tree is necessary.
- Locate construction traffic routes, spoil piles, etc. away from existing vegetation.

17.4 Considerations

- Requires advanced planning and coordination among the owner/developer, contractor, and designer.
- Limited use if final site design does not incorporate existing vegetation.
- Diverse site topography may result in additional expenses to satisfy vegetation preservation and the grading required for the site improvements.
- Limited space for construction activity makes it difficult to preserve existing vegetation.

17.5 What to Inspect

- Are any endangered species identified within the projects limits and protected prior to the start of construction?
- Is there construction equipment, materials, personal vehicles or spoil piles stored on a tree's root system?
- Is construction activity occurring within vegetation setback limits?

17.6 Maintenance

- Immediately repair or replace damaged protection measures.
- Damage to existing trees should be examined and attended to by an arborist.

18 Dewatering Operations

18.1 Description

Practices and procedures to prevent or reduce the discharge of pollutants in non-storm water and accumulated precipitation from areas requiring dewatering activities so construction activity may proceed.

18.2 Applications

Construction sites requiring the removal of non-storm water to create a dry work area or to remove the accumulation of non-storm water from a work area.

18.3 Installation and Implementation

- Dewatering non-storm water into storm drains and open bodies of water is prohibited without approval from the State of Hawaii Department of Health, Clean Water Branch (CWB).
- The Engineer must submit a complete Notice of Intent for Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Appendix G, NPDES General Permit Coverage Authorizing Discharges Associated with Construction Activity Dewatering, no later than 30 days before the proposed starting date of the discharge or 30 days before the expiration date of the applicable notice of general permit coverage.
- The permittee shall comply with all requirements from HAR Title 11, Chapter 55, Appendix G and Appendix A, Standard General Permit Conditions. In case of conflict between the conditions listed in Appendix G and Appendix A, the more stringent conditions shall apply.

18.4 Types of Pollutants from Dewatering Discharges

Due to the nature of dewatering operations, high sediment content is common. Toxics and petroleum products, however, are not prevalent unless heavy industrial activities or groundwater contamination occurred in the surrounding area.

- Sediment
- Toxics and petroleum products

18.4.1 Sediment Removal

- Use sediment controls such as a sediment trap to remove sediment from dewatering discharges. See section 42 Sediment Trap for more information.
- Apply filtration methods to remove sediment from the sediment trap. These include:
- Sump pit combined with a perforated/slit standpipe, which is wrapped in geotextile filter fabric. As water collects in the pit, stones placed around the standpipe filter the water, which collects in the pit prior to being pumped out. Due to the wrapped standpipe, an increased suction inlet area may be required to prevent clogging and unacceptable pump operation.
- Floating suction hose, which allows cleaner surface water to be pumped out.

18.4.2 Toxics and Petroleum Products Removal

- Areas of known or suspected groundwater contamination shall be tested by a certified laboratory for known or suspected pollutants using methods detailed in 40 CFR Part 136. The laboratory shall enforce a quality assurance/quality control measures program. Comply with the dewatering requirements in subsection 209.03 (D) of the 2005 Hawaii Standard Specifications for Road and Bridge Construction, Standard Specifications & Special Provisions Section, as in effect.
- Discharges to the sanitary sewer system shall receive approval from the State of Hawaii Department of Health (DOH) and the owner of the wastewater system. Additional testing and disposal requirements may be necessary.
- Testing of the dewatering effluent should be completed and the results identified prior to discharging to a receiving waterbody or storm drainage system.

18.5 Considerations

- Contaminated water may be an indication of contaminated soil. See section 8 Contaminated Soil Management for more information.

18.6 What to Inspect

- Is contaminated water evident in excavated areas?
- Is discoloration, oily sheen, or odor observed?

18.7 Maintenance

- Remove and properly dispose of sediment collected in sediment control devices.

19 Dust Control

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

19.1 Description

Measures to minimize erosion and reduce the amount of dust generated by construction activities.

19.2 Applications

Dust control shall be used on all exposed soils or any construction activity generating dust. Dust control shall apply to the following:

- Clearing, grubbing, and grading
- Construction vehicular travel on unpaved roads
- Drilling and blasting
- Soil and debris stockpiles
- Excavation and handling of soil or aggregate from excavators, loaders, and backhoes
- Unstable soil areas
- Sawcutting, jack hammering and grinding
- Sifting operations

19.3 Installation and Implementation

- Minimize exposed areas through the schedule of construction activities.
- Anticipate the prevailing wind direction to determine BMP placement in order to minimize the amount of dust generated.
- Identify and stabilize primary entrances/exits prior to commencement of construction to prevent tracking and dust generation.
- Direct construction vehicular traffic to stabilized roadways.
- Maintain dust screens until permanent ground cover has been established.

- Use methods to mitigate or eliminate the amount of dust produced, such as spraying water from water truck, using misters, chemical dust controlling agents, or combination thereof; hydromulching, keeping soil moist, and grassing.
- Light spray of water or use of vacuum can minimize dust when drilling, sawcutting, jack hammering or grinding.
- Do not overspray water for dust control purposes, which will result in runoff from the area.
- Prevent water from wetting vehicles, pedestrians, and existing pavements.
- Washing down of debris or dirt into drainage, sewage systems, or state waters is not allowed.
- Chemicals used as soil stabilizers for dust control must be approved by the Engineer before use.
- Large areas and stockpiles can be hydromulched with a tackifier (with or without seed) to prevent wind erosion/dust. See section 3 Stockpile Management for more information.
- Geobinders with surfactants may be used to minimize water consumption.
- Cover exposed surface of materials completely with tarpaulin or similar device when transporting aggregate, soil, excavated material or material that may be sources of fugitive dust.
- Utilize vegetation, mulching, sprinkling, and stone/gravel layering to quickly stabilize exposed soil.
- Comply with the 2005 Hawaii Standard Specifications for Road and Bridge Construction, Standard Specifications & Special Provisions Sections 209 and 619, as in effect.

19.4 Considerations

- Daily or more frequent **APPLICATIONS** of water may be necessary since water is a short- term dust preventative.
- Erosion may result from overwatering.
- Oil may not be used for dust control since the oil may discharge into a drainageway or seep into soil.
- Some dust suppression chemicals may cause soil to become water repellent resulting in increased runoff.

19.5 What to Inspect

- Is there evidence of off-site runoff?
- Is dust being suppressed during construction activity?
- Are dust screens properly maintained?
- Is dust from the construction site impeding public safety or health?
- Is water being over-sprayed?

19.6 Maintenance

- Install, repair, or replace BMPs to cover bare ground or redirect off-site runoff.
- Apply water as conditions require.
- Repair water truck leaks immediately.

20 Paving Operations

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

20.1 Description

Practices and procedures to prevent or reduce the discharge of pollutants into the storm drain system or adjacent waterbodies from paving, sawcutting, or grinding activities.

20.2 Applications

- Paving operations and activities including the following:
- Paving equipment storage
- Asphalt cleaning
- Removal of existing asphalt or concrete
- Concrete, asphalt, seal coat, tack coat, or slurry applications
- Recycling of pavement

20.3 Installation and Implementation

- Limit paving operations during wet weather when possible.
- Store materials for paving activities away from concentrated runoff.
- Place drip pans/drip pads under paving equipment to contain leaks and spills. Clean up spills with absorbent materials immediately.
- Drip protection must be placed under entire asphalt hopper, roller assemblies and spray arms that are not being used. Place a layer of geotextile filter fabric on top of 10 mil plastic sheeting to create a berm able to contain any possible spills and/or leaks.
- Ensure full inlet and scupper protection per the Storm Water Pollution Prevention Plan (SWPPP) during application of tack coat, seal coat, slurry seal, and fog seal.
- Do not remove inlet protection until paving and striping operations are complete.
- Clean any asphalt from inlet protection immediately following paving to allow water to drain.

- Remove saw cuts or boring slurry from site by vacuuming.
- Provide storm drain inlet protection during sawcutting to prevent slurry from entering the storm drains. See section 39 Storm Drain Inlet Protection for more information.
- Use asphalt emulsions as prime coat when possible.
- Clean asphalt-coated equipment off-site.
- Clean up asphalt millings by the end of the working day and properly dispose of or recycle, as necessary.
- See section 4 Concrete Wash and Waste Management for activities involving Portland cement concrete (PCC).
- Keep an ample supply of cleanup material in case of a spill or leak. See section 10 Spill Prevention and Control for more information.

20.4 Asphalt Concrete Paving

- Properly dispose of old or spilled asphalt. Collect and remove broken asphalt. Recycle asphalt when possible.
- If waste asphalt (new) must be stored, rather than removed, it must be stored on an impervious material, covered with impervious material such as 10 mil plastic sheeting and have full perimeter control. It cannot be stored in dirt or rubble spoil piles.
- Sweep excess sand and gravel to prevent discharge into the storm drainage system or adjacent water bodies.
- Comply with storm water permitting requirements for industrial activities if paving requires an on-site mixing plant.

20.5 Considerations

- Restrict paving operations during wet weather to prevent contact between storm water and paving materials.
- Limited space to stage paving equipment.

20.6 What to Inspect

- Is there drip protection under paving equipment?
- Is inlet protection installed and well-maintained?
- Is there drip protection under paving equipment not being used?
- Are asphalt millings cleaned up at the end of the work day?
- Is paving equipment properly staged within project limits?
- Is there evidence of saw cut slurry entering the storm drain?

20.7 Maintenance

- Keep an ample supply of drip pans and absorbent materials on-site.
- Regularly maintain paving equipment to minimize potential leaks or drips.

21 Structure Construction and Painting

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

21.1 Description

Practices and procedures to reduce or prevent the discharge of pollutants from structure construction and painting activities into the storm drain system or adjacent waterbodies. Pollutants include solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, epoxy compounds, adhesive residues, and old asbestos insulation.

21.2 Applications

Construction or maintenance activities involving painting or structure repair and construction.

21.3 Installation and Implementation

- Maintain a clean and orderly work site.
- Use recycled or less hazardous products if practical.
- Comply with local air quality and Occupational Safety and Health Administration (OSHA) regulations during painting activities.
- Properly store paints, solvents, and epoxy compounds in appropriate secondary containment and under impermeable cover.
- Properly store and dispose waste materials generated from painting and structure repair and construction activities.
- Avoid drift by enclosing or covering painting operations.
- Collect residue from sand blasting or scraping operations on a drop cloth. Dispose of this residue properly.
- Use appropriate application equipment to minimize overspray.
- Minimize inadvertent disposal of residual paints and other liquids by ensuring nearby storm drains are clearly marked.

- Inspect the storm drain system in the immediate work area and remove dirt or debris upon completion of the activity.
- Clean painting equipment used with water-based paints in a sink connected to the sanitary sewer system.
- Mix paints in a covered and contained area, when possible, to minimize adverse impacts from spills.
- Immediately clean up spills.
- Testing of waste generated from painting may be required to determine if any hazardous waste are present per the contract documents. See section 6 Solid Waste Management and 9 Hazardous Materials and Waste Management for more information on proper disposal of solid and hazardous waste.
- Comply with applicable laws and regulations for recycling/disposal of residual paints, solvents, lumber, and other materials.
- Treat paint chips containing lead or tributyl tin as hazardous waste. See section 9 Hazardous Materials and Waste Management for more information.
- Properly dispose of material from sand blasting activities. Consider chips and dust from marine paints or paints containing lead as hazardous waste. Sweep paint chips and dust from non-hazardous dry stripping and sand blasting and dispose of as solid waste. See sections 6 Solid Waste Management and 9 Hazardous Materials and Waste Management for more information on proper disposal of solid and hazardous waste.

21.4 Considerations

- Availability of recycled or less hazardous products may be limited.
- Hazardous waste which may not be recycled or reused shall be disposed of by a licensed hazardous waste transporter.
- Storm water quality protection measures shall comply with OSHA and air quality regulations

21.5 What to Inspect

- Is there evidence of paint entering the storm drain system or adjacent waterbodies?
- Are paints and solvents properly stored?
- Is paint and construction repair waste disposed of properly?
- Are inlet protection devices installed at inlets in the direct vicinity of structure construction and painting?
- Are inlet protection devices properly installed and maintained?
- Are any leaks or spills evident where painting materials are being stored?

21.6 Maintenance

- Keep materials and equipment for proper housekeeping and disposal practices readily available.

22 Topsoil Management

22.1 Description

Practices and procedures to manage the reuse of native topsoil and other selected materials during revegetation activities. Salvaging, stockpiling, and reapplication of native topsoil is integral to successful revegetation efforts, especially for the reestablishment of native vegetation.

22.2 Applications

Reestablishment of areas where vegetation with native plant species is desirable. Appropriate for sensitive habitat areas, floodplains, wetlands, and stream banks.

22.3 Installation and Implementation

- Preserve native topsoil where practicable.
- Conduct a site-specific soil survey of the area prior to soil-disturbing activities to assess the location, depth, and amount of soils suitable for salvaging.
- Salvage and stockpile all suitable topsoil and other material for future use during revegetation of the area. See section 3 Stockpile Management for more information.
- Carefully remove shrubs suitable for revegetation and store with the roots covered with mulch or loose soil.
- Apply topsoil or growth medium directly to disturbed areas and seed once construction activity is complete. Water area daily until the area is stabilized. However, avoid over water which can create runoff and erosion.
- Restrict vehicle/equipment use in areas where vegetative stabilization will occur to avoid soil compaction.

- Soil replacement depths are determined by factors such as soil depth prior to disturbance, type of vegetation, and physical and/or chemical properties of the material to be covered. A deeper soil layer is required for soils with poor physical and chemical properties. Testing (nutrients, pH, and toxicity factors) of replacement soils and material to be covered shall be completed prior to reapplication.

22.4 Topsoil Management Considerations

- Quality and amount of native topsoil or growth medium.
- Area of surface disturbance to which topsoil or growth medium will be applied and the required depth of application.
- Methodology for salvaging topsoil or growth medium.
- Stockpile location, duration of storage, and required erosion control measures to protect stockpile.
- Feasibility of direct application of salvaged soils.
- Availability of other growth media to supplement topsoil reclamation.

22.5 Considerations

- Stockpiles may limit the area available for construction activity.
- Runoff from stockpiles may adversely impact water quality.
- Topsoil is contaminated prior to the start of construction activity.
- Avoid placement of topsoil prior to expected rain events.

22.6 What to Inspect

- Is topsoil effectively stockpiled?
- Are BMPs maintained to effectively prevent contact with storm water?
- Is dust originating from stockpiles?

22.7 Maintenance

- Adequately water plantings until they are established.
- Replace/repair damaged stockpile cover, as needed.
- Ensure that the plastic cover is in contact with the ground around the entire pile and properly anchored.
- Replace/repair damaged temporary perimeter sediment barrier.
- After the stockpile has been removed, revegetate the disturbed area, if applicable. Reapply temporary stabilization (i.e., hydromulch, tackifier, etc.), if needed.

23 Temporary Stream Crossing

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

23.1 Description

Temporary structures placed across a waterway to provide vehicular access while minimizing or reducing erosion and sedimentation.

23.2 Applications

- Streams or dry channels subject to frequent vehicular crossings.
- Detour roads on bridge replacement projects.

23.3 Installation and Implementation

- Design should be by a registered civil and/or structural engineer knowledgeable in stream flows, soil strength, and hydraulic and construction loading requirements.
- Provide stability in crossing and adjacent areas to withstand design flow. Choose a crossing site where erosion potential is low.
- Consider construction during dry periods to minimize disturbance and flow levels.
- Install means to trap sediment downstream of crossing.
- All materials used in construction should be clean, washed material with a cellular confinement system to prevent downstream contamination.
- Stabilize construction roadways (See section Construction Road and Parking Lot Stabilization Stabilization), adjacent work areas, and stream bottoms against erosion.

- Any temporary artificial obstruction within flowing water should be built with material that does not introduce sediment or silt into the watercourse.
- Temporary waterbody crossing should be built to minimize scour.
- Minimize disturbance to existing vegetation and immediately restabilize the waterway once construction activity is completed.
- Equipment operations that will encroach on the waterbody within the project must be free of grease, oil, fuel, and residues.
- Construction in waterbodies may require temporary stream diversion and dewatering.
- Restrain from excavating in waterways or embedding crossings.
- Minimize or eliminate the need to cross streams by using alternative routes, as applicable.
- Vehicle and equipment maintenance, fueling, storage and cleaning should not be conducted on temporary bridges.

23.3.1 Culverts

- Applicable to perennial or intermittent streams.
- Effective in controlling erosion.

23.3.2 Fords

- Applicable to arid areas during the dry season.
- Low maintenance.
- Provides minimal erosion and sediment control.

23.3.3 Bridges

- Applicable to high velocity, steep gradient conditions.
- Where temporary restrictions in the channel are not allowed.

23.4 Considerations

- Duration of construction projects shall not exceed 1 year.
- Not applicable for general traffic use.
- Additional BMPs will be necessary during installation and removal to minimize soil disturbance.
- Stream Channel Alteration Permit (Refer to Hawaii Administrative Rules (HAR) Title 13, Chapter 169-50, Protection of Instream Users).
- Waterways will be disturbed during installation and removal.
- For construction traffic only. Not intended for public use.
- Bridges generally cost more than alternative methods, but cause the least amount of disturbance to existing conditions.

Subject to permit requirements of the U.S. Army Corps of Engineers (USACE) and State of Hawaii Department of Land and Natural Resources (DLNR):

- USACE 404 Permits
- State of Hawaii Department of Health, Clean Water Branch (CWB) 401 Certifications
- DLNR, Commission on Water Resource Management (CWRM)

23.5 What to Inspect

- Are channels blocked from stream crossing during rain events?
- Is there debris accumulated in culverts, behind fords, or under bridges?
- Is there evidence of abutment erosion, rip-rap displacement, channel scour, piping in soil and/or structural degradation?
- What is the turbidity of water downstream?

23.6 Maintenance

- Remove silt and debris periodically.
- Replenish aggregate from culvert inlets and outlets as necessary.
- Remove temporary crossings once no longer needed.

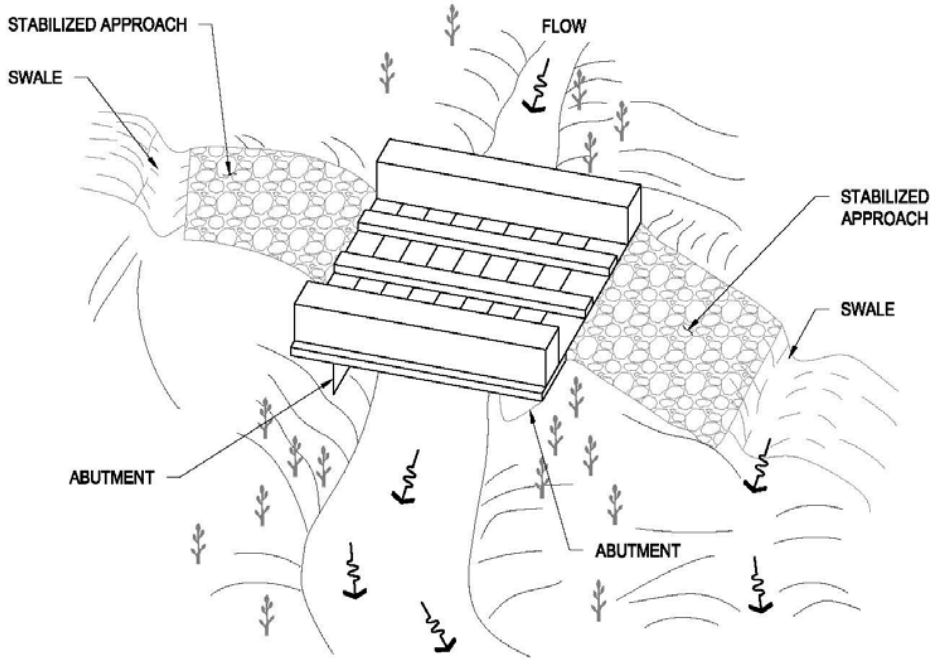


Figure 23-1. Example of a typical bridge crossing

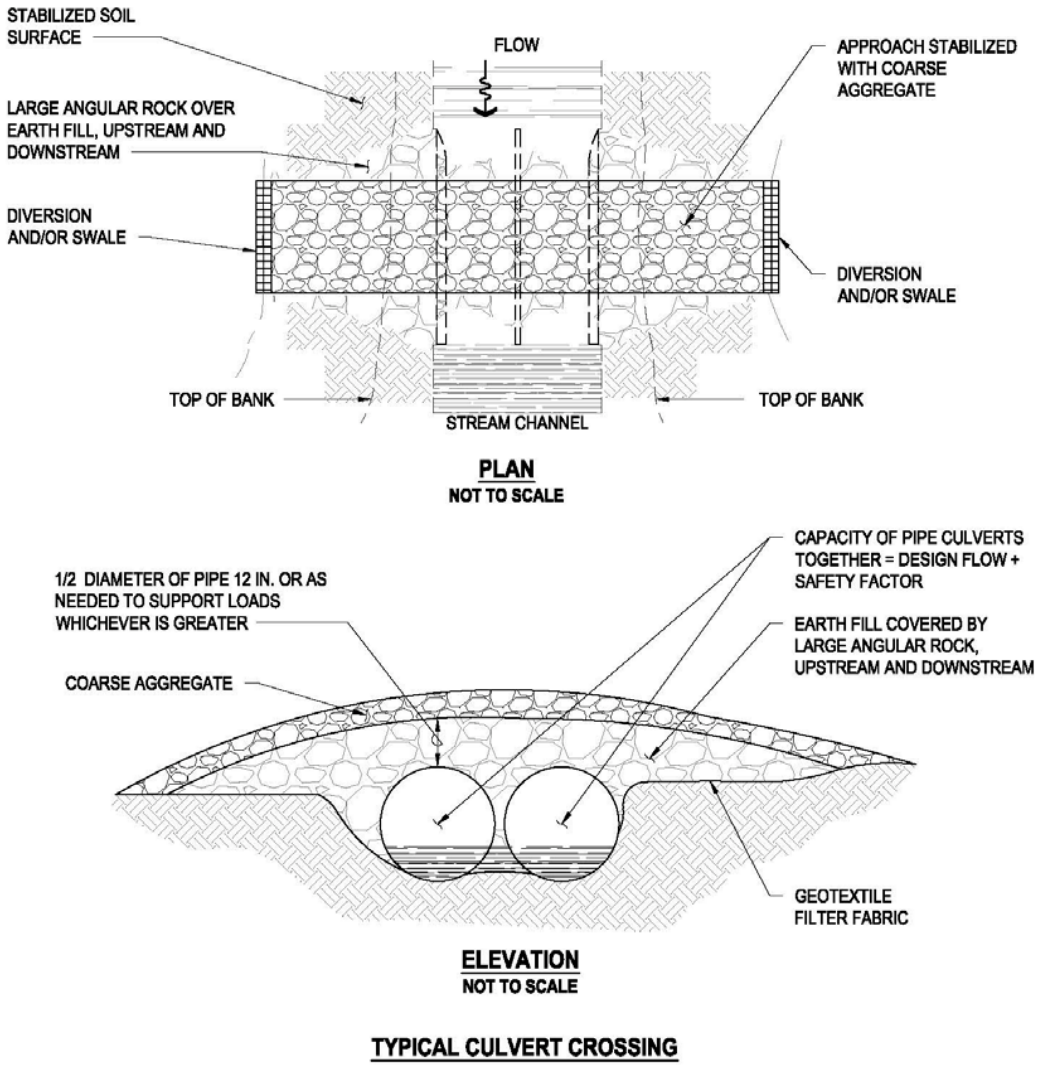


Figure 23-2. Example of a typical culvert crossing

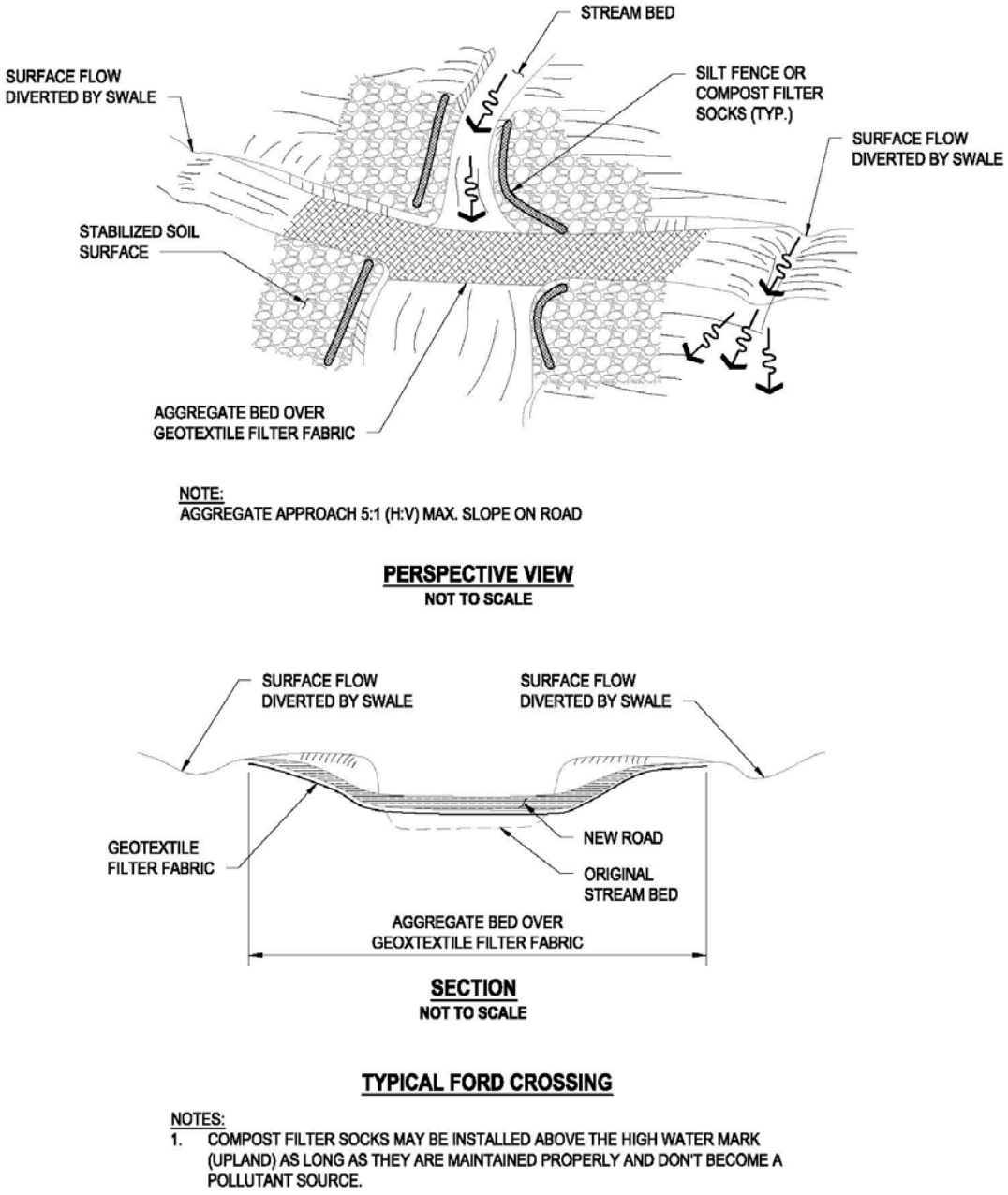


Figure 23-3. Example of a typical ford crossing

24 Flared Culvert End Section

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

24.1 Description

Devices placed at the inlet or outlet of pipes and channels to enhance hydraulic operation while minimizing scour and erosion.

24.2 Applications

Flared culvert end sections may be placed at inlets and outlets of slope drains and culverts.

24.3 Installation and Implementation

- Construct on level ground where possible. Flatter slopes reduce the potential of erosion and scour.
- Supplement with additional outlet protection devices.
- Protect the transition to the flared end section at inlets to prevent scouring.
- Extend additional rip-rap downstream of outlet to reach stable conditions and minimize scouring.
- Ensure geotextile filter fabric is installed under rip-rap.
- All disturbed areas must be immediately stabilized with native vegetation once construction is complete.
- Monitor accumulation of debris and sediment and remove within 60 days of notification. Immediately clean culverts located where Class AA or Class 1 waters or highway safety may be adversely affected. Refer to Hawaii Administrative Rules (HAR) Title 11, Chapter 54 for state waters classification.

24.4 Considerations

- Limited use as an erosion control measure. Primarily used to increase hydraulic efficiency.
- Improperly designed culverts could result in erosion, scouring, or ponding.
- Pipes can clog if they are not adequately protected from litter.
- Pipe outlets may cause critical levels of erosion if devices are not installed to dissipate the velocity of storm water flow.
- Additional erosion control BMPs will need to be added to slope drains on slopes greater than 10%, due to highly erosive velocities.
- The contractor may need to temporarily remove rip-rap to repair/replace geotextile filter fabric under rip-rap.

24.5 What to Inspect

- Is flared culvert end section installed correctly, per manufacturer's specifications?
- Is there evidence of scour around and beneath flared culvert end sections?
- Is there a non-storm water discharge observed from pipes?
- Is ponding occurring in traffic lanes or private property?
- Is geotextile filter fabric installed under rip-rap?

24.6 Maintenance

- Remove accumulated sediment from inlets, outlets, and rip-rap.
- Refresh rip-rap that has been dislodged.
- Add additional BMPs if erosion and scouring are observed.
- Repair geotextile filter fabric that has rips and/or tears.
- Remove temporary BMPs when drainage area is stabilized and construction is complete.

25 Run-on Diversion

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

25.1 Description

Devices that intercept, divert, and convey off-site surface run-on around or through the project site to prevent site erosion. Run-on (storm water entering the site) diversion devices include dikes, swales, compost filter berms, sandbags, check dams and slope drains.

25.2 Applications

- Along paved surfaces to intercept runoff.
- Upslope from project site to prevent erosion of disturbed areas located on-site.
- Downslope of project site to convey runoff to a sediment control device such as a sediment trap or sediment basin.
- Around material storage areas, maintenance and fueling areas, or areas with runoff containing contaminants or pollutants.
- Below steep grades to intercept concentrated runoff.
- Diversion devices can provide protection from storm water runoff when located around adjacent property and buildings.
- Devices can be used to divert run-on storm water through the construction site without eroding disturbed areas.

25.3 Installation and Implementation

- A designer should provide flow rate calculations to the Engineer for approval before installation to ensure the size of the diversion device is effective.
- Use a layered approach to divert storm water run-on and minimize sediment from leaving the site.
- Select flow velocity based on evaluation of potential risks due to erosion, overtopping, flow backup, washout, and drainage flow patterns of the project.

- Immediately stabilize earth dikes and swales.
- See section 27 Earth Dikes, Swales, and Ditches for more information. See section 29 Slope Drains and Subsurface Drains for more information.

25.4 Considerations

- Run-on diversion devices do not remove sediment from runoff.
- If run-on cannot be diverted around the construction site it will need to be directed through the project without causing erosion.
- Ditches and swales may require check dams or lining to prevent erosion.
- All diversions shall have stabilized outlets that will convey concentrated runoff without erosion.
- Once storm water run-on enters a construction site, it becomes the contractor's responsibility to effectively manage.
- Not all devices are effective individually. A layered approach is more appropriate.

25.5 What to Inspect

- Is there evidence of sediment buildup at inlets?
- Is there erosion at channel embankments, washouts, or ditch beds?
- Is there evidence of erosion or scour at outlets and/or perimeter of site?
- Are there signs of storm water run-on entering the construction site?
- Is sediment accumulating at perimeter control devices?
- Are additional BMPs needed to prevent run-on?

25.6 Maintenance

- Remove accumulated sediment and debris and repair damages as necessary.
- Temporary diversions shall be completely removed and area stabilized at the completion of construction.
- Repair/replace BMP devices that are not properly performing.

26 Slope Roughening, Terracing, and Rounding

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

26.1 Description

Methods of slope grading to reduce potential erosion by decreasing runoff velocities, trapping sediment, shortening slope length, and increasing infiltration into the soil.

26.2 Applications

- Areas where seeding, planting, and mulching erosion control measures may be enhanced by roughening of the soil surface. Graded areas with smooth, hard surfaces.
- Areas requiring terracing to shorten the slope length.
- Locations where vegetation is not adequate erosion protection and is affecting construction activity.

26.2.1 Cut Slope Roughening

- Cut slopes steeper than 3:1 (H:V) shall use stair-step grading or furrows.
- Use stair-step grading on soft soils that may be ripped by a bulldozer. Stair-step grading is particularly suitable for slopes consisting of soft rock with some subsoil.
- The vertical cut shall not exceed 2 feet in soft materials and 3 feet in rocky material.
- The vertical cut must be shorter than the horizontal cut. The typical stair width is 1 to 2 feet.
- Slope the horizontal cut towards the face of the slope, so storm water drains towards the slope and allows time for sediment to settle.
- Create ridges and depressions along the slope contours using machinery.

26.2.2 Fill Slope Roughening

- Fill slopes steeper than 3:1 (H:V) shall be placed in lifts not exceeding 9 inches. Each lift shall be properly compacted.
- Slope faces shall consist of 4 to 6 inches of loose and uncompacted soil.
- Grooving or tracking shall be used to roughen slope faces as necessary.
- Apply seed, fertilizer, and mulch. Track or punch in the mulch. See section 36 Mulching 34 Seeding and Planting for additional information.
- The final slope face shall not be bladed or scraped.

26.2.3 Cuts, Fills, and Graded Areas

- Slopes that will be maintained by mowing shall be no steeper than 3:1 (H:V).
- Create shallow grooves by normal tilling, disking, harrowing, or use of a cultivator- seeder. Final pass of tillage shall be along the contour. Spacing between grooves shall be 10 inches or less. Groove depth shall be a minimum of 1 inch.

26.2.4 Roughening with Tracked Machinery

- Roughening with tracked machinery is only applicable to soils with a sandy texture. Other types of soil may be over-compacted by tracked machinery.
- Application is best for slope grades 3:1 (H:V) or flatter.
- Leave horizontal depressions in the soil by operating tracked machinery up and down the slope. During the final grading operation, do not back blade.
- Minimize the number of passes the tracked machinery makes to avoid over-compaction.
- Roughened areas shall be seeded and mulched for optimum seed germination and growth.

26.2.5 Terracing

- Slope grades of 5:1 (H:V) shall include terraces or benches when slope heights exceed 30 feet. Steeper slope or highly erosive soil conditions may warrant terraces or benches for slope heights of 15 feet or higher.
- Runoff collected along terraces and benches shall be routed to lined diversion ditches. Install lined diversion ditches at the intersection of the terrace and slope.
- Vertical cut shall be between 1 and 2 feet. Horizontal cut must be longer than the vertical cut and slope inward towards the face of the slope. Benching width is usually made wide enough for mowing equipment.

26.2.6 ROUNDING

- All slopes shall be rounded with no sharp breaks in plan or profile.

26.3 Considerations

- Since terracing is permanent, design and approval shall be under the direction of a licensed, qualified engineer.
- Design of terraces shall provide adequate drainage and stabilized outlets.
- Roughening may result in increased grading costs and sloughing in soil.
- Stair-step grading are for cut slopes only and may not be applicable to sandy, steep, or shallow soils.

- During intense rainfall events, roughening may not be an effective temporary erosion control measure.
- Surface roughening must not be used to keep an area under the qualification of “actively working” to prolong the stabilization deadline.
- Slopes need to be regraded and reseeded if rills and gullies form, creating channels for runoff.
- Excessive compaction with tracking machinery can inhibit vegetation growth and cause higher runoff rates.
- What to Inspect
- Is there evidence of rills and gullies on seeded and planted slopes?
- Does the slope have adequate vegetation coverage?
- Are proper cuts and methods being used to reduce erosion?

26.4 Maintenance

- Regrade and reseed areas where rills or gullies have formed.
- Revegetate bare areas on slope.

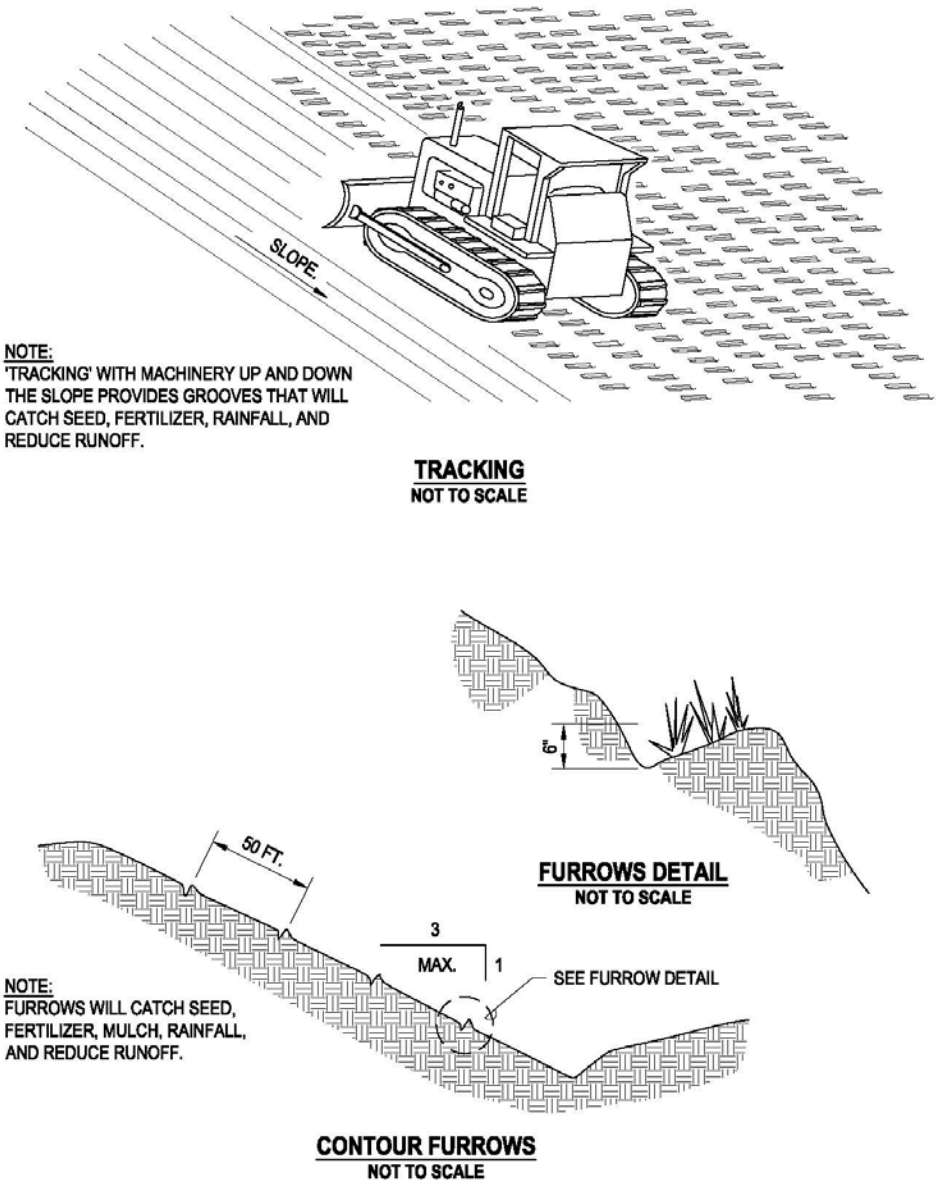
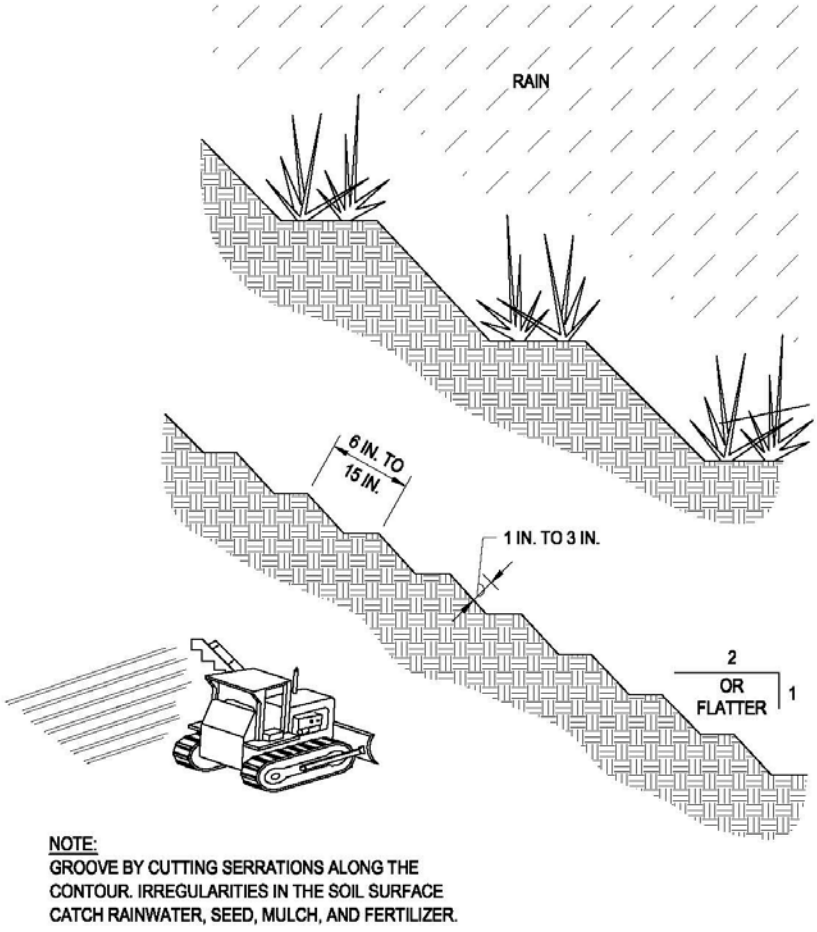


Figure 26-1. Example of contour furrows



SERRATED SLOPE
NOT TO SCALE

Figure26-2. Example of Serrated Slope

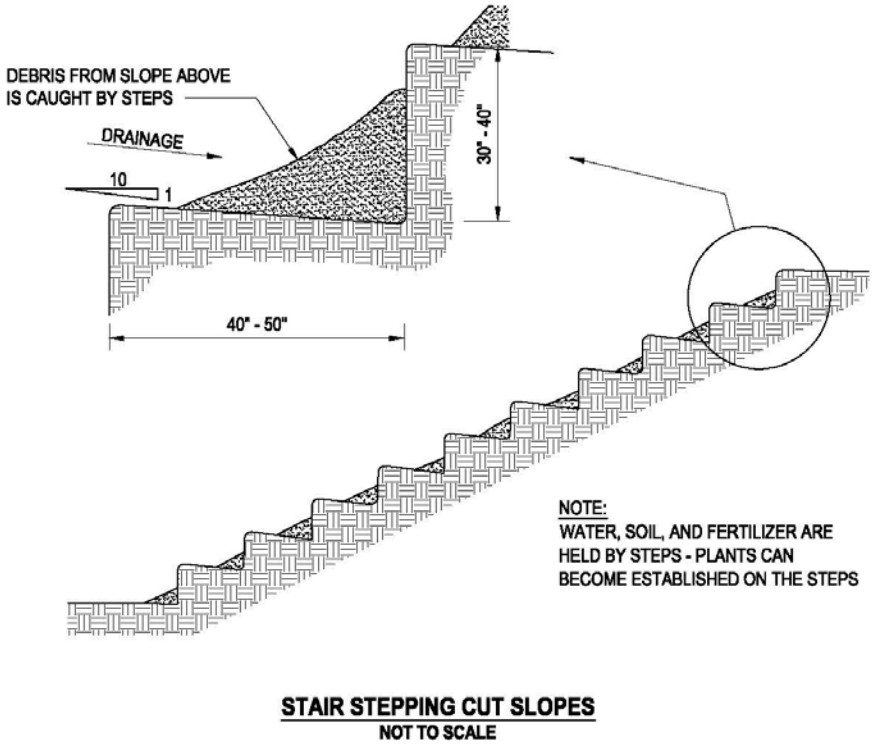


Figure 26-3. Example of stair stepping cut slopes

27 Earth Dikes, Swales, and Ditches

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

27.1 Description

Structures that prevent erosion by intercepting, diverting, and conveying surface run-on to a stabilized area or other sediment trapping device.

27.2 Applications

- Use earth dikes for drainage areas smaller than 10 acres.
- Use swales and ditches for drainage areas smaller than 5 acres.
- Direct runoff around unstable or disturbed areas to a stabilized water course, drainage pipe, or channel.
- Divert runoff to sediment basins or sediment traps.
- Along perimeter of the site or disturbed area to divert storm water run-on and runoff.
- Intercept runoff at the point of concentration.
- Supplement other sediment control measures.
- Intercept and divert runoff to prevent sheet flow over sloped surfaces.
- Convey surface runoff down sloping land.
- Provide containment for a specified and limited area including stockpiling or material storage areas within the project limits.

27.2.1 Earth Dikes

- Firmly compact to minimize erosion and prevent unequal settling.
- Drain to a stabilized outlet.
- Divert sediment-laden runoff to a sediment trapping device.
- Ensure continuous, positive grade along dike to prevent ponding of runoff.
- Stabilize earth dikes with vegetation, chemicals, or other physical devices.

- Conform to predevelopment drainage patterns and capacities.
- Berm size is determined by factors including slope length and grade, soil characteristics, climate, and presence of existing vegetation.
- Berms may be vegetated or unvegetated.
- Use velocity dissipation devices within and at the outlet of temporary drains and swales to minimize erosive flow velocities. See section 30 Outlet Protection and Velocity Dissipation Devices for more information.
- Determine design flow and safety factor by an evaluation of risks associated with overtopping, flow backups, or washout of structures.
- Evaluate potential run-on from off-site properties. Install before earth-disturbing activity on slopes.
- Determine flow velocity limit by on-site soil type and drainage flow patterns.
- Establish minimum flow velocity requiring lining (rip-rap, geotextile filter fabric, vegetation, concrete) for earthen diversion devices.
- Incorporate an emergency overflow section or bypass area into the design for storms exceeding the design storm.

27.2.2 Swales and Ditches

- If rip-rap is used, use 4- to 12-inch rock depending on the grade.
- Stabilize earth dikes, drains, and swales with vegetation, chemicals, or other physical devices.

27.3 Considerations

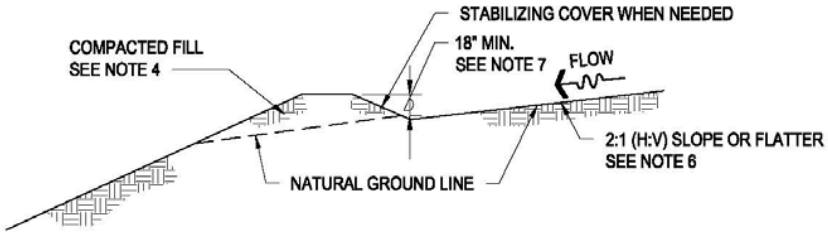
- Access and space can prohibit or limit the installation of a dike.
- Despite simplicity of installation, improper design can limit effectiveness.
- Use of additional sediment and erosion control devices may be required to prevent scour and erosion in recently graded dikes, swales, and ditches.
- Select size and location to prevent unintended consequences such as erosion along steep and unlined ditches and ponding within the travelway or material storage areas.
- Alteration of existing waterways and clearing of existing vegetation are subject to permit requirements of the U.S. Army Corps of Engineers (USACE) and state or local agencies.
- Unsuitable for use as a sediment trapping device.

27.4 What to Inspect

- Is there erosion along berms, channel linings, embankments, beds of ditches and downgradient?
- Is there excess sediment/debris evident in the swale?
- Is there sediment accumulation along dike?
- Is proper size rip-rap used?
- Will runoff remain within diversion channel?
- Are embankments stabilized?
- Is there evidence of potential signs of failure for dike walls, embankments, compacted fills, and earthen channel sidewalls?

27.5 Maintenance

- Restore all bare areas with the appropriate lining material.
- Remove accumulated sediment and debris once it reaches one-half the height of the dike.
- As needed, reseed/stabilize the dike as needed to maintain stability.
- Remove dikes, swales, and ditches after stabilization of the surrounding drainage area or completion of construction.
- Restore any cracks, washouts, animal habitation, exposed materials, or other signs of potential failure. Coordinate restoration with Maintenance Engineer or Material Testing and Research Section as necessary. The Hydraulic Section shall also be consulted for problems associated with structural design or runoff flow patterns.



SECTION
NOT TO SCALE

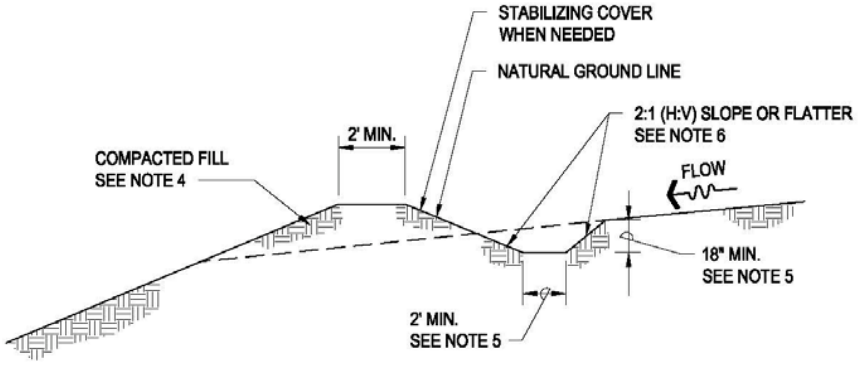
NOTES:

1. ALL DIKES SHOULD BE COMPACTED BY EARTH MOVING EQUIPMENT.
2. ALL DIKES SHOULD HAVE POSITIVE DRAINAGE TO AN OUTLET.
3. ALL DIKES SHOULD HAVE 2:1 OR FLATTER SIDE SLOPES, 18 INCH MINIMUM HEIGHT, AND A MINIMUM TOP WIDTH OF 24 INCHES. WIDE TOP WIDTHS AND FLAT SLOPES ARE USUALLY NEEDED AT CROSSINGS FOR CONSTRUCTION TRAFFIC.
4. THE OUTLET FROM THE EARTH DIKE SHOULD FUNCTION WITH A MINIMUM AMOUNT OF EROSION. RUNOFF SHOULD BE CONVEYED TO A SEDIMENT TRAPPING DEVICE SUCH AS SEDIMENT TRAP OR SEDIMENT BASIN WHEN EITHER THE DIKE CHANNEL OR DRAINAGE AREA ABOVE THE DIKE ARE NOT ADEQUATELY STABILIZED.
5. TEMPORARY STABILIZATION MAY BE ACHIEVED USING SEED AND MULCHING FOR SLOPES LESS THAN 5% AND EITHER RIP-RAP OR SOD FOR SLOPES IN EXCESS OF 5%. IN EITHER CASE, STABILIZATION OF THE EARTH DIKE SHOULD BE COMPLETED IMMEDIATELY AFTER CONSTRUCTION OR PRIOR TO THE FIRST RAIN.
6. IF RIP-RAP IS USED TO STABILIZE THE CHANNEL FORMED ALONG THE TOE OF THE DIKE, THE FOLLOWING TYPICAL SPECIFICATIONS APPLY:

CHANNEL GRADE	RIP-RAP STABILIZATION
0.5-1.0%	4 IN. ROCK
1.1-2.0%	6 IN. ROCK
2.1-4.0%	8 IN. ROCK
4.1-5.0%	8 IN. - 12 IN. ROCK

EARTH DIKE

Figure 27-1.Example of an Earth Dike



SECTION
NOT TO SCALE

NOTES:

1. PLACE DRAINAGE SWALES ABOVE OR BELOW, NOT ON, A CUT OR FILL SLOPE.
2. DRAINAGE OR SWALES SHOULD BE LAID AT A GRADE OF AT LEAST 1 PERCENT, BUT NOT MORE THAN 15 PERCENT.
3. REMOVE ALL TREES, STUMPS, OBSTRUCTIONS, AND OTHER OBJECTIONABLE MATERIAL FROM THE SWALE.
4. FILL MATERIAL ALONG THE PATH OF THE SWALE SHOULD BE COMPACTED TO AT LEAST 90% COMPACTION.
5. SWALE TOP AND BOTTOM WIDTH SHOULD BE AT LEAST 2 FT.
6. SIDE SLOPES SHOULD BE 2:1 OR FLATTER.
7. DEPTH OF THE SWALE SHOULD BE AT LEAST 18 IN.
8. CONSTRUCT THE DRAINAGE SWALE WITH A POSITIVE GRADE TO A STABILIZED OUTLET.
9. USE A LINED DITCH FOR HIGH FLOW VELOCITIES.
10. TEMPORARY STABILIZATION MAY BE ACHIEVED USING SEED AND MULCHING FOR SLOPES LESS THAN 5% AND EITHER RIP-RAP OR SOD FOR SLOPES IN EXCESS OF 5%.
11. IF RIP-RAP IS USED TO STABILIZE THE CHANNEL FORMED ALONG THE TOE OF THE DIKE, THE FOLLOWING TYPICAL SPECIFICATIONS APPLY:

CHANNEL GRADE	RIP-RAP STABILIZATION
0.5-1.0%	4 IN. ROCK
1.1-2.0%	6 IN. ROCK
2.1-4.0%	8 IN. ROCK
4.1-5.0%	8 IN. - 12 IN. ROCK

TEMPORARY DRAINAGE SWALE

Figure 27-2.Example of a temporary drainage swale

28 Level Spreader

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

28.1 Description

Device used at outlets to convert concentrated flow to sheet flow, preventing erosion of the receiving area. Tops of channels, earthen berms, or rigid weir-like structures may function as level spreaders.

28.2 Applications

- Flat or gentle sloping areas.
- Outlets for dikes and diversions.
- Where concentrated flows are discharged.

28.3 Installation and Implementation

- Construct on undisturbed soil.
- Do not construct on fill material.
- Locate where reconcentration of water will not occur.
- A stabilized and well vegetated slope of less than 10% shall be located below the level spreader.
- Filter runoff containing high sediment loads through a sediment-trapping device prior to release to the level spreader.
- Incorporate a rigid outlet lip design for high discharge flows.
- 0% grade on the spreader lip is necessary for uniform sheet flow.
- Avoid operating vehicles and heavy equipment on the level spreader to maintain a smooth level surface for the overflow weir.

28.4 Considerations

- Not applicable to sediment-laden runoff.
- The level spreader lip needs to be at a 0% grade to confirm no erosion or concentration of flows occur.
- Not recognized as a pollutant reduction BMP when by itself, but is necessary for other BMP devices to function properly. It will also remove some pollutants due to some suspended sediment that settles out.
- Storm water approaching the BMP should not be high energy.

28.5 What to Inspect

- Is there accumulated debris or sediment in the level spreader?
- Does the level spreader have a slope of 0% along the spreader lip?
- Is there evidence of erosion, channelization, or concentrated flow at the discharge area?
- Are there low spots in spreader?

28.6 Maintenance

- Keep level spreader at 0% grade.
- Remove any accumulated debris and sediment and properly dispose off-site.
- Mow grass to assure the level spreader is properly functioning.

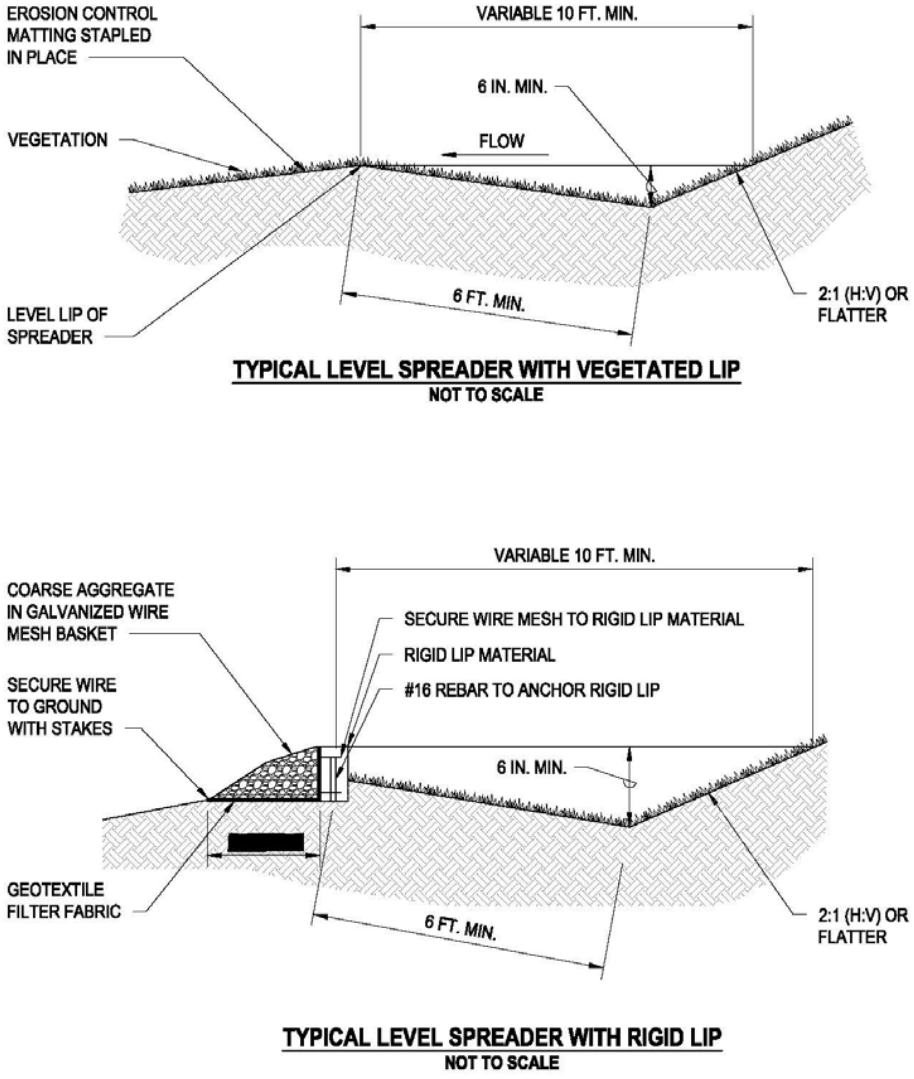


Figure 28-1. Examples of level spreaders

29 Slope Drains and Subsurface Drains

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

29.1 Description

Pipes to prevent erosion along slopes by intercepting and conveying runoff or groundwater from the top of the slope to a stabilized discharge point located at the bottom of the slope. Slope drains are primarily used to convey runoff down cut or fill slopes. Subsurface drains are primarily used to remove water from the soil in sloped areas.

29.2 Applications

- Use of slope drains is applicable to the following:
- Drainage of concentrated runoff from within swales or behind dikes located at the top of slopes.
- Drainage of surface runoff to prevent erosion along the slope.
- Emergency spillways for sediment basins.
- Use of subsurface drains is applicable to areas where water must be removed from the soil to lower the groundwater table or to prevent excessive soil saturation.

29.2.1 SLOPE DRAIN DESIGN CONSIDERATIONS

- Consult with a hydrogeologist or qualified engineer regarding design flows.
- Limit drainage area discharging to slope drain to 5 acres.
- Direct surface runoff into slope drain using interceptor dikes at the top of slope. See section 27 Earth Dikes, Swales, and Ditches for more information.
- Pipe slope drains exceeding 12 inches in diameter require a standard flared end section or headwall constructed at the inlet and outlet.
- Common materials used for slope drains is plastic lining, fiber matting, flexible plastic pipe, metal pipe, rigid pipe, and half round pipe.

- Install lining such as vegetation or geotextile filter fabric to protect area around inlet.
- Install rip-rap or other energy dissipation device at outlets.
- Place rip-rap so it extends to the maximum flow depth, or to a point where vegetation will be satisfactory to control erosion.
- Compact soil under and around inlet, outlet, and along the pipe.
- Slope drain must be installed on a slope gradient of 3% or greater.
- Slope drains may be installed above-ground or buried beneath the slope surface.
- Drains that are buried beneath the slope surface must have an earth dike, a minimum of 12 inches, on top of the pipe at the top of slope.
- Above-ground installation shall utilize pipe anchors to secure pipe to ground and be spaced a maximum of 10 feet apart.
- Align slope drain perpendicular to contours of slope. Generally, limit maximum slope to 2:1 (H:V). For slopes exceeding 2:1 (H:V), velocity dissipation is required at the pipe outlet.
- A half round pipe, fiber matting or plastic lining can be installed for shorter slopes that have a gradient flatter than 2:1 (H:V).
- Berms must remain relatively low and vegetated. Limit berm height to no more than 24 inches in height.
- The pipe should have a minimum diameter of 12 inches and should be equal over the entire length. Maximum pipe diameter is 24 inches due to height limitations of berms.
- Direct sediment-laden storm water to a sediment trap or sediment basin.

29.3 Considerations

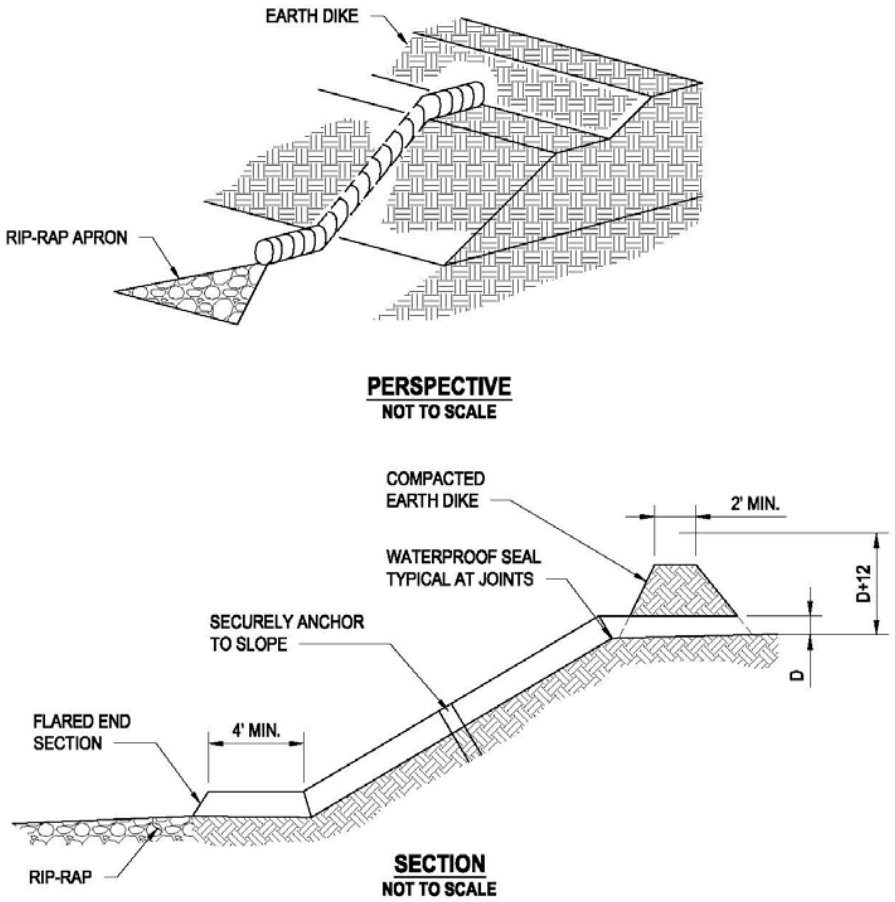
- Drainage area discharging to slope drains shall not exceed 5 acres. For larger areas, use multiple pipes, paved chute, or rock lined channel.
- Clogged slope drains direct runoff around pipe which may result in erosion along the slope.
- High flow velocities at the pipe outlet require implementation of velocity dissipation devices to prevent downstream erosion. See section 30 Outlet Protection and Velocity Dissipation Devices for more information.
- High flows may wash away velocity dissipation devices at the outlet, which leaves the area susceptible to erosion.
- Severe flooding and erosion may result from failure of slope drains and storm water overtopping the berm.

29.4 What to Inspect

- Are slope drains accumulating debris and sediment?
- Is there evidence of scour or erosion at the outlet?
- Is the pipe damaged or leaking?
- Are the pipe connections watertight?
- Is the pipe anchored to the slope?
- Is ponding occurring in active traffic lanes or material storage areas?

29.5 Maintenance

- Repair damage caused by erosion and scour, and install energy dissipation devices as necessary.
- Remove sediment and debris from entrances, outlet, and within drains to maintain flows.
- Repair/replace pipe if it is leaking or damaged.



NOTES:

1. INSTALL SLOPE DRAINS PERPENDICULAR TO SLOPE CONTOURS.
2. SLOPE DRAINS CAN BE PLACED ON OR BURIED UNDERNEATH THE SLOPE SURFACE.
3. COMPACT SOIL AROUND AND UNDER ENTRANCE, OUTLET, AND ALONG LENGTH OF PIPE.
4. SECURELY ANCHOR AND STABILIZE PIPE AND APPURTENANCES INTO SOIL.
5. CHECK TO ENSURE THAT PIPE CONNECTIONS ARE WATERTIGHT.
6. PROTECT AREA AROUND INLET WITH FILTER CLOTH.
7. TOP OF INTERCEPTOR DIKES SHOULD BE LIMITED TO 12" HIGHER THAN THE TOP OF THE SLOPE DRAIN.
8. MAXIMUM SLOPE IS GENERALLY LIMITED TO 2:1 (H:V).
9. DIRECT SURFACE RUNOFF TO SLOPE DRAINS WITH INTERCEPTOR DIKES.
10. PROTECT OUTLET OF SLOPE DRAINS USING FLARED END SECTION WHEN OUTLET DISCHARGES TO A FLEXIBLE ENERGY DISSIPATION DEVICE. THE FLARED SECTION SHOULD SLOPE TOWARDS THE PIPE INLET.

PIPE SLOPE DRAIN (RIGID)

Figure 29-1. Example of a rigid pipe slope drain

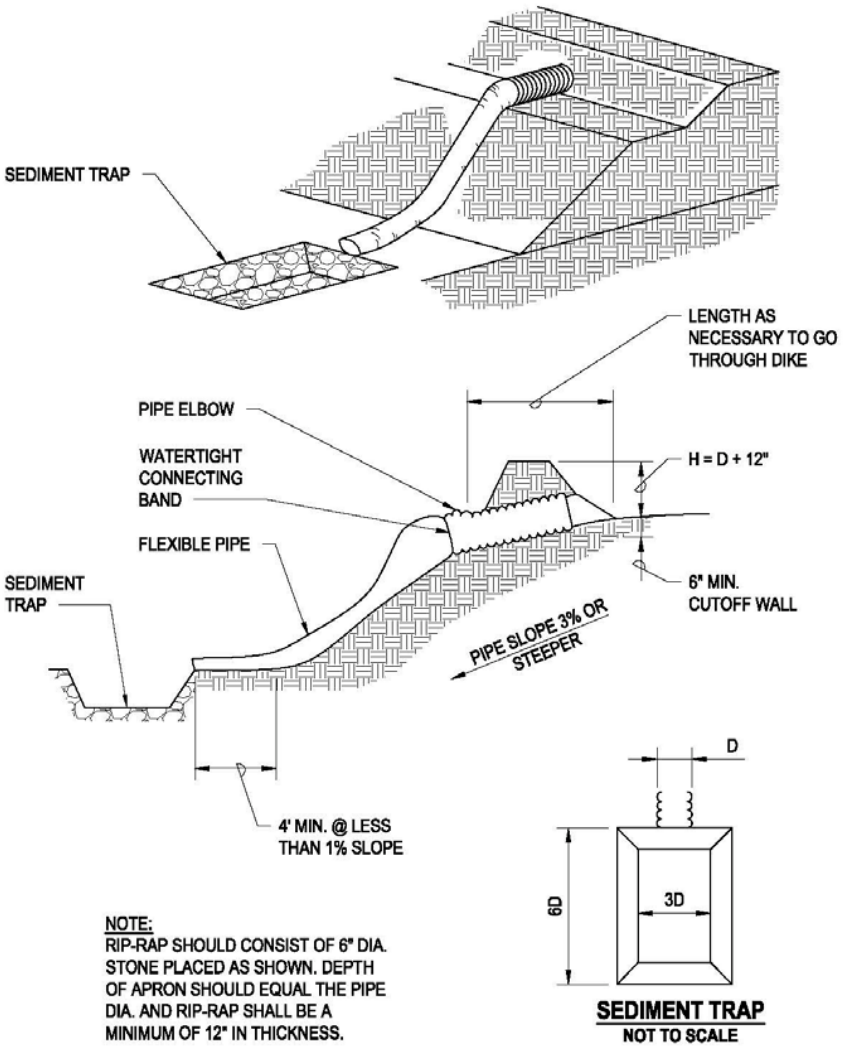


Figure 29-2. Example of a flexible pipe slope drain

30 Outlet Protection and Velocity Dissipation Devices

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

30.1 Description

Devices placed at outlets of pipes and channels to prevent or minimize scouring and erosion by reducing the velocity of storm water flow.

30.2 Applications

- Outlets with continuous flows.
- Outlets located at the bottom of slopes.
- Outlets subject to short, intense flows.
- Discharge points from lined conveyances to unlined conveyances.
- Inflow protection.
- Outlet protection that diverts runoff to a natural or manmade drainage element.
- In-stream/channel designed to prevent banks from erosion.

30.3 Installation and Implementation

- Apron length shall be determined by outlet flow rate and tailwater level.
- Align apron with direction of flow and avoid curves in apron. If a curve is necessary, place it in the upper section of the apron.
- Protect the underlying geotextile filter fabric with a 4-inch minimum rock blanket if the rip-rap is 12 inches or larger.
- Increase rock size to counteract high flow velocities.
- Place geotextile filter fabric between aggregate and the underlying soil to prevent soil movement.
- Outlets on slopes steeper than 10% must have additional protection.
- Place and extend rip-rap downstream until stable conditions are met.

30.4 Considerations

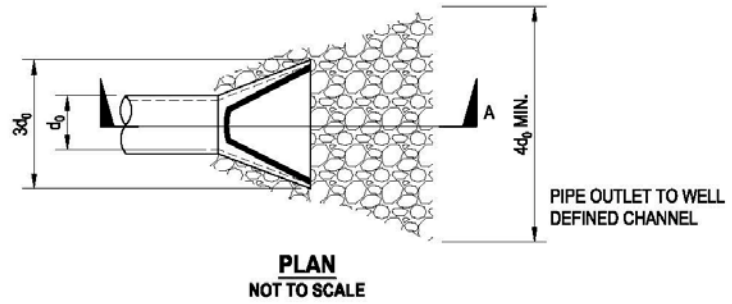
- Potential for stones to wash away during high velocity flows.
- Break up of grouted rip-rap can result from hydrostatic pressure caused by water accumulation.
- It is difficult to repair underlying geotextile filter fabric without removing rip-rap.
- Larger stones are prone to damaging the geotextile filter fabric during installation when installing with a machine and may require installing by hand.

30.5 What to Inspect

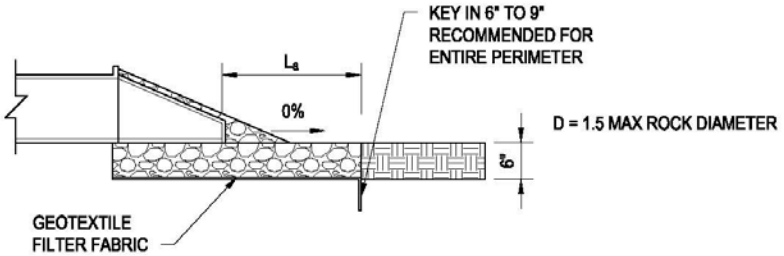
- Is there scour evident beneath the rip-rap and around the outlet?
- Is accumulated sediment wedged in-between rip-rap?
- Can illicit discharge be found in the outlet?
- Is the proper size rock being used?
- Is there damage to underlying geotextile filter fabric?
- Is outlet free of obstructions?

30.6 Maintenance

- Immediately repair damaged slopes or underlying geotextile filter fabric with priorities based on highway safety and protection of Class AA and Class 1 waters, followed by erosion potential and possible damage to downslope areas.
- Replace displaced rip-rap.
- Remove accumulated sediment in aggregate.
- Remove obstruction and repair damage as necessary.



PLAN
NOT TO SCALE



SECTION A
NOT TO SCALE

NOTES:

1. THE APRON LENGTH AND ROCK SIZE GRADATION ARE DETERMINED USING THE TABLE.

2. INSTALL RIP-RAP, GROUTED RIP-RAP, OR CONCRETE APRON AT SELECTED OUTLET. RIP-RAP APRONS ARE BEST SUITED FOR TEMPORARY USE DURING CONSTRUCTION. GROUTED OR WIRED TIED ROCK RIP-RAP CAN MINIMIZE MAINTENANCE REQUIREMENTS.

3. CAREFULLY PLACE RIP-RAP TO AVOID DAMAGING THE FILTER FABRIC.

   a. STONE 4 IN. TO 6 IN. MAY BE CAREFULLY DUMPED ONTO FILTER FABRIC FROM A HEIGHT NOT TO EXCEED 12 IN.

   b. STONE 8 IN. TO 12 IN. SHOULD BE HAND PLACED ONTO FILTER FABRIC, OR THE FILTER FABRIC MAY BE COVERED WITH 4 IN. OF GRAVEL AND THE 8 IN. TO 12 IN. ROCK MAY BE DUMPED FROM A HEIGHT NOT TO EXCEED 16 IN.

   c. STONE GREATER THAN 12 IN. SHOULD ONLY BE DUMPED ONTO FILTER FABRIC PROTECTED WITH A LAYER OF GRAVEL WITH A THICKNESS EQUAL TO ONE HALF THE D50 ROCK SIZE, AND THE DUMP HEIGHT LIMITED TO TWICE THE DEPTH OF THE GRAVEL PROTECTION LAYER THICKNESS.

4. OUTLETS ON SLOPES STEEPER THAN 10 PERCENT SHOULD HAVE ADDITIONAL PROTECTION.

PIPE DIAMETER, (Inches)	DISCHARGE (ft^3/s)	APRON LENGTH, La (ft)	RIP-RAP D50 DIAMETER, MIN (inches)
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	

FOR LARGER OR HIGHER FLOWS CONSULT A LICENSED CIVIL ENGINEER.
SOURCE: USDA-SCS

PIPE OUTLET CONDITIONS

Figure 30-1. Example of a pipe outlet

31 Slope Interceptor or Diversion Ditches/Berms

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

31.1 Description

Methods to minimize sheet flow over slopes and reduce erosion by intercepting and conveying runoff to sediment removing structures or a protected drainage system.

31.2 Applications

- Protecting slopes from sheet flow runoff.
- Areas which must be protected from runoff flowing down slopes.
- Installed horizontally across disturbed slopes to reduce runoff velocity.
- Slopes where runoff must be intercepted at bottom of slope.
- Terraced areas on large/long slopes.
- Remove runoff to treatment area.
- A built-in ditch/swale at the base or top of the disturbed slope to divert storm water to an area where erosion control is prevalent.

31.3 Installation and Implementation

- Design flows and safety factors shall be determined by an evaluation of risks associated with erosion and overtopping, flow backups, or structure washouts. Consult with the District maintenance Engineer or Highways Division's Hydraulic Section to determine these values.
- Ditches with high flow velocities shall be lined or stabilized. Consider use of rock check dams to slow flow.
- Direct flows at top of slopes to slope drains or a sediment trap. See sections 29 Slope Drains and Subsurface Drains and 42 Sediment Trap for more information.
- A BMP device (dike, berm, compost filter sock) should be installed at the top of disturbed slopes until the slope is revegetated or temporary erosion control is installed on the face of the slope.
- Protect outlets from erosion.

- Place slope interceptors as follows:
- Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 feet.
- Slope inclination between 4:1 and 2:1 (H:V): Fiber rolls should be placed at a maximum interval of 15 feet.
- Slope inclination 2:1 (H:V) or greater: Fiber rolls should be placed at a maximum interval of 10 feet; a closer spacing is more effective.
- Stakes should be installed to secure compost filter berms. Drive stakes at least 12 inches into the ground. See section 44 Compost Filter Berm/Sock for more information.

31.4 Considerations

- Additional sediment trapping BMP devices may be necessary for sediment-laden runoff.
- Slope interceptors on steeper slopes will need to be spaced closer due to faster flows.
- Slopes made up of a higher percentage of clay will increase the velocity of sheet flow.

31.5 What to Inspect

- Are washouts evident in ditches or berms?
- Are structures accumulating sediment and/or debris?
- Is there evidence of rill or gully erosion?
- Is sediment discharging into outlets?
- Are berms correctly trenched and staked?
- Are berms properly spaced on slope?
- Is a BMP device installed at the top of the disturbed slope?
- Are additional BMPs required to prevent erosion and undermining?

31.6 Maintenance

- Repair or replace rip-rap as needed.
- Repair damaged lining as needed.
- Use soil stabilizers.
- Compact fill berms and revegetate.
- Compact and revegetate ditches as needed.
- Remove accumulated sediment when it reaches one-half the height of the berm.
- Repair/replace compost filter berms that have rips and tears.

32 Rip-rap and Gabion Inflow Protection

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

32.1 Description

Devices to protect soil surfaces from erosion by stabilizing slopes, and slowing the velocity of concentrated runoff. Rip-rap consist of large, irregular shaped rocks that fit into place to provide erosion control and slow the velocity of concentrated runoff. Gabions are wire baskets filled with rock, concrete, or other materials that lines drainageways to stabilize the flow channel along steep slopes, shorelines, and stream banks against erosion.

32.2 Applications

32.2.1 Rip-Rap

- Use of rip-rap inflow protection applies to slopes between 10:1 and 4:1 (H:V)
- Erosion-resistant ground cover
- Pipe outlet protection
- Channel lining
- Stabilized slopes
- Shoreline stabilization
- Dissipates high velocities or concentrations of storm water

32.2.2 Gabions

- Use of gabion inflow protection applies to slopes exceeding 4:1 (H:V)
- Retaining structures
- Foundation construction e.g., dams
- Aesthetic purposes
- Rip-rap and gabions are relatively maintenance free and long lasting
- These devices can be used as a temporary or permanent BMP
- Temporary flood walls
- Shoreline stabilization
- Change direction of source water
- Energy dissipation device in channels

32.3 Installation and Implementation

32.3.1 Rip-Rap

- A licensed civil Engineer must provide a design and calculations for approval prior to installation.
- 2:1 (H:V) side slopes, 3-foot minimum bottom width, and 1-foot minimum depth.
- Line channel with 4- to 12-inch rip-rap at a depth of 18 inches. The larger stones must be predominant, while the smaller stones fill the voids.
- Install geotextile filter fabric under all rip-rap to separate rocks with underlying soil. Prior to placing geotextile filter fabric, provide a 3-day notice to the Engineer for inspection of foundation.
- Blend rip-rap into existing ground at uniform thickness so the stream width is not radically narrowed.
- Stones shall be clean, sound, durable, and angular in shape, resistant to weathering and water action, and free from organic material. Stones shall be shaped so that neither their breadth nor thickness are less than one-third their length, not rounded, and have minimum unit weight of 155 pounds per cubic foot. Refer to 2005 Hawaii Standard Specifications for Road and Bridge Construction, Standard Specifications & Special Provisions Section 655.

32.3.2 Gabions

- A licensed Civil Engineer must provide a design and calculations prior to installation.
- Gabion inflow may be used in lieu of rip-rap inflow protection.
- Gabions are prefabricated wire baskets filled with a well-graded mixture of aggregate. The larger stone must be predominant, while the smaller stones fill the voids.
- Baskets must be made of hexagonal triple twist mesh with heavily galvanized steel wire.
- Construct 2:1 (H:V) side slopes, 3-foot bottom width, and 1-foot deep from 9-foot × 3- foot × 1-foot gabion baskets. Install geotextile filter fabric under all gabion baskets.
- A bedding layer of aggregate can be placed before the gabion baskets are installed to level the surface and maximize stability.
- Fill gabion baskets with 4- to 7-inch clean (no fines) stone.
- Hand place rocks in gabion baskets to minimize voids and/or bulges. Rock edges must not poke through the gabion basket. Install gabions in accordance with manufacturer's recommendations.

- The wire mesh of the gabion basket will eventually fail due to corrosion. The designer must consider this and plan for overall stability when the basket fails.

32.4 Considerations

- Gabion installation is labor intensive (hand installation).
- Costly compared to vegetative devices.
- Not always aesthetically pleasing.
- Scour tends to occur at toe and end of rip-rap.
- If gabions or rip-rap is used within a U.S. Army Corps of Engineers (USACE) jurisdictional waterbody that coordination with the USACE is required.

32.5 What to Inspect

- Is there evidence of scour around rip-rap or gabions?
- Has debris and/or sediment accumulated around or in rip-rap?
- Has an underlying filter fabric/geotextile been installed?
- Has the BMP device been installed correctly?
- Are rocks displaced?
- Does the gabion structure show signs of bulging or gaps?
- Is there damage to the gabion basket?
- Is there evidence of rock failure?
- Does the BMP need to be cleaned out or replaced?

32.6 Maintenance

- Remove accumulated sediment lodged between rip- rap that is affecting filtration purposes.
- Replace/refresh rocks that have been displaced.
- Repair damage to filter fabric/geotextile under rip- rap.
- Any evident damage or abnormalities to the gabion must be repaired.

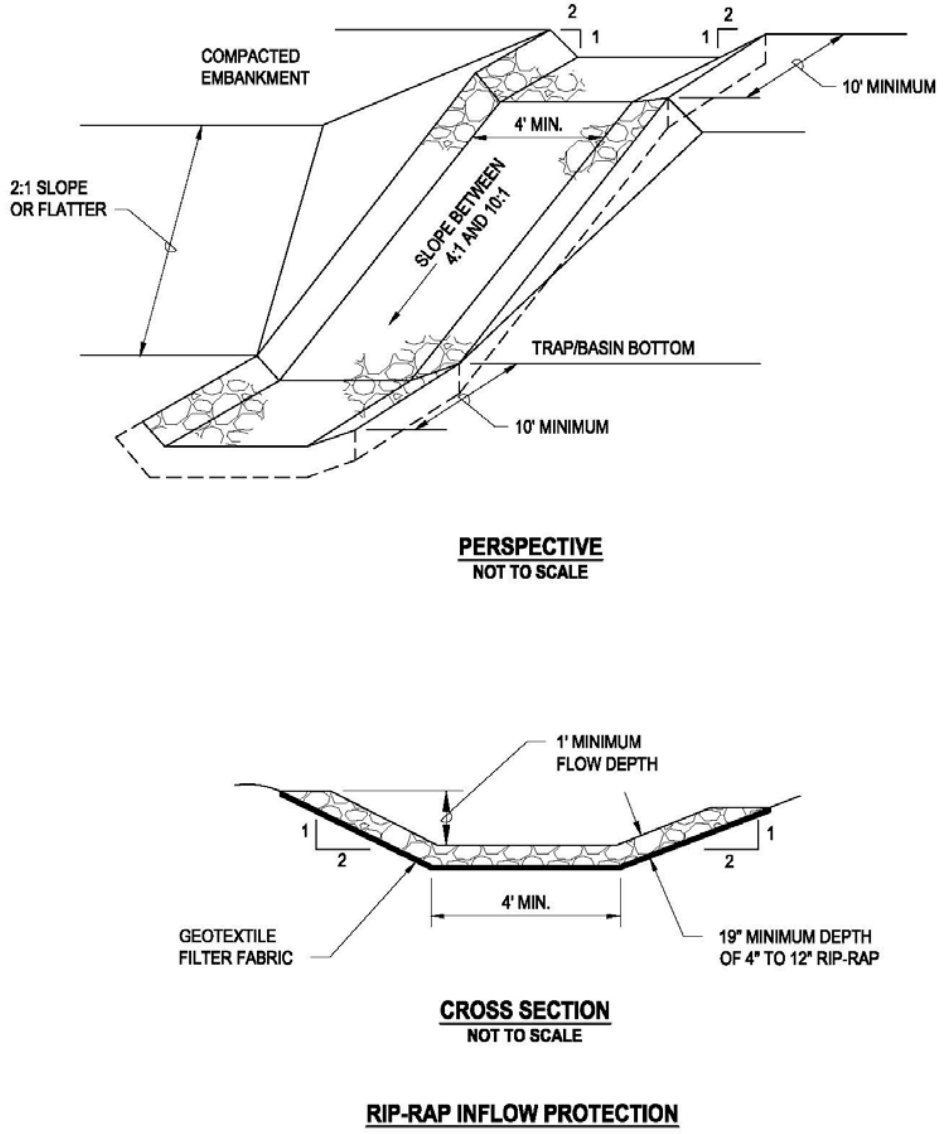


Figure 32-1. Example of rip-rap inflow protection

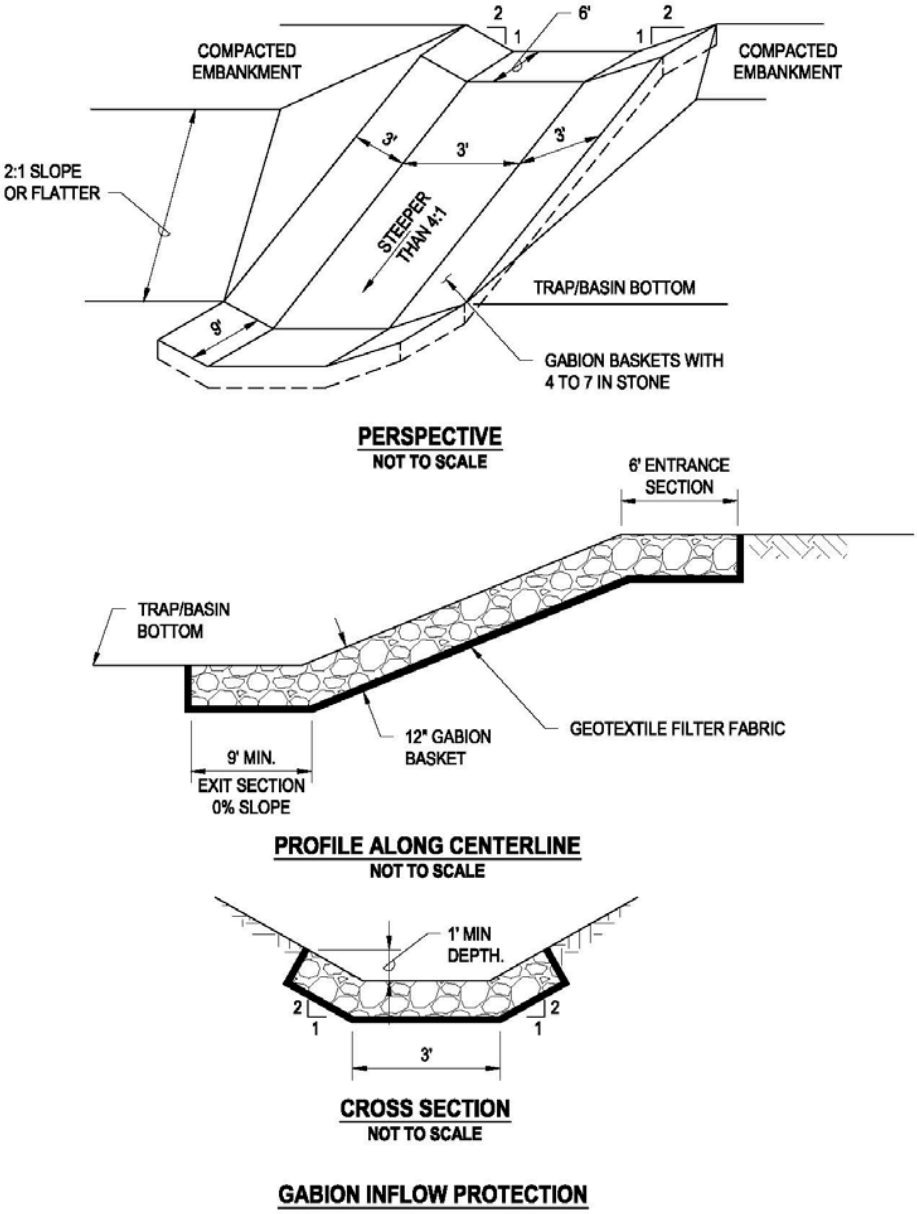


Figure 32-2. Example of gabion inflow protection

33 Geotextiles and Mats

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

33.1 Description

Natural or synthetic mats are roll-type materials used for temporary or permanent soil stabilization and protection from rain/wind erosion.

33.2 Applications

- Stabilize drainage ditches, channels, and stream banks.
- Stabilize steep slopes with high potential for erosion.
- Stabilize slope until vegetation is established.
- Hold water near surface to assist in vegetation growth.
- Protect stockpiles from wind erosion.
- Suppress weed growth.
- Provide temporary cover for bare areas that are idle.

33.3 Installation and Implementation

- Apply matting to disturbed soils and areas where vegetation has been removed.
- Install matting immediately after the area is seeded and fertilized.
- Minimize disturbance of slopes greater than 15% in grade.
- Phase disturbances and use stabilization techniques designed for steep grades if disturbance of steep slopes is unavoidable.
- Grade and shape disturbed slopes prior to installing geotextiles and/or erosion control matting.
- Prepare area by removing rocks, vegetation and other obstructions that will inhibit direct contact with soil.
- Entrench or anchor material at the top and bottom of the slope in a 6-inch × 6-inch trench or per manufacturer's specifications, whichever is more stringent. The trench should be placed a minimum of 12 inches from the top of the slope.

- • Intermittent check slots can also be installed for large or long lengths of matted areas to increase stability of the area.
- Do not stretch matting. Maximize mat contact with soil by loosely laying blankets and securing to slope with stakes.
- Ensure matting maintains direct contact with soil to prevent rills, gullies, and undermining.
- Follow manufacturer's specifications on overlapping and stake spacing requirements. Steep slopes may require additional staking requirements.
- If geotextile matting is to be installed on steep slopes greater than 15%, space stakes every 2 feet.
- Organic matting provides temporary protection until permanent vegetation has been established or construction activities recommence. Organic matting materials include the following:
- Jute matting
- Straw matting
- Synthetic matting provides temporary or post- construction soil stabilization in both vegetated and non-vegetated areas. Synthetic matting materials include the following:
- Excelsior™ matting
- Glass fiber matting
- Stakes
- Mulch netting
- Plastic sheeting/covering
- Key in temporary plastic sheeting at top of slope and weigh down by gravel bags no more than 6 feet apart.
- Install erosion control measures or devices at the top and toe of the slope to filter sediment-laden runoff and decrease storm water velocity.
- Other proprietary devices may be used and shall be installed per manufacturer's recommendations.
- The contractor shall immediately initiate soil stabilization measures when earth- disturbing construction activities on exposed areas have been completed or will be temporarily inactive for 14 or more calendar days.

33.4 Considerations

- Minimize use of matting to areas where other erosion control measures are not applicable such as channels or steep slopes since matting is costly compared to other erosion control measures.
- Seed germination may be delayed due to decreased soil temperature.
- Extensive soil preparation is needed before installation for adequate contact with slope.
- Mats made of natural material have a limited life and low shear strength.
- High material cost and extensive manpower needed.
- Generally, the slope needs to be smooth and free of large rocks.
- Plastic sheeting results in 100% runoff and is easily torn/damaged.

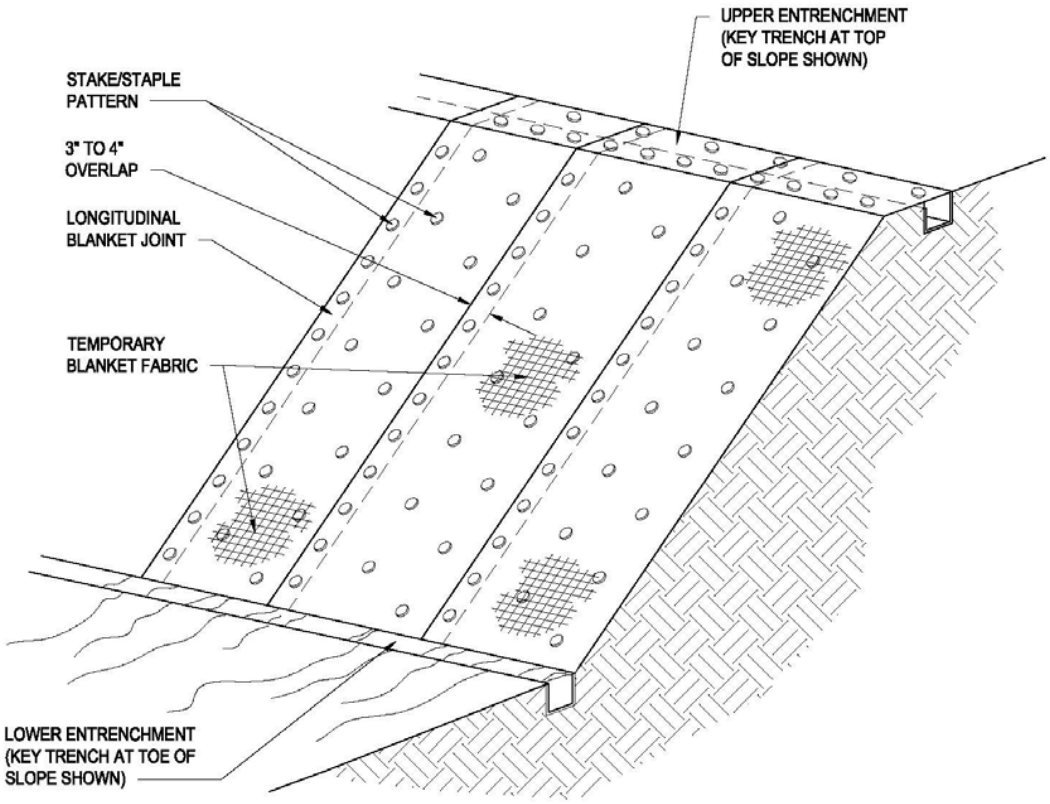
33.5 What to Inspect

- Is there evidence of undercutting at the top of slope?
- Is the slope eroding beneath the blanket?
- Are blankets firmly anchored and trenched in at top and bottom of slope?
- Are blanket segments properly overlapped?

- Are stakes properly spaced and driven into the soil to prevent the blanket from lifting away from soil?
- Is matting free from any defects or tears?
- Are there areas not adequately growing vegetation?

33.6 Maintenance

- Repair undermining or erosion.
- Repair/replace damaged blankets.
- Replace stakes and sandbags as needed.
- Reseed and fertilize areas not adequately growing vegetation.



TEMPORARY EROSION CONTROL BLANKET ON SLOPE
NOT TO SCALE

NOTES:
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS, AND GRASS. SOIL CONTACT SHALL BE MAXIMIZED.

2. LAY BLANKETS LOOSELY AND STAKE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.

3. INSTALLATION MAY VARY ACCORDING TO MANUFACTURER'S RECOMMENDATIONS. APPLY THE MORE STRINGENT REQUIREMENT.

Figure 33-1.Example of a temporary erosion control blanket on a slope

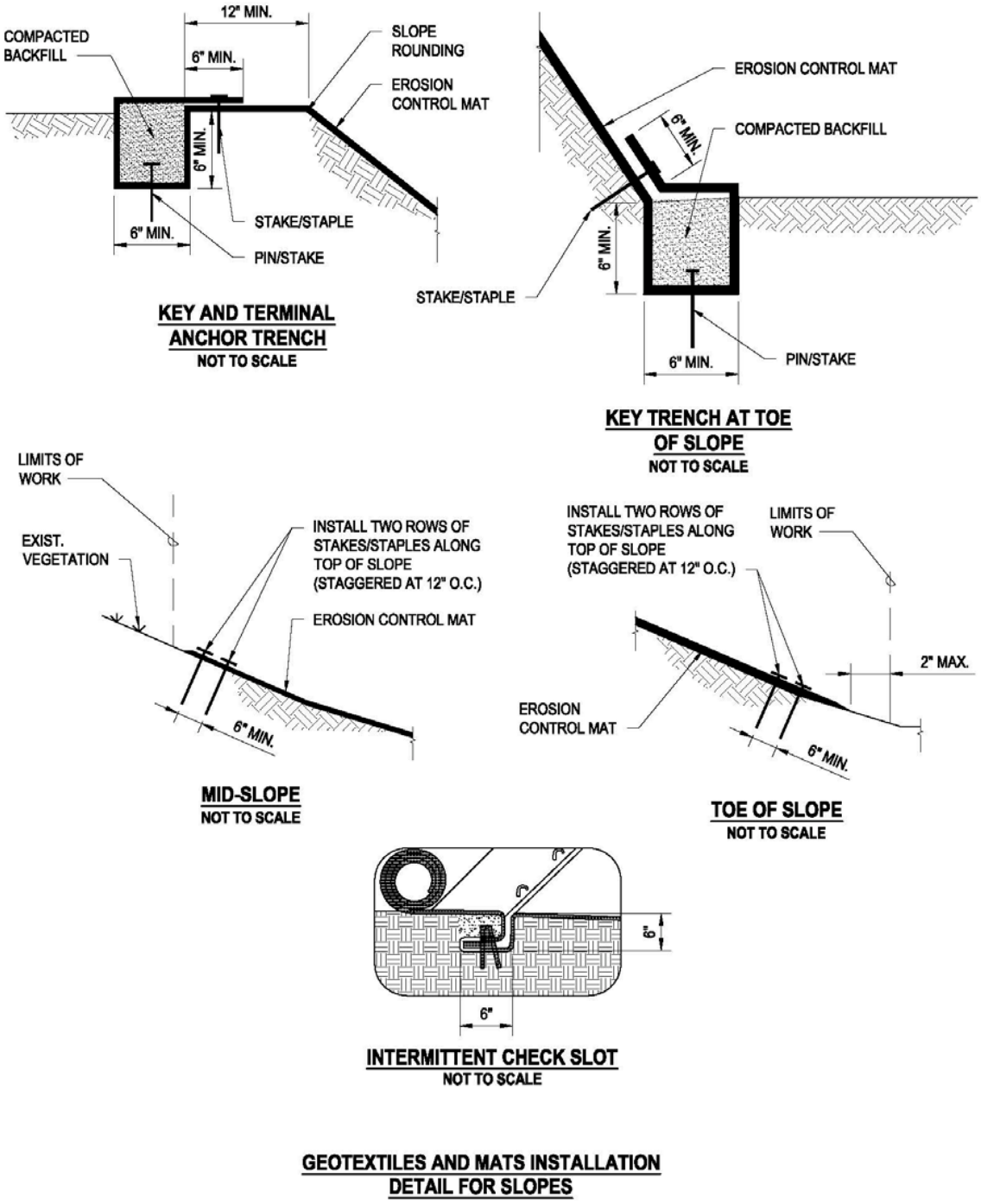


Figure 33-2. Example of the installation of geotextiles and mats

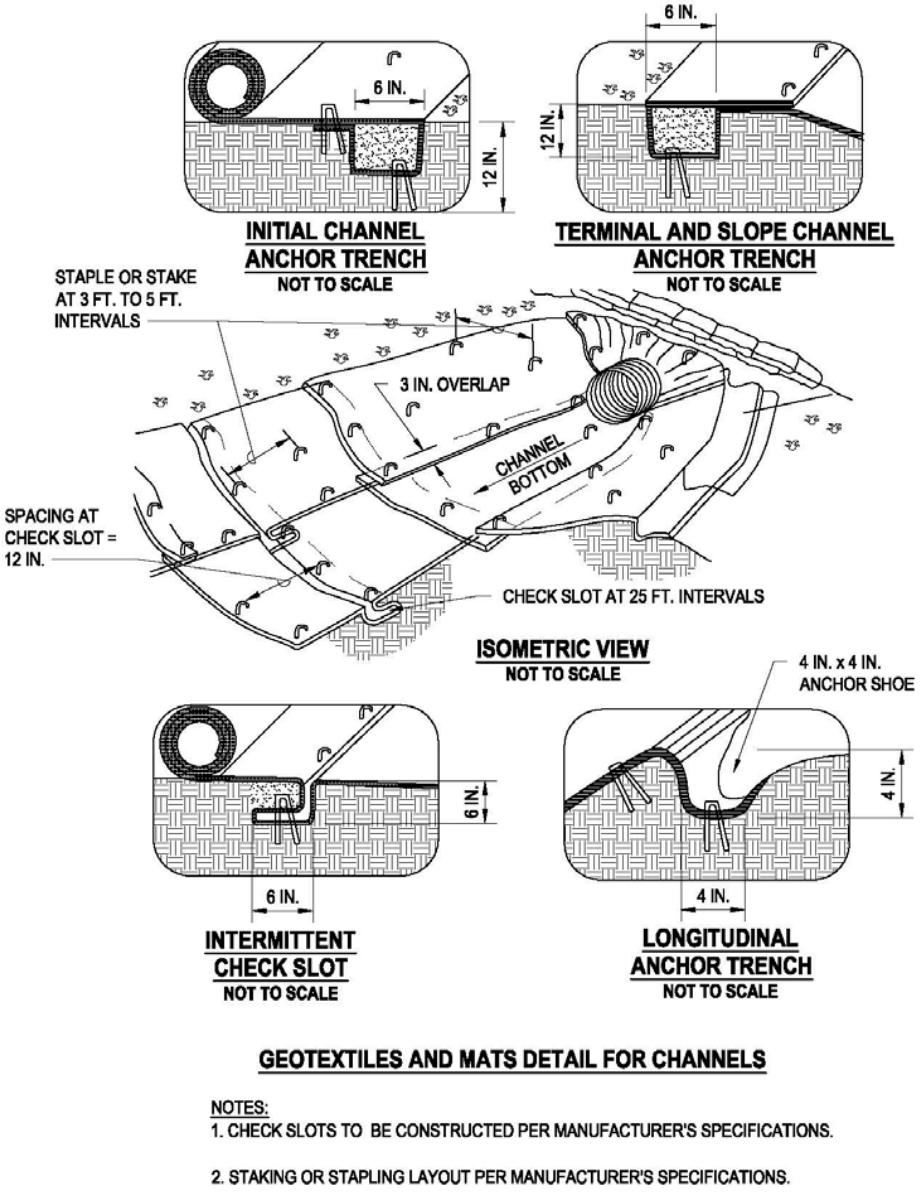


Figure 33-3. Example of installation of geotextiles and mats in channels

34 Seeding and Planting

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

34.1 Description

Practices and procedures to provide ground cover for temporary or permanent stabilization of soil.

34.2 Applications

Soil stabilization during or after the construction phase applies to the following site conditions:

- Graded/cleared areas upon temporary or permanent cessation of earth-disturbing activities
- Open space and fill areas
- Steep slopes
- Spoil piles or temporary stockpile of fill material
- Vegetated swales
- Landscape corridors
- Stream banks

34.3 Installation and Implementation

- Coordinate temporary vegetative stabilization with permanent vegetative stabilization.
- Restrict vehicle/equipment use in areas where vegetative stabilization will be used to avoid soil compaction.
- A licensed landscape architect should review the proposed vegetation to be used for the project.
- Condition the soil to promote vegetative growth prior to planting in areas where vehicle/equipment use cannot be avoided.
- Contractor shall keep records of application dates, type(s), amount of fertilizer used, and the areas covered.
- Minimize the amount of exposed soil during construction activity by phasing disturbances.
- Preserve native topsoil and vegetation where practicable.

- Use of invasive species is prohibited.
- Types of activities that constitute initiation of stabilization include the following:
- Prepping the soil for vegetative or non-vegetative stabilization.
- Applying mulch or other non-vegetative product to the exposed area.
- Seeding or planting the exposed area.
- Starting any activities listed above on a portion of the area to be stabilized, but not on the entire area.
- Finalizing arrangements to have stabilization product fully installed in compliance with the deadline for completing initial stabilization activities.
- Stabilization activities must be completed as soon as practicable, but no later than 14 days after the initiation of soil stabilization measures. If area drains to impaired waters, stabilization activities must be completed as soon as practicable, but no later than 7 days after the initiation of soil stabilization measures. Refer to the Hawaii Administrative Rules (HAR) Title 11, Chapter 55, Appendix C for more information.
- Types of activities that constitute completion of initial stabilization activities include the following:
- For vegetative stabilization, all activities necessary to initially seed or plant the area to be stabilized.
- For non-vegetative stabilization, the installation or application of all such non- vegetative measures.
- Vegetative coverage must be perennial.
- Establish uniform vegetation, which provides 70% of coverage that was provided by vegetation prior to commencing earth-disturbing activities.
- The contractor should take pictures of the area being used prior to installing BMPs. This will provide evidence of the amount of vegetation in the area prior to commencing earth- disturbing activities.
- Immediately after seeding the area the contractor shall install non-vegetative erosion controls, to the extent necessary, to provide cover to the area while vegetation is becoming established.
- Install perimeter controls around exposed areas where vegetation is becoming established to prevent sediment-laden runoff from entering storm drain systems and open waterbodies.
- Remove non-vegetative erosion controls once the area is deemed stabilized by the Engineer.

34.3.1 Seeding and Planting Application Considerations

- Type of vegetation
- Site and seedbed preparation
- Seasonal planting times
- Fertilizers
- Water

34.3.2 Grasses

- Plant vegetation immediately after Engineer approval.
- Ground preparation requires fertilization, scarification, and mechanical stabilization of the soil.
- Can tolerate short-term temperature extremes and waterlogged soil conditions.
- Appropriate soil conditions include a shallow soil base, good drainage, and 2:1 (H:V) or flatter slope.
- Quickly develops from seeds.

- Vigorous grass growth depended on mowing, irrigating, and fertilizing.
- Immediately after seeding or planting the area to be vegetatively stabilized, to the extent necessary to prevent erosion on the seeded or planted area, install non- vegetative erosion controls that provide cover (e.g., mulch, rolled erosion control products) to the area while vegetation is becoming established.

34.3.3 Trees and Shrubs

- Selection dependent on vigor, species, size, shape, and potential wildlife food source.
- Consider wind/exposure and irrigation requirements.
- Plant indigenous species where possible.

34.3.4 Vines and Ground Cover

- Lime and fertilizer required for ground preparation.
- Use appropriate seeding rates.
- Consider requirements for drainage, acidity, and ground slope.
- Plant indigenous species where possible.
- Avoid species that require irrigation.

34.3.5 Fertilizer Use

- Do not apply fertilizers or pesticides during or just before a rain event.
- Do not apply to storm water conveyance channels with flowing water.
- Comply with fertilizer and pesticide manufacturer's recommended usage and disposal instructions. Do not over apply.
- Apply fertilizers at the appropriate time of year for the location, and preferably as closely as possible to the period of maximum vegetation uptake and growth.
- Where possible, till fertilizer into soil rather than surface spreading or spraying on steep slopes.
- Minimize discharges of fertilizers containing nitrogen or phosphorus.
- Store fertilizer in original container with proper labeling, sealed, and under cover or covered with secondary containment.
- Follow federal, state, and local laws regarding fertilizer application.

34.3.6 Watering

- Quantity and frequency of watering may vary depending on type of vegetation, type of soil, location, frequency of rainfall, and slope.
- Regulate quantity of water to prevent erosion and formation of gullies.
- Temporary irrigation may be required for initial establishment of vegetation and sustained growth.
- Permanent water supply source may be required for certain types of vegetation.

34.3.7 Stabilization

- Initiate soil stabilization measures immediately whenever earth-disturbing activities have permanently or will/has temporarily ceased for 14 or more calendar days on any portion of the site to prevent erosion.

34.4 Considerations

- During dry periods without irrigation, permanent and temporary vegetation may not grow.
- Improper application of fertilizer may contribute to storm water pollution.
- Vegetative coverage must be perennial for final stabilization.
- Lack of dedicated water supply may require a temporary water source.
- Rainwater can wash away seeds and fertilizer from areas being restabilized.
- It is common for topsoil to be lost from grading, which causes the soil to lack nutrients for seeds to germinate.
- Disturbed areas may be difficult to stabilize if soil has been compacted.

34.5 What to Inspect

- Is vegetation growing?
- Is there evidence of erosion?
- Are fertilizers being properly stored and handled?
- Are fertilizers being over applied or applied in an improper area?
- Is there at least 70% vegetative coverage?
- Are temporary non-vegetative stabilization devices installed?
- Has soil been conditioned?
- Are native plants being used?
- Has the contractor initiated vegetative stabilization within the required timeframe?

34.6 Maintenance

- Water, fertilize, mow, weed, and/or prune the grasses/plants as needed.
- Repair broken or leaking water lines, sprinklers, or valves used for irrigation.
- Mow temporary plantings as needed to prevent signage/site obstructions, fire hazards, or nuisances to the public.
- Replace plants that fail to develop healthy growth, become injured, or die.
- Remove invasive species.
- Reseed areas where the grass did not grow and/or any areas affected by erosion.

35 Hydroseeding

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

35.1 Description

Application of a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydromulch equipment to temporarily protect exposed soils from wind and water erosion.

35.2 Applications

- Temporary ground cover until permanent vegetation has been established.
- Suitable for disturbed areas that will be redisturbed following an extended period of inactivity.

35.3 Installation and Implementation

- Seed type must be carefully selected based upon anticipated soil type and future irrigation. All seeds must be in conformance with the State of Hawaii Department of Agriculture (HDOA). For information on appropriate seed mixes, visit the Hawaii office of the United States Department of Agriculture, Natural Resources Conservation Service (NRCS) website.
- Avoid use of hydroseeding in areas where future earthwork activities will commence.
- Roughen the slope, fill area, or area to be seeded with the furrow trending along the contours prior to application of hydroseed. Rolling with a crimping or punching type roller or track walking is required on all slopes prior to hydroseeding. See 26 Slope Roughening, Terracing, and Rounding for more information.
- Apply mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- Avoid spraying hydroseed onto sidewalks, lined drainage channels, roads, and existing vegetation.

35.4 Evaluation of Site Conditions Considerations

The following items should be considered to select the appropriate hydroseeding mixtures.

- Soil conditions
- Site topography
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

35.5 Considerations

- Steep slopes are difficult to protect with temporary seeding.
- Hydroseeding shall only be used when there is sufficient time to ensure adequate vegetation establishment and provide adequate erosion control.
- Temporary seeding may not be appropriate without supplemental irrigation.
- Temporary vegetation may have to be removed before permanent vegetation is applied.
- Hydroseeding shall not be used in areas subject to heavy traffic.
- To ensure complete coverage over roughen terrain, hydroseeding may have to be applied from multiple angles and sides.

35.6 What to Inspect

- Is there evidence of erosion?
- Are there bare areas that need to be reseeded?
- Is an irrigation system installed?
- Does the irrigation system apply complete coverage to the desired areas?
- Is the irrigation system working?
- Are there any areas of exposed soil showing?

35.7 Maintenance

- Are there any areas of exposed soil showing?
- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Replace ornamental and landscape mulches of bark or wood chips if soil is visible in more than 75% of the designated area.
- Follow-up applications must be made as needed to cover weak spots and to maintain adequate soil protection.
- If erosion has occurred, additional mulch may be required. Eroded areas need to be repaired prior to additional mulch being added.

36 Mulching

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

36.1 Description

Application of loose bulk material to stabilize disturbed soil by protecting bare soil, increasing infiltration, and reducing runoff. Materials suitable for mulching include green material, vegetable fibers (hay or straw), and wood/bark chips.

36.2 Applications

- Temporary ground cover until permanent vegetation has been established.
- Method may be used in combination with temporary or permanent seeding to enhance plant growth.
- Areas requiring soil moisture retention to prevent cracking of the soil.
- Ground cover for exposed soil between trees or shrubs.
- Mulch should be used in conjunction with other BMPs for optimal erosion control, especially on slopes.

36.3 Installation and Implementation

36.3.1 Vegetable Fibers (Hay or Straw)

- Loose hay or straw which may be used in combination with seeding. Mulching usually follows seeding and the process is described in the following:
- Apply seed and fertilizer to bare soil.
- Apply loose hay or straw over top of seed and fertilizer prior to seed germination.
- Apply at a rate of 2,000 pounds per acre by machine or hand distribution.
- Evenly distribute mulch on the soil surface to cover 80% to 90% of the ground.
- Maintain maximum fiber length. Average fiber length shall be greater than 6 inches.

- Use a tackifier, netting, or mechanical “punching” method to anchor mulch. “Punching” refers to the act of crimping or compressing to anchor to the ground. Methods depends on slope steepness, accessibility, soil conditions, and longevity.
- Punching straw or hay to anchor the mulch to the ground is the preferred method of anchoring mulch for the following conditions:
- Use a spade or shovel on small areas.
- Use a knife-blade roller or straight bladed coulter (“crimper”) on slopes with soil, which can support construction equipment without undesirable compaction or instability.
- Use plastic netting or jute on small areas and/or steep slopes. Geotextile pins, wooden stakes, or 11-gauge wire staples shall secure netting in place. This condition warrants consideration of the use of matting rather than mulch.
- Use tackifiers on steep slopes unable to support construction equipment or large application areas where use of nettings, straw, or hay is not cost- effective. Tackifiers glue vegetable fibers together and to the soil surface until the establishment of permanent vegetation.

36.3.2 Green Material

- Consists of recycled vegetation trimming such as grass and shredded shrubs and trees.
- Generally applied manually.
- Temporary ground cover with or without seedings.
- Evenly distribute green material on soil surface. Depth shall not exceed 4 inches.
- Anchor with a tackifier or netting on steep slopes or for areas with anticipated overland sheet flow. The condition warrants consideration of the use of matting rather than mulch.

36.3.3 Wood/Bark Chips

- Suitable for areas which will not be mowed such as around trees, shrubs, and landscape plantings.
- Test soils prior to application. Add a minimum of 12 pounds of nitrogen per ton of mulch to counteract the effect of decomposing wood-based materials, which extract nitrogen from soil. Use a balanced, slow-release fertilizer or an organic source such as compost.
- Apply mulch manually.
- Evenly distribute wood/bark chips on soil surface and maintain a 2-inch mulch depth to tree basins and a 4-inch mulch depth to shrub beds.

36.4 Considerations

36.4.1 Vegetable Fibers (Hay or Straw)

- Requires 3-step machinery.
- Labor intensive installation.
- For applications using straw blowers, the applicable area must be located within 150 feet of a road or surface capable of supporting loads from large vehicles. Use of straw is preferred, in lieu of hay, if available.
- Avoid applying fibers prior to an anticipated rain event.

- **Green Material**

- Limited commercial availability.
- Variable quality.
- Application primarily uses manual labor.
- Unpredictable effectiveness as an erosion control measure. Requires overspray with a tackifying agent to increase effectiveness.
- Application of fertilizer may be required.
- Limit use to non-critical steep slopes and areas where alternative erosion control measures may be readily applied. A critical slope surface exists when a combination of soil and slope factors create a high potential for slope face failure and subsequent erosion, such as a slope greater than 2:1 (H:V) on freshly graded or disturbed slopes. Refer to Slope Face Stabilization for Critical Slope Surfaces at website – www.ccriindia.org/pdf/Object335PDFEnglish.pdf for more information on critical slopes.

36.4.2 Wood/Bark Chips

- Poor erosion control effectiveness.
- Anchoring of chips onto sleep slopes is difficult due to potential movement from high winds.
- Subject to displacement from concentrated flows.
- Use of fertilizer with a high nitrogen content is required. This is to prevent nutrient deficiency in plants due to the decomposing wood-based materials, which extract nitrogen from soil. Improper fertilizer use may contribute to water quality pollution.
- Limit use to non-critical steep slopes and areas where alternative erosion control measures may be readily applied.

36.5 What to Inspect

- Is mulch applied to areas which will be regraded and/or revegetated?
- Is there uniform coverage of mulch?
- Was the application rate sufficient for the area?
- Is there evidence of rills or gullies?

36.6 Maintenance

- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Replace ornamental and landscape mulches of bark or wood chips if soil is visible in more than 75% of the designated area.
- If erosion has occurred, additional mulch may be required.

37 Hydromulching

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

37.1 Description

Application of loose bulk material to stabilize disturbed soil by protecting bare soil, increasing infiltration, and reducing runoff. Materials used for mulching include hydraulic matrices, hydraulic mulches of recycled paper or wood fiber.

37.2 Applications

- Temporary ground cover until permanent vegetation has been established.
- Method used in combination with temporary or permanent seeding to enhance plant growth.
- Areas requiring soil moisture retention to prevent cracking of the soil.
- Ground cover for exposed soil between trees or shrubs.
- Mulch should be used in conjunction with other BMPs for optimal erosion control, especially on slopes.

37.3 Installation and Implementation

37.3.1 Hydraulic Mulches of Recycled Paper

- Consists of recycled newsprint, magazines, and other wastepaper sources.
- May be applied with or without tackifiers.
- Hydraulic mulch materials shall conform to 2005 Hawaii Standard Specifications for Road and Bridge Construction, Standard Specifications & Special Provisions Sections 209, 619 & 641, as in effect.

- Mix mulch in a hydraulic application machine (hydroseeder) and apply as a liquid slurry.
- May be sprayed from a cannon up to 200 feet or from a hose up to 1,500 feet away from the application area.
- Mix mulch with seed and fertilizer as specified by the manufacturer. Apply mulch at the manufacturer's recommended rate to ensure uniform and effective coverage.
- Mulch used as temporary ground cover shall be reapplied to bare areas until permanent vegetation has been established.
- Avoid spraying mulch onto sidewalks, lined drainage channels (i.e., concrete swales and concrete culverts), travelway areas, and existing vegetation.

37.3.2 Hydraulic Mulches of Wood Fiber:

- Consists of wood waste from lumber mills or urban sources.
- May be manufactured with or without a tackifier.
- Hydraulic mulch shall conform to 2005 Hawaii Standard Specifications for Road and Bridge Construction, Standard Specifications & Special Provisions Sections 209, 619, & 641, as in effect. Mix mulch in a hydraulic application machine (hydroseeder) and apply as a liquid slurry.
- Mix mulch with seed and fertilizer as specified by the manufacturer.
- Apply mulch at the manufacturer's recommended rate to ensure uniform and complete coverage.

37.3.3 Hydraulic Matrices

- Hydraulic slurries consisting of wood fiber, paper fiber, or a combination of wood and paper fiber mixed with a binder system.
- Exceeds erosion control performance of blankets due to close contact with soil.
- Apply as an aqueous slurry (with seed) using standard hydroseeding equipment.
- Application rates vary for different combinations of conditions and products.

37.3.4 Bonded Fiber Matrix (BFM) Consisting Of Premixed Fiber And Binders

- After application and upon drying, BFM shall adhere to soil and form a 100% cover. The cover shall be biodegradable, promote vegetation, and prevent soil erosion.
- Are composed of long strand, thermally produced wood fibers (>88% of total volume by weight), held together by organic tackifiers (10%) and mineral bonding agents (<2%), which become insoluble and non-dispersible upon drying. Composition of BFM varies based on supplier.
- Perform a free liquid quality control test on the liquid slurry.
- Binder shall not dissolve or disperse upon watering.
- Upon applications to the soil, holes in the matrix shall not exceed 0.04 inches in size.
- There shall not be any gaps between the matrix and the soil.
- Minimum water holding capacity of the matrix shall be 1.2 gallons per pound matrix.
- The matrix shall be free of germination of growth inhibiting factors and shall not form a water-resistant crust.
- Materials used for the matrix shall be 100% biodegradable and 100% beneficial to plant growth.
- Testing and evaluation of the matrix by an independent research laboratory shall have been conducted to verify reported erosion control performance.
- A trained and manufacturer certified applicator with knowledge of proper mixing and product application shall install the BFM.

- Typical BFM application rates range from 3,000 to 8,000 pounds per acre per recommendations from various manufacturers.
- BFM shall not be applied 24 hours before an anticipated rain event, during a rainfall event, or immediately after a rainfall event to ensure a drying time of 24 hours after installation.

37.4 Considerations

37.4.1 Hydraulic Mulches of Recycled Paper

- Limited erosion control effectiveness due to short fiber length and absence of a tackifier.
- Limited moisture and soil temperature moderation.
- Residual inks within mulches may be undesirable in environmentally sensitive areas.
- Significant decrease in longevity compared with wood fiber mulch.
- Difficulty budgeting for this product due to volatile prices for recycled paper products.

37.4.2 Hydraulic Mulches of Wood Fiber

- Limited erosion control effectiveness.
- Short-term use of 1 growing season.

37.4.3 Hydraulic Matrices

- Avoid applying mulch 24 hours before an anticipated rainfall event, during a rainfall event, or immediately after a rainfall event.
- Hydromulch requires a drying time of 24 hours.
- To ensure complete coverage over roughen terrain, hydromulch may have to be applied from multiple angles and sides.

37.5 What to Inspect

- Is mulch applied to areas which will be regraded and/or revegetated?
- Is there uniform and complete coverage?
- Was the application rate sufficient for the disturbed area?
- Is there evidence of rill or gullies?

37.6 Maintenance

- Mulches applied to seeded areas may be disturbed due to wind or runoff. Recover exposed areas until permanent vegetation has been established.
- Replace ornamental and landscape mulches of bark or wood chips if soil is visible in more than 75% of the designated area.
- If erosion has occurred, additional mulch may be required.

38 Soil Binders

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

38.1 Description

Application of soil binders to exposed soil to temporarily prevent water- and wind- induced erosion.

38.2 Applications

- Disturbed areas requiring short-term temporary protection.
- Good alternative to mulches in areas where grading activities will soon resume.
- Suitable for use on stockpiles.
- Applied in conjunction with mulching or seeding applications.

38.3 Installation and Implementation

- Soil types will dictate appropriate soil binders to be used.
- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and must not stain paved or painted surfaces. Soil binders must not pollute storm water. Prior to application, submit the manufacturer's material product data sheets to the Engineer for review and approval.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.
- Avoid overspray onto roads, sidewalks, lined drainage channels (i.e., concrete swales and concrete culverts), existing vegetation, etc.

38.3.1 Selecting A Soil Binder

- Properties of common soil binders used for erosion control are provided in Table 38-3. Use the Table to select an appropriate soil binder.
- Consult with the Engineer if soil binders are an appropriate option for temporary stabilization.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation
- Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders.
- Soil types and surface materials
- Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
- Frequency of application
- The frequency of application can be affected by subgrade conditions, surface type, climate, and maintenance schedule. Frequent applications could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment cleanup.

38.3.2 Plant-Material Based (Short-Lived) Binders

- Guar: Guar is a non-toxic, biodegradable, natural galactomannan (or plant carbohydrates/sugars) based hydrocolloid treated with dispersant agents for easy field mixing. It must be mixed with water at the rate of 11 to 15 pounds per 1,000 gallons. Recommended minimum application rates are as provided in Table 38-1.
- Psyllium: Psyllium is composed of the finely ground mucilloid coating of seeds (from Plantago plant) 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 rewettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12- to 18-hours drying time. Application rates must be 80 to 200 pounds/acre, with enough water in solution to allow for a uniform slurry flow.
- Starch: Starch is non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 pounds/acre. Approximate drying time is 9 to 12 hours.

Table 38-1 Application rates for Guar soil stabilization

Slope Gradient (H:V)	Pounds/Acre
Flat	40
4:1	45
3:1	50
2:1	60
1:1	70

38.3.3 Plant-Material Based (Long-Lived) Binders

- Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin must be a minimum of 26% of the total solids content. The soil stabilizer must 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 and must be applied as follows:
- For clayey soil: 5-parts water to 1-part emulsion.
- For sandy soil: 1-part water to 1-part emulsion.
- Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

38.3.4 Polymeric Emulsion Blend Binders

- 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 in accordance with manufacturer's recommendations and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after applications.
- 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, as described in Table 38-2.
- Polyacrylamide and Copolymer of Acrylamide: Linear copolymer polyacrylamide is packaged as a dry flowable solid. When used as a standalone stabilizer, it is diluted at a rate of 11 pounds/1,000 gallons of water and applied at the rate of 5 pounds/acre.
- Hydro-Colloid Polymers: Hydro-Colloid Polymers are various combinations of dry flowable polyacrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 pounds/acre. Drying time is 0 to 4 hours.

Table 38-2 Application rates for copolymers of sodium acrylates and acrylamides

Slope Gradient (H:V)	Pounds/Acre
Flat to 5:1	3 – 5
5:1 to 3:1	5 – 10
2:1 to 1:1	10 – 20

38.3.5 Cementitious-Based Binders

- 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%. It is mixed in a hydraulic seeder and applied at rates of 4,000 to 12,000 pounds/acre. Drying time is 4 to 8 hours.

38.3.6 Applying Soil Binders

- After selecting an appropriate soil binder, the untreated soil surface must be prepared before applying the soil binder. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. The following steps shall be followed:
- Follow manufacturer's specifications for application rates, pre-wetting of application area, and cleaning of equipment after use.
- Prior to application, roughen embankment and fill areas.
- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders shall not be applied during or immediately before rainfall.
- Avoid overspray onto roads, sidewalks, drainage channels (i.e., concrete swales and concrete culverts), sound walls, existing vegetation, etc. Soil binders shall not be applied to areas with standing water, under rainy conditions, or when the temperature is below 40° Fahrenheit during the curing period.
- More than 1 treatment is often necessary, although the second treatment may be diluted or have a lower application rate.
- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's instructions for specific cure time.
- For liquid agents:
- Crown or slope ground to avoid ponding.
- Uniformly pre-wet ground at 0.03 to 0.3 gallons/yard^2 or according to manufacturer's recommendations.
- Apply solution under pressure. Overlap solution 6 to 12 inches.
- All treated area to cure for the time recommended by the manufacturer; typically, at least 24 hours.
- Apply second treatment before first treatment becomes ineffective, using 50% application rate.
- In low humidity, reactivate chemicals by rewetting with water at 0.1 to 0.2 gallons/yard^2.

38.4 Considerations

- Soil binders are temporary in nature and may need reapplication.
- Some soil binders may not be compatible with existing vegetation.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer.
- Soil binders may need reapplication after a rain event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.

- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.
- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- Soil binders may not cure if low temperatures occur within 24 hours of application.
- A sampling and analysis plan should be incorporated into the Storm Water Pollution Prevention Plan (SWPPP), as soil binders could be a source of non-visible pollutants.

38.5 What to Inspect

- Has soil binder broken down due to natural elements?
- Is there evidence of erosion?
- Does the soil binder need to be reapplied?
- Are the soil binders an effective BMP for the area?

38.6 Maintenance

- Repair areas where erosion is evident and reapply BMPs as soon as possible. Care must be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.

Table 38-3 Properties of soil binders used for erosion control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short-lived)	**Plant Material Based (Long-lived)**	**Polymeric Emulsion Blends**	**Cementitious-Based Binders**
Relative Cost	Low	Low	Low	Low
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time Before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/ Powder	Powder	Liquid	Liquid/powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies	Varies	Varies	4,000 to 12,000 pounds/acre

39 Storm Drain Inlet Protection

39.1 Description

Devices installed at storm drain inlets that detain large objects and sediment-laden runoff prior to entering the storm drain system. These devices are often the last treatment measure, so a layered BMP approach is crucial to mitigating sediment-laden runoff from entering the MS4 or storm drainage system, including surface waters.

39.2 Applications

- All storm drain inlets, both within the project limits and beyond the project limits, that may intercept sediment-laden runoff from the construction site shall be protected prior to commencing land-disturbing activity.
- Where disturbed areas have not been stabilized.

39.3 Installation and Implementation

- Install inlet protection devices prior to upgradient land-disturbing activity.
- Inlet protection causes ponding, which is necessary to allow the sediment to settle. The storm drain inlet must not be completely blocked when public safety is of concern.
- The contractor shall monitor the weather for rainfall events and coordinate with the Engineer to adjust inlet protection to prevent hazardous conditions and flooding.
- For maximum effectiveness, minimize the demand on inlet protection devices by installing and maintaining erosion and sediment control devices upslope of the inlet.

- Immediately stabilize slopes and disturbed areas that are no longer active to reduce potential runoff. Inlet protection shall only be removed once disturbed areas upgradient of the catch basin has been stabilized.
- Grated drop inlets and curb inlets/catch basins are the 2 types of inlets most present on construction sites. There are various types of BMP devices that are applicable in protecting these inlets from accepting sediment-laden runoff.

39.3.1 Grated Drop Inlet (GDI)

- Installing a geotextile filter fabric under the grate to cover the insert is a common inexpensive practice to prevent sediment from entering the GDI. The fabric should be placed fully under the grate to completely shield the inlet. Allow 6 inches, minimum, of excess fabric to extend past the grate on all sides. The fabric is easily clogged by sediment. Other methods are preferred such as a witch's hat, which will facilitate drainage while filtering sediment.
- Compost filter socks or sand bags can be placed around the perimeter of the GDI, to divert and/or detain storm water before it enters the inlet. See section 44 Compost Filter Berm/Sock and section 46 Sandbag Barrier for more information.

The following list below are applicable devices for GDI's:

- Geotextile filter fabric fence.
- Geotextile filter fabric under grate.
- Witch's hat
- Inbox protection.
- Fiber roll with additional in box protection.
- Sand bag, rock bag, or snake bag.

39.3.2 Curb Inlet/Catch Basin

- Devices installed at curb inlets are in place to prevent sediment-laden runoff from entering the storm drain. An ample amount of space must be provided to allow water to pond around the inlet. This allows the sediment to settle, as the storm water slowly enters the MS4.
- Devices must extend at least 1 foot past the inlet insert on both sides, unless manufacturer's specifications differ.
- Non-destructive supporting brackets may be used to prevent inlet protection devices from falling into the curb inlet/catch basin.
- Ensure flooding of nearby properties or impeding traffic is avoided.
- Use check dams to reduce the demand of sediment-laden runoff flowing towards a curb inlet. See section 41 Check Dams for more information.
- In addition to the methods of inlet protection described above, there are other effective methods and proprietary devices, which may also be used. These are limited to drainage areas that are less than 1 acre, unless a sediment trap intercepts the runoff prior to reaching the inlet protection device.
- Other proprietary devices may be used and shall be installed per manufacturer's recommendations.

39.4 Considerations

- Short-term flooding at a protected inlet will occur but must not become a traffic or pedestrian hazard.
- Drainage area is limited to 1 acre or less.
- Straw bales shall not be used for inlet protection.
- Runoff on slopes may bypass protected inlets.
- In the event of a severe storm event where flooding conditions will likely be an issue; the contractor may be directed by the Engineer to remove inlet protection. The inlet protection must be reinstalled immediately following the event.
- Geotextile filter fabric used to protect GDI inserts must be cleaned or replaced often due to the limited capacity of sediment the device can hold.
- Inlet protection devices can be tedious to maintain and become ineffective when sediment accumulates. Regular maintenance is required.
- Inlet protection is the last line of defense, which requires proper erosion and sediment controls in place upgradient.
- Inlet protection BMPs that completely block the insert will cause ponding that could create a traffic and pedestrian hazard or cause damage to nearby properties.
- Some GDI grates require heavy machinery to remove the grate to install geotextile filter fabric.

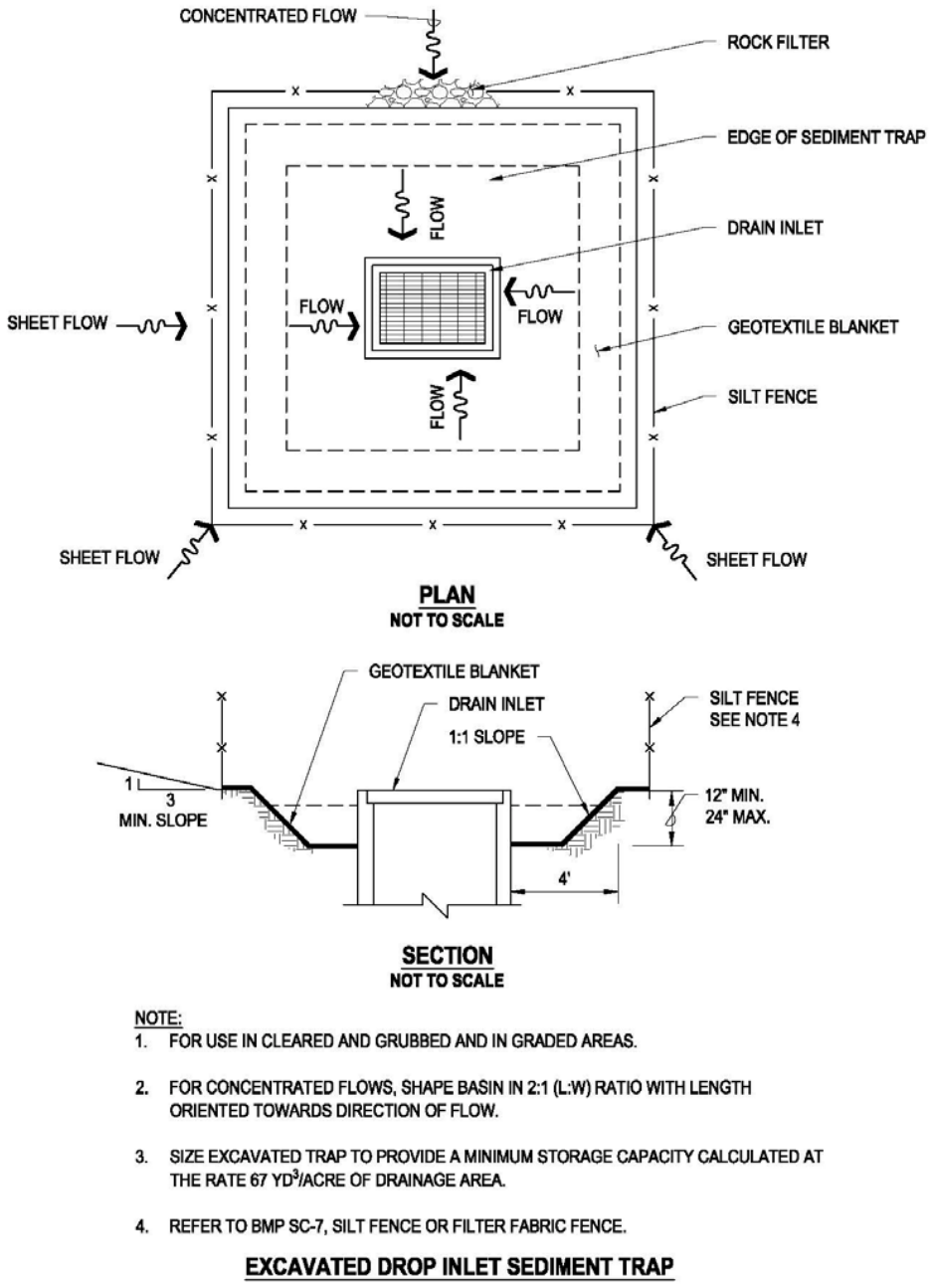
39.5 What to Inspect

- Is proper contact made against curb and gutter to prevent water from undercutting or bypassing inlet protection?
- Can sediment enter catch basin from the top or backside of the structure?
- Is sediment accumulated in front or inside of the inlet protection?
- Is the catch basin insert installed properly and being maintained per manufacturers guidelines?
- Is BMP falling into the inlet?
- Does sediment need to be removed?
- Are there rips/tears in BMP that will allow sediment to bypass it?
- Are compost filter socks damaged with rips/tears that expose the compost media?
- Is there evidence of sediment settling in front of the storm drain following a rain event?

39.6 Maintenance

- Routine maintenance should be initiated the same day the deficiency is identified and completed by the end of the same business day.
- Installation of a new erosion or sediment control device or a significant repair to a device shall be completed within 7 calendar days.
- Immediately replace clogged geotextile filter fabric or stone filters.
- Devices must be inspected, and all accumulated sediment removed before and after each rainfall event.
- During prolonged rainfall events, remove accumulated sediment when depth reaches one-half of the filter height or one-half of the sediment trap depth.
- Remove inlet protection only after stabilization of upstream soils and sweeping of streets is completed. Properly dispose of trapped sediment.
- Clean, remove, or replace protection measures as sediment accumulates, filter becomes clogged, and/or performance is compromised.

- When there is evidence of sediment accumulation adjacent to the inlet protection measures, remove deposited sediment by the end of the same day in which it is found or by the end of the following work day if removal by the same day is not possible.
- Devices that fall into inlets must be pulled out and repositioned. Devices must be installed per the manufacturer's specifications and procedures for proper effectiveness.
- Address devices experiencing flow bypasses over, underneath, or around the sides of the BMP.
- Regularly maintain inlet protection devices to abide by manufacturer's specifications.

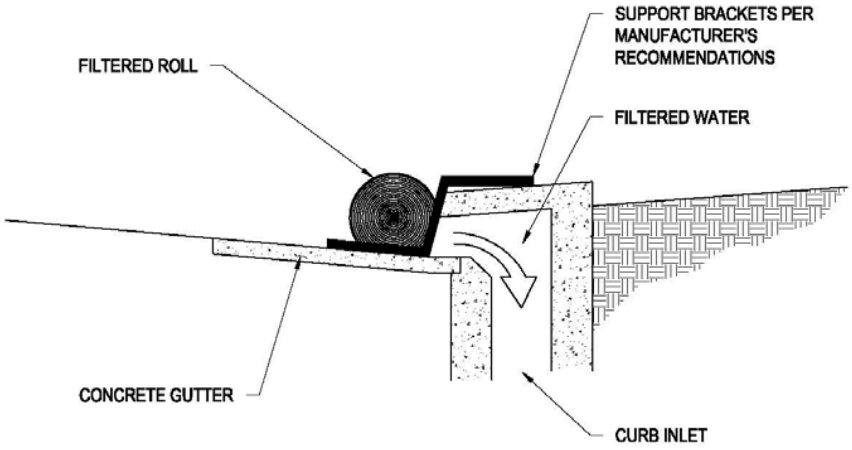


NOTE:

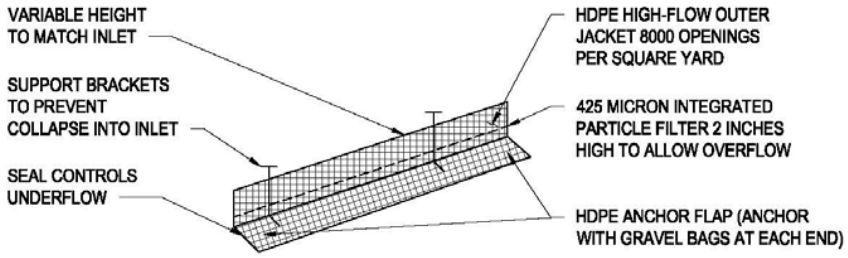
1. FOR USE IN CLEARED AND GRUBBED AND IN GRADED AREAS.
2. FOR CONCENTRATED FLOWS, SHAPE BASIN IN 2:1 (L:W) RATIO WITH LENGTH ORIENTED TOWARDS DIRECTION OF FLOW.
3. SIZE EXCAVATED TRAP TO PROVIDE A MINIMUM STORAGE CAPACITY CALCULATED AT THE RATE 67 YD^3/ACRE OF DRAINAGE AREA.
4. REFER TO BMP SC-7, SILT FENCE OR FILTER FABRIC FENCE.

EXCAVATED DROP INLET SEDIMENT TRAP

Figure 39-1. Example of an excavated drop inlet sediment trap



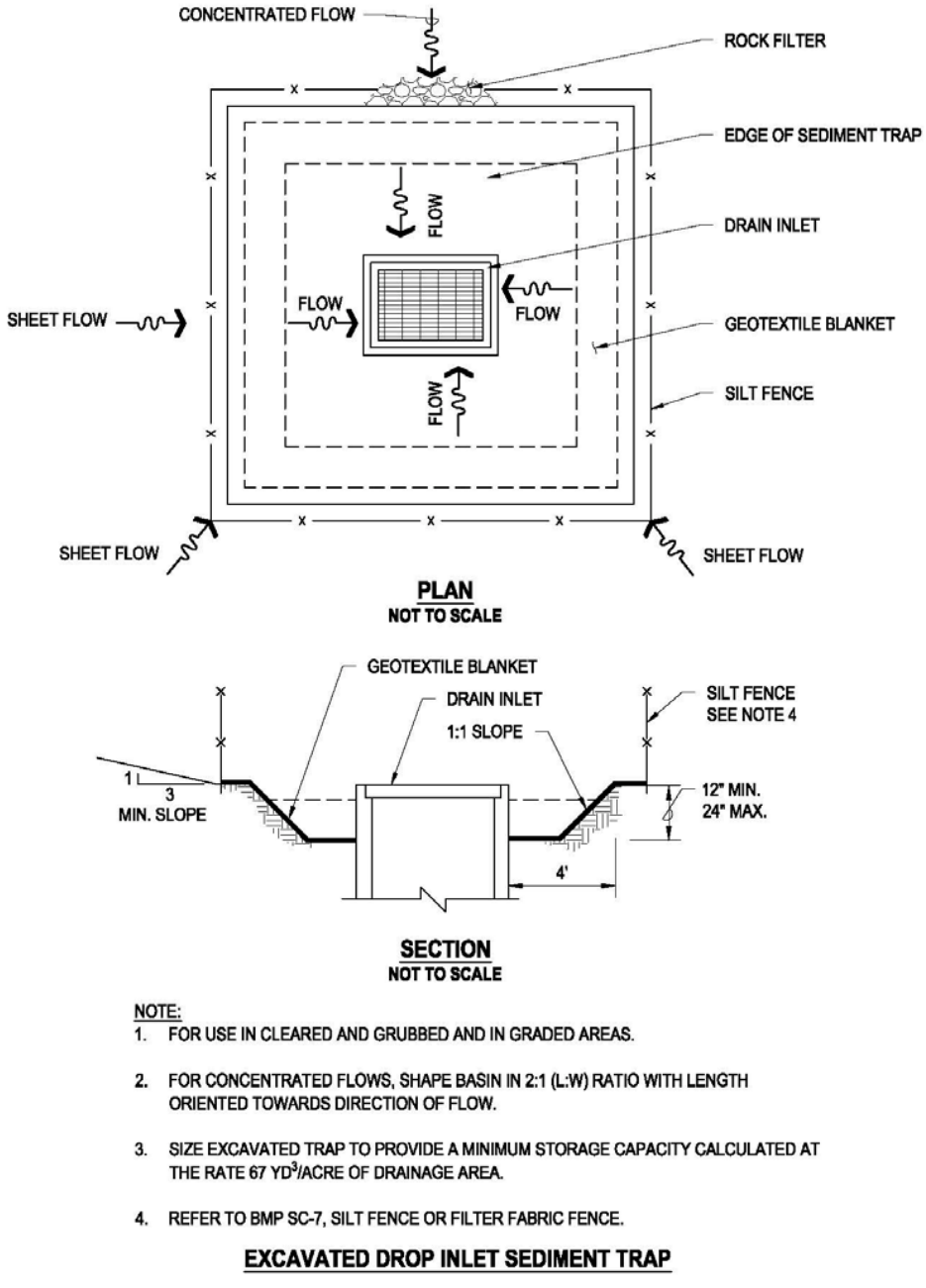
FILTER ROLL WITH SUPPORTS FOR CURB INLET
NOT TO SCALE



NOTES:
1. ADD GRAVEL BAGS AT ENDS AND EACH OVERLAP.

GEOTEXTILE INSERT WITH SUPPORTS FOR CURB INLET
NOT TO SCALE

Figure 39-2. Example of a geotextile insert with supports



NOTE:

1. FOR USE IN CLEARED AND GRUBBED AND IN GRADED AREAS.
2. FOR CONCENTRATED FLOWS, SHAPE BASIN IN 2:1 (L:W) RATIO WITH LENGTH ORIENTED TOWARDS DIRECTION OF FLOW.
3. SIZE EXCAVATED TRAP TO PROVIDE A MINIMUM STORAGE CAPACITY CALCULATED AT THE RATE 67 YD^3/ACRE OF DRAINAGE AREA.
4. REFER TO BMP SC-7, SILT FENCE OR FILTER FABRIC FENCE.

EXCAVATED DROP INLET SEDIMENT TRAP

Figure 39-3. Example of an excavated drop inlet sediment trap

40 Vegetated Filter Strips and Buffers

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

40.1 Description

Vegetative buffer strips and channels help to protect ditches and banks from erosion, increase infiltration, and remove pollutants from surface runoff providing protection to downstream receiving inlets and waterbodies.

40.2 Applications

- Any site suitable for establishment of vegetation.
- Vegetated buffer strips are appropriate for uncurbed, paved areas; steep slopes; potentially unstable slopes; and areas adjacent to sensitive waterbodies and state waters.
- Vegetated channels are appropriate for surface runoff conveyed by channels to downstream inlets or receiving waters.

40.3 Installation and Implementation

- Minimize the disturbance to existing vegetation at the site when installing a filter strip. Proper care of existing vegetation before and after construction is required. See section 17 Preservation of Existing Vegetation for more information.
- If a boundary of the disturbed area is within 50 feet of state waters, comply with 1 of the following:
- Provide and maintain a 50-foot undisturbed natural buffer and sediment control.
- Provide and maintain an undisturbed natural buffer that is less than 50 feet and double sediment control (e.g., double perimeter control) spaced a minimum of 5 feet apart.
- If it is infeasible to provide and maintain an undisturbed natural buffer of any size, provide and maintain double sediment control (e.g., perimeter control) spaced a minimum of 5 feet apart and complete stabilization within 7 calendar days of the temporary or permanent cessation of earth-disturbing activities.

- Hawaii Revised Statutes Title 13. Planning and Economic Development 205A. Coastal Zone Management defines "shoreline" as "the upper reaches of the wash of the waves at high tide during the season of the year in which the highest wash of the waves occurs, excluding storm surge or seismic action". The shoreline is considered the starting point for any buffer/filter strips employed during construction. Perimeter control BMPs must be placed according to where the shoreline has been defined.
- Vegetation must be fully established before storm water flows through the buffer. Vegetation used should be competitive with common weed species in area.
- Installation of a buffer strip with new vegetation shall comply with the following:
- Prior to cultivation of the designated buffer strip area, remove and dispose of all weeds and debris in accordance with the following:
- During construction, strip and stockpile good topsoil for surface preparation purposes prior to planting activities.
- Plant the area upon completion of grading in the area.
- Do not remove trees to create an area for vegetated filter strips.
- Vegetated filter strips shall be sloped 5% or less. This allows the storm water to be pulled down the slope by gravity, while moving slow enough to allow sediment and pollution removal.
- Fine grade and roll areas to be planted after cultivating soil and, if applicable, installing the irrigation system.
- Provide additional watering or irrigation of vegetation to supplement rainfall until vegetation has been established.
- Fertilize vegetation in accordance with manufacturer's instructions and grass/soil requirements determined by testing of the soil.
- Soil should not be compacted. Loosen soil and add top soil as needed before seeding.
- Vehicular traffic passing through vegetated buffer strips or channels shall be avoided to protect vegetation from damage and maximize its effectiveness.
- Comply with applicable regulations and manufacturer's instructions when applying fertilizers, pesticides, soil amendments, or chemicals
- Wider filter strips will be more effective and remove finer sediments.
- Vegetated filter strips should be a minimum width of 5 feet.
- Buffer strip edges should have dense growth to breakup concentrated flow.
- Seeding activities shall comply with the following:
- Add soil amendments such as fertilizer when preparing seedbed. Apply mulch after seeding to protect vegetation during establishment. Select an appropriate seed mixture based on site conditions.
- Seed mixture should receive approval in writing prior to installation.
- Native plants should be prioritized, but non-native plants can be used if accepted by the Engineer.
- Dense grasses are more effective in reducing flow velocities and removing sediment. Thick root structures are necessary for erosion control.

- Use proper equipment and methods to ensure uniform distribution and appropriate seed placement.
- Overseed, repair bare spots, and apply additional mulch as necessary.
- Sodding activities shall comply with the following:
- Protect sod with tarps or other types of protective covering during delivery and do not allow sod to dry between harvesting and placement.
- Restore any irregular or uneven areas observed prior to or during the plant establishment period to a smooth and even appearance.
- Ensure ground surface is smooth and uniform prior to placing sod.
- Areas which will be planted with sod and are adjacent to paved surfaces such as sidewalks and concrete headers, shall be 1.5 ± 0.25 inches below the top grade of the paved surface after fine grading, rolling, and settlement of the soil.
- Stagger the ends of adjacent strips of sod a minimum of 24 inches apart.
- Place edges and ends of sod firmly against paved borders.
- Lightly roll sodded area to eliminate air pockets and ensure close contact with the soil after placement of the sod.
- Water the sodded area to moisten the soil to a depth of 4 inches after rolling.
- Do not allow sod to dry.
- Avoid planting sod during extremely hot or wet weather.
- Sod shall not be placed on slopes steeper than 3:1 (H:V) if the area will be mowed.

40.4 Considerations

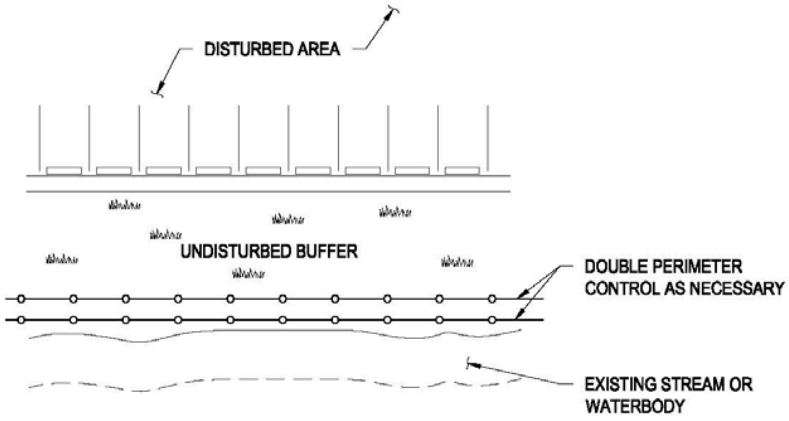
- Site conditions such as availability of land.
- Flow depth and vegetative condition determine BMP effectiveness.
- May require irrigation to maintain vegetation.
- High maintenance requirements may exist depending on the design condition of the vegetation.
- Unless existing vegetation is used as a buffer strip, an area will need to be provided specifically for a buffer strip and vegetation will need to be established.
- Maintaining sheet flow in buffer strips may be difficult.
- Vegetated channels require a larger area than lined channels.
- Vegetated channels require gradual slopes since runoff with high flow velocity may flow over grass rather than through it. Buffer zones do not replace the requirement for site sediment control.
- BMP performance depends on topography and climate conditions for the specific site.

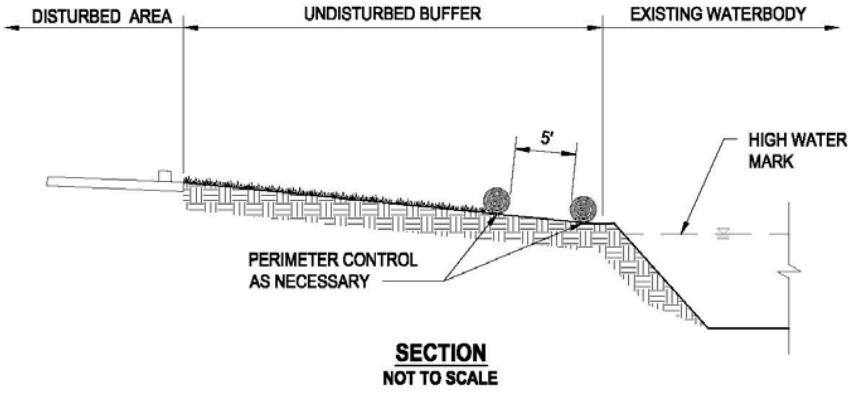
40.5 What to Inspect

- Is there an excess amount of sediment buildup in buffer strips?
- Are buffer strips wide enough to be effective?
- Are rills and gullies formed from runoff?
- Is unwanted vegetation growth observed?
- Are vegetated filter strips fully established prior to receiving flow?
- Have native grasses/plants been planted?

40.6 Maintenance

- Maintenance activities include mowing, weeding, and verification of properly operating irrigation system, if applicable.
- Properly remove and dispose of clippings from mowing and trimming.
- When installed correctly, filter strips require minimal maintenance.
- Unwanted growth should be removed without disrupting existing vegetation.
- Maintain vegetated filter strips so it remains dense and healthy.
- If check dams are installed, repair/replace as necessary.





TYPICAL VEGETATED BUFFER STRIP

NOTES:
1. PROVIDE AND MAINTAIN A 50-FOOT UNDISTURBED BUFFER AND SEDIMENT CONTROL FROM STATE WATERS.
2. IF THE EARTH DISTURBANCES ARE LOCATED LESS THAN 50 FEET FROM STATE WATERS, MAINTAIN AN UNDISTURBED NATURAL BUFFER AND INSTALL DOUBLE SEDIMENT CONTROL (E.G. DOUBLE PERIMETER CONTROL) SPACED A MINIMUM OF 5 FEET APART.
3. THE DEPARTMENT DOES NOT CONSIDER ALL STORM WATER CONTROL FEATURES (E.G. STORM WATER CONVEYANCE CHANNELS, STORM DRAIN INLETS, SEDIMENT BASINS) TO BE STATE WATERS.

Figure 40-1. Example of a typical vegetated buffer strip

41 Check Dams

41.1 Description

Temporary devices placed across channels, ditches or swales to reduce scour and erosion by reducing flow velocity and promoting sedimentation.

41.2 Applications

- Appropriate for small open channels conveying runoff from 10 acres or less.
- Steep channels with runoff velocities exceeding 2 feet/second.
- Temporary ditches which do not require installation of erosion-resistant linings due to expected short-term use.
- May be used in a curb and gutter scenario.

41.3 Installation and Implementation

- Distance between check dams and height of each device shall promote the formation of small pools between adjacent devices.
- Backwater from the downstream check dam shall reach the toe of the upstream check dam.
- Major flows shall flow over the check dam without increasing upstream flooding or damaging the check dam.
- Remove check dams and accumulated sediment upon establishment of vegetative lining. Stone check dams shall consist of stones ranging from approximately 8 to 12 inches in size.
- Stones shall be placed by hand or by other mechanical means, not dumped.
- Stone material shall completely span the channel or ditch to prevent washout of the check dam.
- Geotextile should be installed under stone check dams. Check dams should be 6 inches lower in the center than at the ends to allow flow over the center.

- Log check dams shall consist of logs ranging from 4 to 6 inches in diameter. Logs shall be embedded a minimum of 18 inches into the soil.
- Remove check dams upon establishment of grass used for stabilization of the ditch or channel, unless the slope of the swale exceeds 4%.

41.3.1 APPLICABLE CHECK DAM DEVICES

- Rocks
- Sandbags/gravel bags wrapped in geotextile
- Logs
- Snake bags
- Compost filter berms/socks

41.4 What to Inspect

- Is height of check dam effective?
- Is there evidence of sediment bypassing the check dam?
- Does the rock check dam have dislodged stones?
- Are check dams adequately spaced to slow the velocity of flow?
- Is there traces of undercutting?
- Has accumulated sediment reached one-half the height of the check dam?
- Are check dams the required diameter?
- Are check dams properly oriented?

41.5 Maintenance

- Remove accumulated sediment when depth reaches one-half the sump depth.
- Replace/repair damaged gravel bags or sandbags.
- Replace dislodged stones from rock check dams to sustain initial design.
- Reposition and clean compost filter sock check dams that get pushed out of position by a heavy flow.

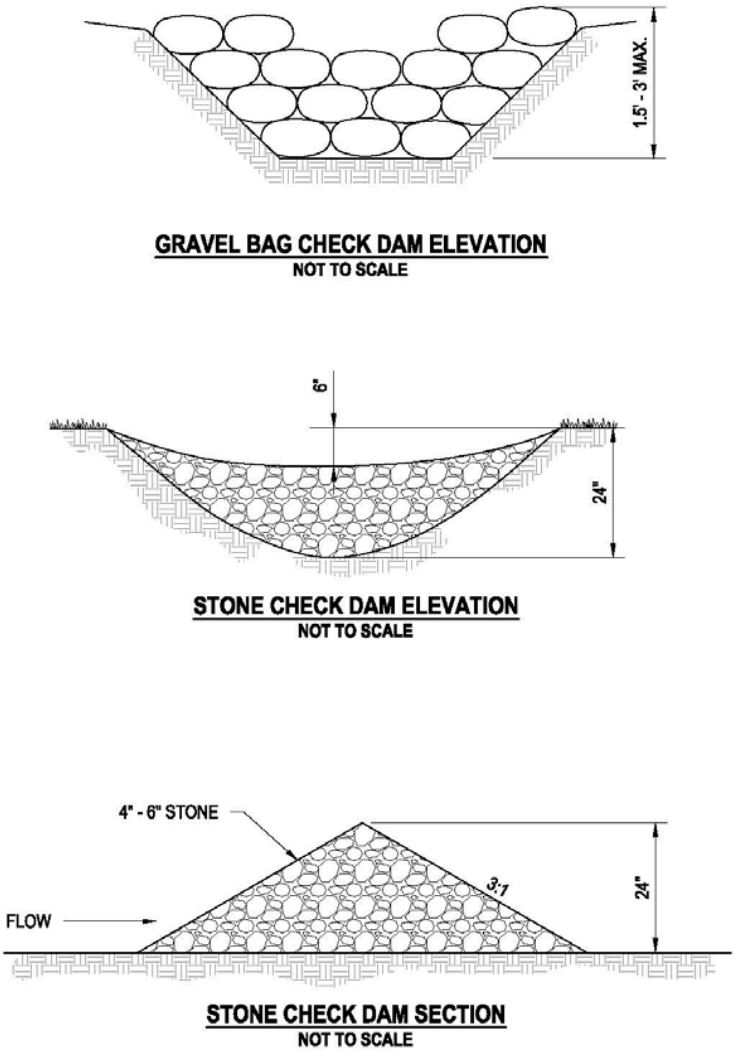


Figure 41-1. Examples of check dams

42 Sediment Trap

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

42.1 Description

A temporary runoff containment area to promote sedimentation prior to discharge of the runoff through a stabilized spillway.

42.2 Applications

- Drainage areas less than 5 acres.
- Areas along the perimeter of the site where sediment-laden runoff is discharged off- site.
- Areas requiring additional sediment containment measures such as bodies of water or discharge points to a drainage system.
- On-site discharge points to a stabilized or natural area or waterway.

42.3 Installation and Implementation

- Construct sediment trap prior to engaging in clearing, grubbing, or grading activities.

42.3.1 Location of Sediment Trap

- Area where a low embankment may be constructed across a swale.
- Area where failure of sediment trap will not cause property damage or loss of life.
- Area where maintenance crew may easily access sediment trap.

42.3.2 Sediment Trap Sizing

- Minimum trap settling volume of 133 cubic yards per acre.
- Minimum trap sediment storage volume of 33 cubic yards per acre.

- Trap width shall be less than one-half of the trap length.
- Flood volume.
- Construct sediment trap by excavating ground or constructing an earthen embankment to create a containment area.
- Area under embankment shall be cleared, grubbed, and stripped of vegetation and root mat.
- Fill material for embankment shall be free of roots, woody vegetation, oversized stones, rocks, organic material, or other objectionable material. Compact embankment by traversing with construction equipment.
- Stabilize trap outlet with stone or vegetation.
- Install fencing to prevent unauthorized entry and for safety purposes.
- All pipe joints shall be watertight when a riser is used.
- The top two-thirds of the riser shall be perforated with holes 1 to 4 inches in diameter. The holes shall be vertically spaced at 8-inch intervals and horizontally spaced at 10- to 12-inch intervals.
- Outlet crest elevation of an earth or stone outlet shall be a minimum of 1 foot below the top of the embankment.
- If the sediment trap is to remain in place for 14 calendar days or more, the embankments, berms, and other areas of exposed soil must be temporarily stabilized.

42.4 Considerations

- Applies to maximum drainage area of 5 acres. Drainage areas exceeding 5 acres shall implement Sediment Basins. See section 43 Sediment Basin for more information.
- Only removes large and medium size particles.
- Requires protective fencing.
- Do not install in live streams.
- Availability of right-of-way may limit size of sediment trap.

42.5 What to Inspect

- Are spillways or outlets obstructed or damaged?
- Is there evidence of erosion at the outlets?
- Are the areas stabilized around outlets?
- Is fencing damaged?

42.6 Maintenance

- Remove obstruction and repair damage as necessary.
- Remove sediment which has accumulated to within 1 foot of the maximum storage elevation.
- Properly dispose of sediment and debris removed from sediment trap.

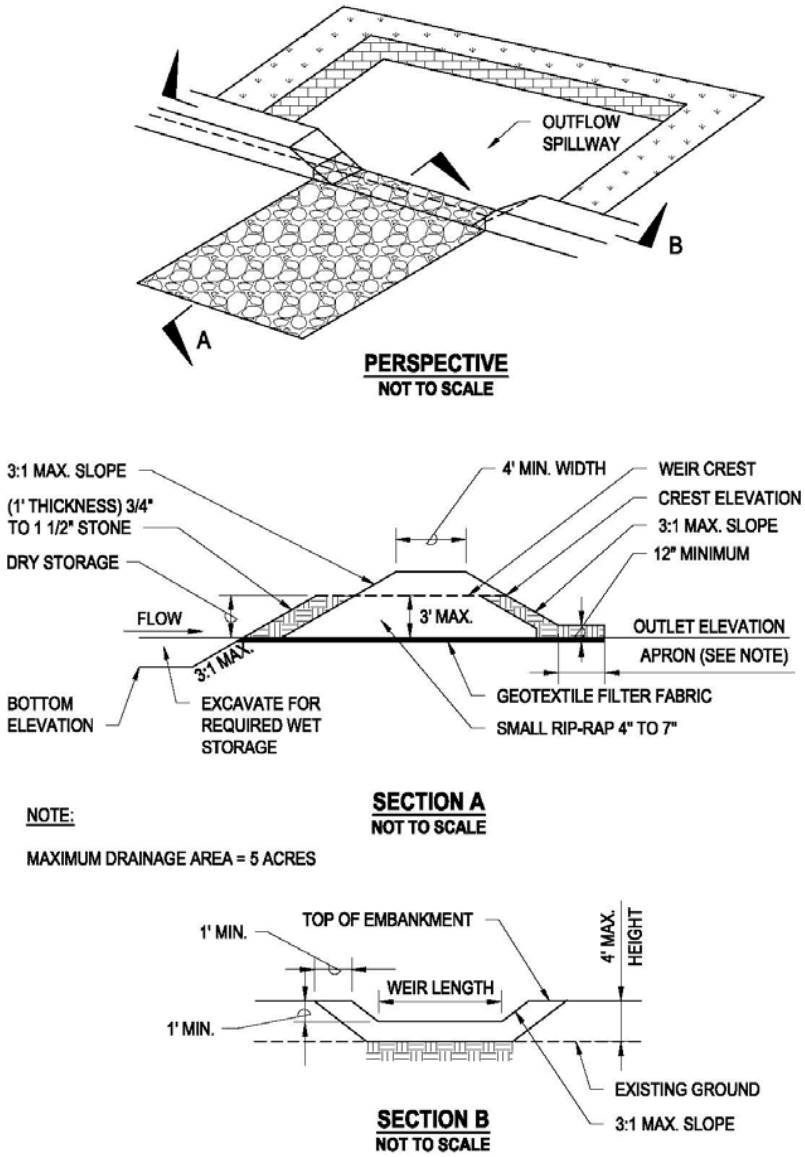


Figure 42-1. Example of a stone outlet sediment trap

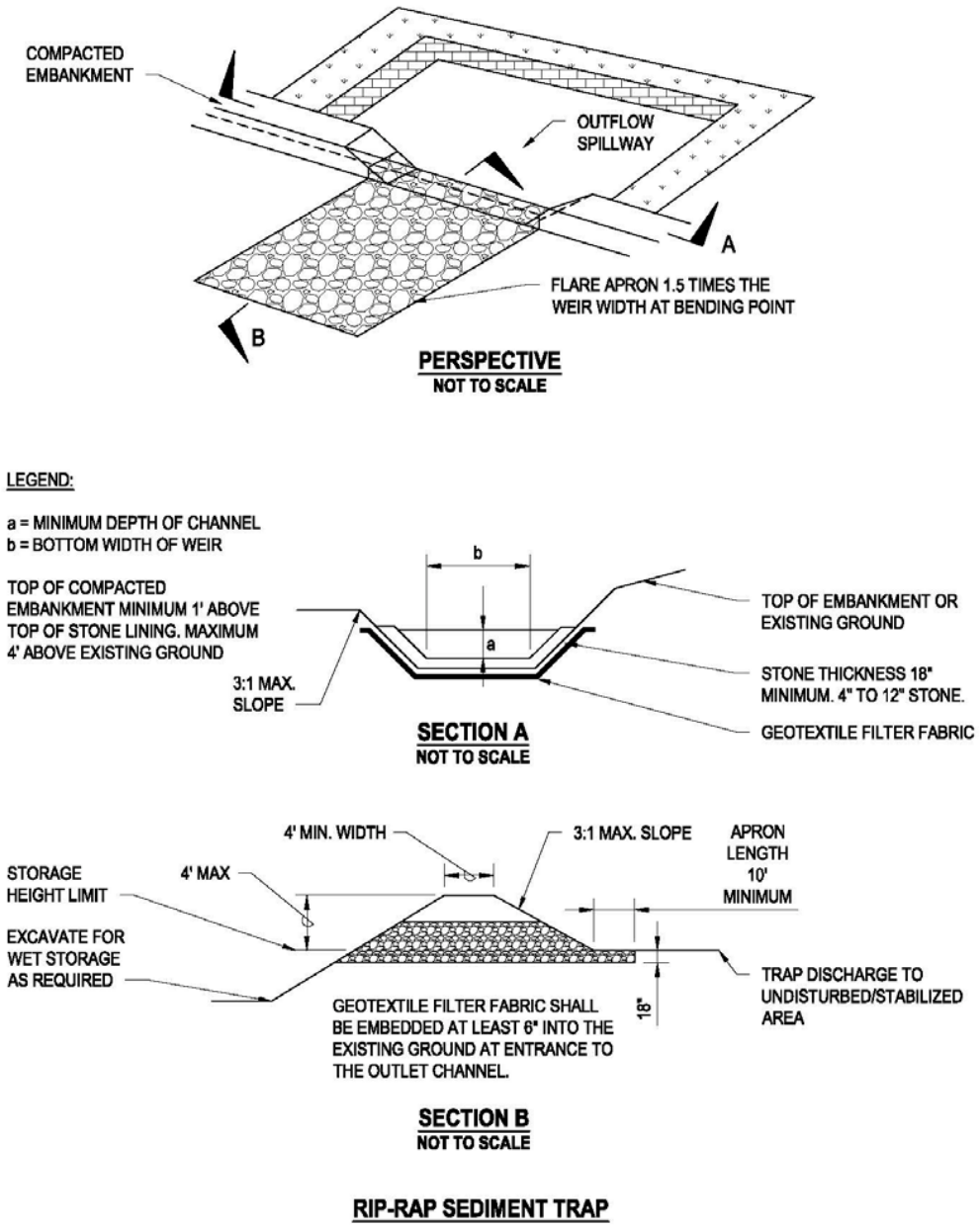


Figure 42-2. Example of a rip-rap sediment trap

43 Sediment Basin

43.1 Description

Temporary basin that intercepts sediment-laden runoff and allows sediment to settle prior to discharge of runoff from the site.

43.2 Applications

- Drainage areas larger than 5 acres.
- Areas where sediment-laden runoff is discharged to the drainage system or watercourses.

43.3 Installation and Implementation

- Construct sediment basins prior to clearing, grubbing, or grading activities.

Location shall be based on the following:

- Area where terrain forms a natural basin.
- Area which minimizes construction interference.
- Area where maximum benefit may be achieved from the existing terrain to minimize excavation or construction effort to install sediment basin.
- Area where failure of sediment basin will not cause property damage or loss of life.
- Area where maintenance crew may easily access sediment basin.
- Area where permanent detention basin will be constructed.
- Sediment basin shall be designed to allow 70% to 80% of the sediment to settle during a 24- to 40-hour detention time.
- The sediment basin is divided into 2 zones:
- Sediment storage zone with a minimum of 1 foot in depth.
- Settling zone with a minimum of 2 feet in depth.

43.3.1 Sediment Basis of Design

Settling zone volume shall be determined by the following equation: V = 1.2(SD)Q/VSED where:

- V = Settling zone volume.
- SD = Settling depth, which shall be a minimum of 2 feet and greater than the average distance from inlet to outlet of the basin divided by 200.
- VSED = Settling velocity of the design soil particle (medium silt). The settling velocity of a medium silt soil particle is 0.00096 feet per second.
- The discharge rate measured shall be determined by the following equation: Q = CIA where:
- Q = Discharge rate measured in cubic feet per second. C = Runoff coefficient.
- I = Precipitation intensity for the 10-year, 1-hour rain event.
- A = Area draining into the sediment basin in acres.

- Basin geometry for the sediment storage zone shall be determined by a minimum depth of 1 foot and 3:1 (H:V) or flatter side slopes extending from the bottom of the basin. Basin bottom shall be level.
- Provide an emergency spillway with the top of the riser pipe 1 foot below the crest elevation.
- Sediment basin length to settling depth ratio (L/SD) shall not exceed 200.
- Sediment basin length to width ratio shall not be less than 6:1 or baffles shall be installed.
- Install and securely anchor anti-seep collar on the outlet pipe/riser.
- Construct sediment basin by excavating ground or constructing an embankment of compacted soil. Embankments should be stabilized.
- Sediment basin may have more than 1 inflow point.
- Stabilize inlet, outlet, and slopes of basin with rock or vegetation.
- Install fencing to prevent unauthorized entry and for safety purposes.
- Refer to the Storm Water Permanent Best Management Practices Manual for more information.

43.4 Considerations

- Limited design life of 12 to 18 months.
- Sediment basin removes medium size particles.
- Additional BMPs such as seeding, mulching, and diversion dikes may be used to reduce the amount of sediment intercepted by the basin.
- Requires protective fencing.
- Inappropriate for installation in live streams.
- Availability of right-of-way may limit size of sediment basin.
- Large basins may be subject to state and local requirements for dam safety.

43.5 What to Inspect

- Is there evidence of obstructions or damage to inlets and outlets?
- Is there erosion around outlets?
- Is fencing damaged?

43.6 Maintenance

- Remove obstructions from inlets and outlets and repair damage as necessary.
- Stabilize outlets and repair fencing as necessary.
- Remove sediment when the sediment storage volume is one-half full.

- Properly dispose of sediment and debris removed from sediment basin.

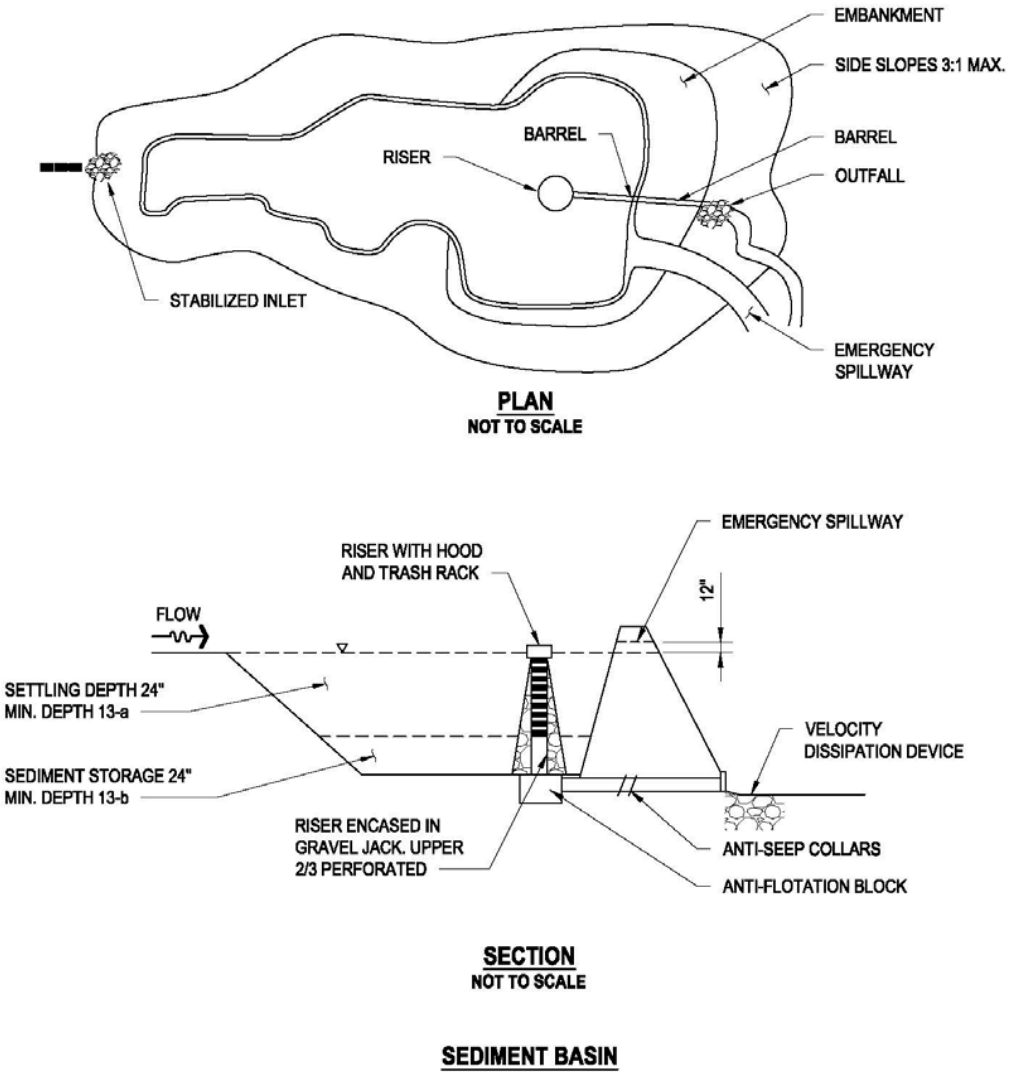


Figure 43-1. Example of a sediment basin

44 Compost Filter Berm/Sock

44.1 Description

Berms consisting of compost material placed perpendicular to runoff to reduce flow velocity and retain sediment and other pollutants. A fiber roll may consist of straw, flax, mulch, or other similar materials bound into a tight tubular roll.

44.2 Applications

- Along the site perimeter.
- Along the slope face and toe of slope (See section 27Earth Dikes, Swales, and Ditches).
- Check dam in small drainage ditches (See section 41Check Dams).
- Inlet protection for storm drains (See section 39 Storm Drain Inlet Protection).
- Surrounding base of temporary stockpiles (See section 3 Stockpile Management).
- Appropriate for small drainage areas and low surface velocity flows (less than 1 cubic feet per second (cfs)).
- Vegetative filtering system.
- Applied as a comprehensive system to storm water management.
- Used as perimeter control for disturbed/bare areas.

44.3 Installation and Implementation

- Usually located at the base of slopes, however, additional berms may be used for velocity dissipation devices mid-slope to increase erosion protection. See section 31 Slope Interceptor or Diversion Ditches/Berms for more information.

- Compost quality shall comply with all local, state, and federal requirements. Installation of a compost filter sock, which consists of a mesh tube filled with composted material, as a type of compost filter berm shall comply with the following:
- Assemble by tying a knot at the end of the mesh sock, filling the sock with compost, and knotting the other end of the sock. A pneumatic blower may be used to fill the sock with compost.
- Socks shall be 8 inches in diameter, minimum.
- If more than 1 compost filter sock is placed in a row, the compost filter socks must be overlapped, not abutted. The overlap shall be 6 inches, minimum (or in accordance with the manufacturer's recommendations), and shall be horizontal, side-by-side. The overlap shall not be vertical, top-to-bottom.
- Compost filter socks used on concrete or other hard surfaces that make staking non-applicable should be weighed down so it does not become displaced during heavy rain/runoff.
- Turn ends of filter sock up slope, a minimum of 3 feet, to prevent flow around ends.
- Compost filter socks must be in continuous contact with the ground. There should be no gaps between the sock and the ground beneath it.
- Compost filter socks may also be used for areas of concentrated flow such as near, but not at or in, streams or shorelines. Compost filter socks cannot be used in-water and must be installed above the high-water mark for streams/shorelines.
- Material and equipment must not be stored on top of the compost filter socks while in place. The compost filter sock must always be accessible for inspection and maintenance.
- When used as velocity dissipation devices on steep slopes, stake compost filter socks into a 2- to 4-inch-deep trench with a width equal to the diameter of the compost filter sock. Stakes must be driven at least 12 inches into the ground, while leaving a minimum stake height of 2 inches above the compost filter sock. Drive stakes through the center at the end of each compost filter sock and space apart 4 feet maximum on center.
- Follow manufacturer's specifications on proper use.
- At the completion of project, filter sock material, including the compost, shall be removed from the site and disposed of/reused properly. Fill and compact trenches once compost filter socks are removed.
- Material for compost berm/filter sock may be left at the site and used as a soil amendment, if approved by the Engineer. Material should be spread, not left in a clump or pile. The geotextile netting must be disposed of properly.

44.4 Considerations

- Do not install below the high-water mark of streams/shorelines or in-water.
- Unsuitable for areas with concentrated runoff unless a low flow rate and small drainage area warrants use of a filter berm/sock. Compost filter socks should be installed per manufacturer's recommendations
- Heavy vegetation must be removed to ensure close contact of compost with the ground surface.
- Difficult to move once saturated.
- Uneven terrain may restrict use of BMP.
- Heavy construction equipment and/or vehicles that run over compost filter socks can easily damage or impair the performance of the device.
- Soil may harden on the geotextile filter fabric, which will inhibit infiltration and proper effectiveness.
- Efficiency quickly decreases as sediment accumulates. Frequent maintenance is needed.

- Berms/socks cannot be staked or trenched when used on concrete and rocky surfaces.

44.5 What to Inspect

- Does the filter sock have rips or tears exposing the filter media?
- Does the filter sock need to be trenched and staked?
- Has sediment accumulated to one-half the height of the berm? Are compost filter socks positioned in the correct orientation to effectively manage storm water? Is there evidence of rills or gullies forming under the compost berm?
- Is there vehicles or equipment stored on top of the berm?
- Are compost filter socks properly installed according to manufacturer's specifications?

44.6 Maintenance

- Remove sediment which has accumulated to within one-half of the berm height.
- Replace disturbed or damaged areas of the berm.
- Repair/replace split, torn or slumping compost filter socks.
- Repairs to damaged compost filter socks must preserve filtration capabilities. Do not use duct tape, glue, or any material that will diminish the effectiveness of the compost filter sock.
- Maintain BMP until the disturbed area above the device is permanently stabilized.
- Reorient compost filter socks that have been disturbed.
- Clean hardened soil on geotextile filter fabric to ensure proper filtration can occur.
- Fix berms/socks that have been driven over and flattened.

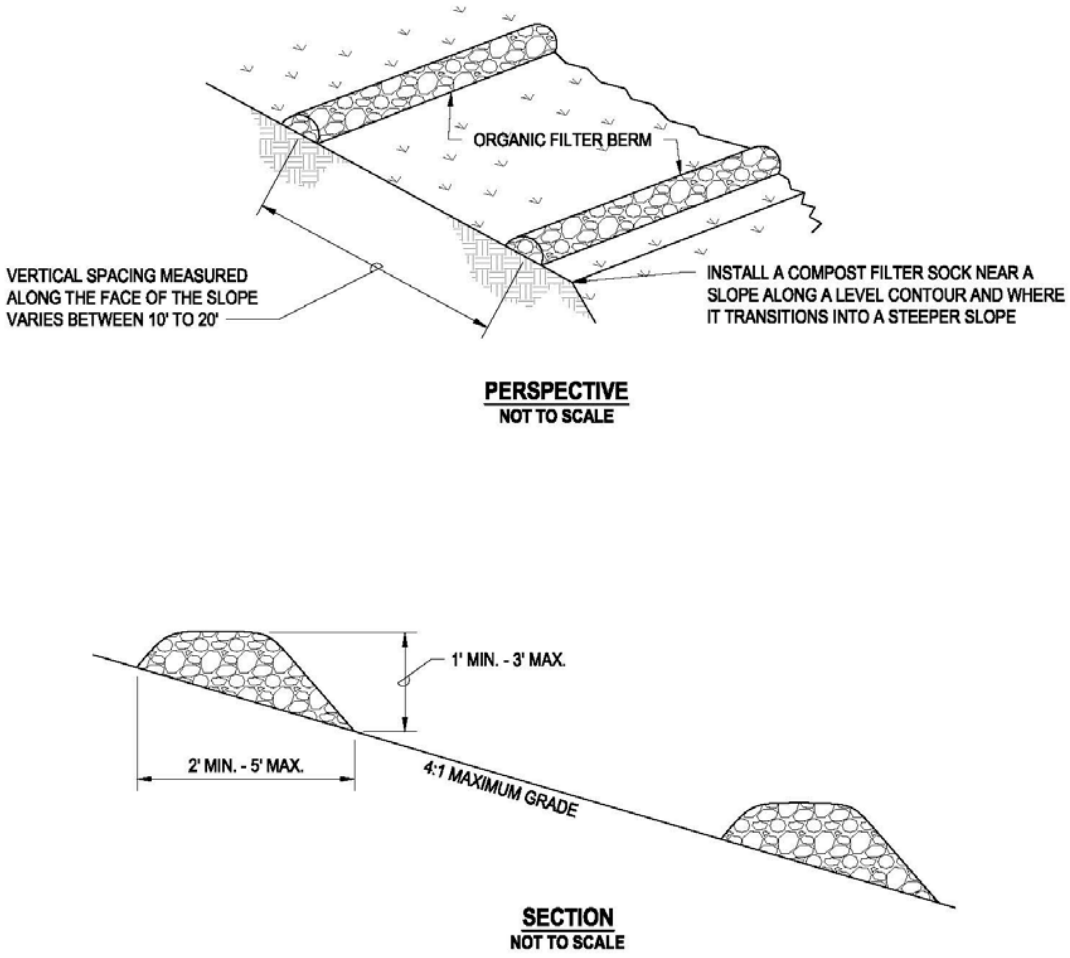
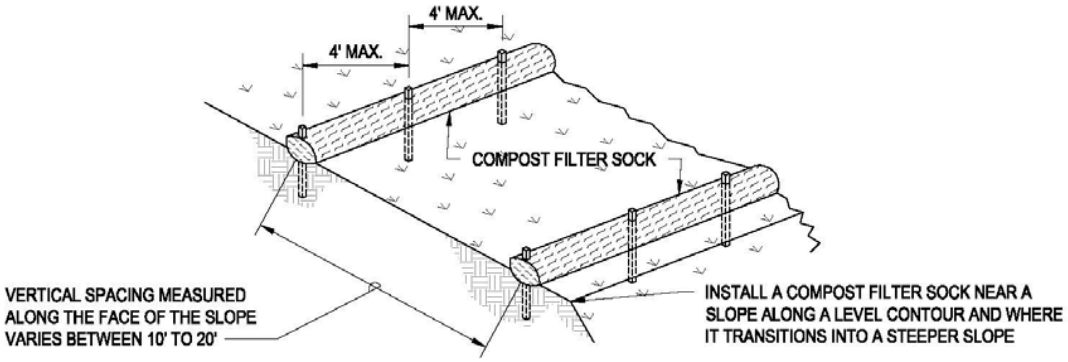
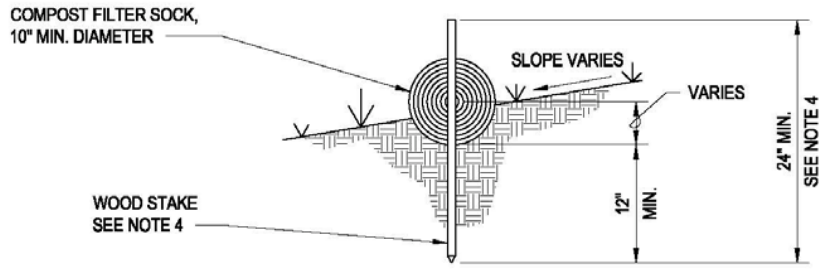


Figure 44-1. Example of a compost filter berm



PERSPECTIVE
NOT TO SCALE



SECTION
NOT TO SCALE

NOTES:

1. COMPOST FILTER SOCKS SHOULD BE EITHER PREFABRICATED OR ASSEMBLED AT SITE.
2. LOCATE COMPOST FILTER SOCKS ON LEVEL CONTOURS SPACED AS FOLLOWS:
   a. SLOPE INCLINATION OF 4:1 (H:V) OR FLATTER: COMPOST FILTER SOCKS AND/OR BERMS SHOULD BE PLACED AT A MAXIMUM INTERVAL OF 20 FT.
   b. SLOPE INCLINATION BETWEEN 4:1 AND 2:1 (H:V): COMPOST FILTER SOCKS (USE OF BERMS NOT RECOMMENDED) SHOULD BE PLACED AT A MAXIMUM INTERVAL OF 15 FT. (A CLOSER SPACING IS MORE EFFECTIVE).
   c. SLOPE INCLINATION OF 2:1 (H:V) OR GREATER: COMPOST FILTER SOCKS SHOULD BE PLACED AT MAXIMUM INTERVAL OF 10 FT.
3. TURN THE ENDS OF THE COMPOST FILTER SOCKS UP SLOPE TO PREVENT RUNOFF FROM GOING AROUND THE ROLL.
4. STAKE COMPOST FILTER SOCKS WITH STAKES WITH A MINIMUM LENGTH OF 14 IN. AND SPACED 4 FT. ON CENTER, OR AS RECOMMENDED BY THE MANUFACTURER, WHICHEVER IS GREATER.
5. IF MORE THAN ONE COMPOST FILTER SOCKS IS PLACED IN A ROW, THE ROLLS SHOULD BE OVERLAPPED, NOT ABUTTED.

COMPOST FILTER BERM (FILTER SOCK)

Figure 44-2. Example of a compost filter berm with filter sock

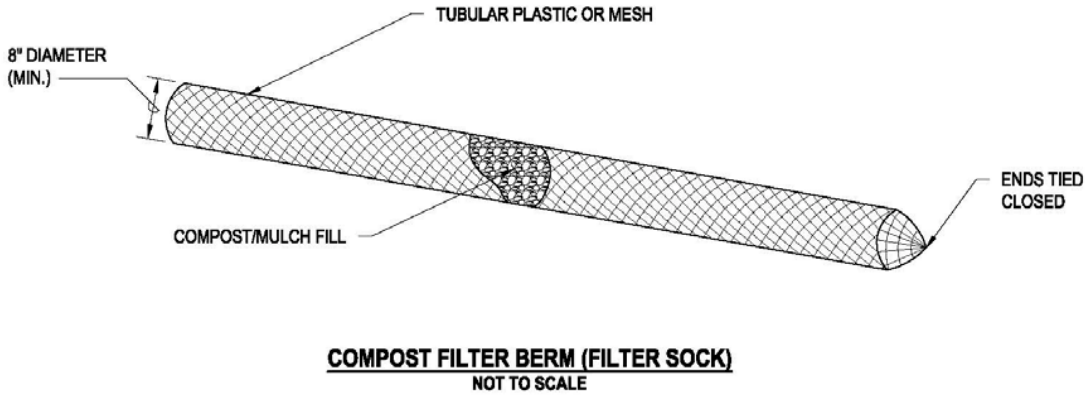


Figure 44-3. Example of a compost filter sock

45 Silt Fence or Filter Fabric Fence

45.1 Description

Temporary linear sediment barrier composed of permeable fabric designed to intercept and slow sediment-laden storm water.

45.2 Applications

- Install along the site perimeter.
- Install around temporary spoil or stockpiles.
- Install along streams and channels.
- Position below the toe of cleared or erodible slopes.
- Protect downslope of exposed soil areas.
- Place along the top of slope or other areas to reduce effects of sheet flow.

45.3 Installation and Implementation

- Install silt fence along or parallel to contours.
- Excavate a trench 6 inches wide and 6 inches deep along the line of the silt fence (soil slicing may be considered).
- Place the bottom of the silt fence in the trench.
- Backfill the trench and compact the soil by hand or mechanically.

- Silt fence posts shall be wooden, 1.25-inch × 1.25-inch × 48-inch, and be driven a minimum of 14 inches into the trench (see silt fence detail). Posts shall be installed on the down slope side of the silt fence. Silt fence posts may be attached to the fabric on- site or silt fence with pre-attached posts may also be used.
- Silt fence products using steel rebars in lieu of wood posts must use #4 or larger rebar and must include a safety cap on all exposed edges.
- Silt fence must be overlapped 6 inches between adjoining segments or may be overlapped, wrapped, and rolled.
- Ends of silt fence shall be turned uphill.
- Primarily used where sheet flow occurs.
- When using 2 rows of silt fence, install far enough apart to prevent the collapse of 1 fence from impacting the other.
- Install silt fence according to the specifications listed above or per manufacturer's specifications, whichever is more stringent.

45.4 Considerations

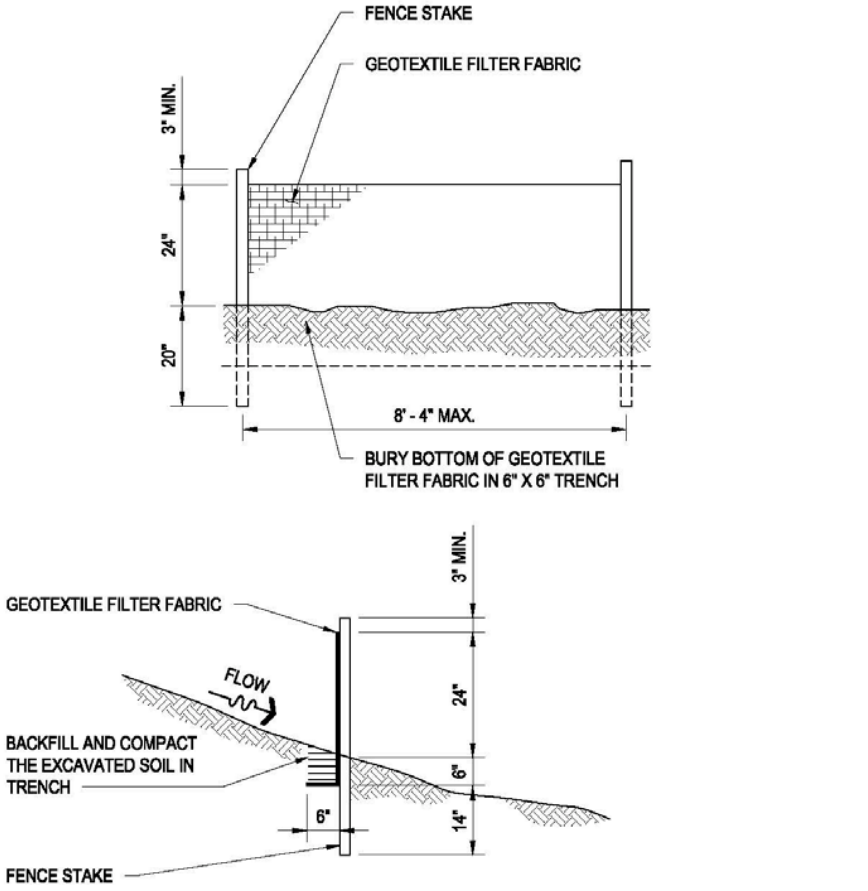
- Avoid installing silt fence on slope. However, if silt fence is placed on a slope, fence posts may need additional embedment.
- Do not install in streams, channels, or areas of concentrated flow.
- Do not use to divert flow.

45.5 What to Inspect

- Is there sediment accumulating behind the silt fence?
- Is the silt fence properly installed?
- Is there evidence of undermining or undercutting?
- Are adjoining segments seamless?
- Does silt fence have rips, tears, or degradation of fabric?
- Are stakes on downgradient side?
- Is the fabric securely attached to the stakes?

45.6 Maintenance

- Repair or replace damaged fence or posts.
- Repair or replace split, torn, slumping, or weathering silt fence.
- Repair or reinstall silt fence where undercutting has occurred.
- Remove all accumulated sediment when depth reaches one-third the barrier height.
- Maintain vegetative ground cover upstream of the silt fence. Bare soil upstream of the silt fence can increase frequency and possibility of silt fence failure.



NOTES:
1. THE FILTER FABRIC SHALL BE A MINIMUM OF 36 INCHES WIDE.

2. IF SILT FENCE IS OBTAINED FROM MANUFACTURER AS A PACKAGE (I.E. FABRIC ATTACHED TO POST) THE MANUFACTURER'S INSTALLATION INSTRUCTION SHALL BE ADHERED TO.

3. FENCE STAKE MAY BE WOOD OR METAL, MUST BE CAPABLE OF SUPPORTING ANTICIPATED LOADS.

4. SILT FENCE MUST BE OVERLAPPED 6" BETWEEN ADJOINING SEGMENTS OR MAY BE OVERLAPPED, WRAPPED, AND ROLLED.

SILT FENCE
NOT TO SCALE

Figure 45-1. Example of silt fence

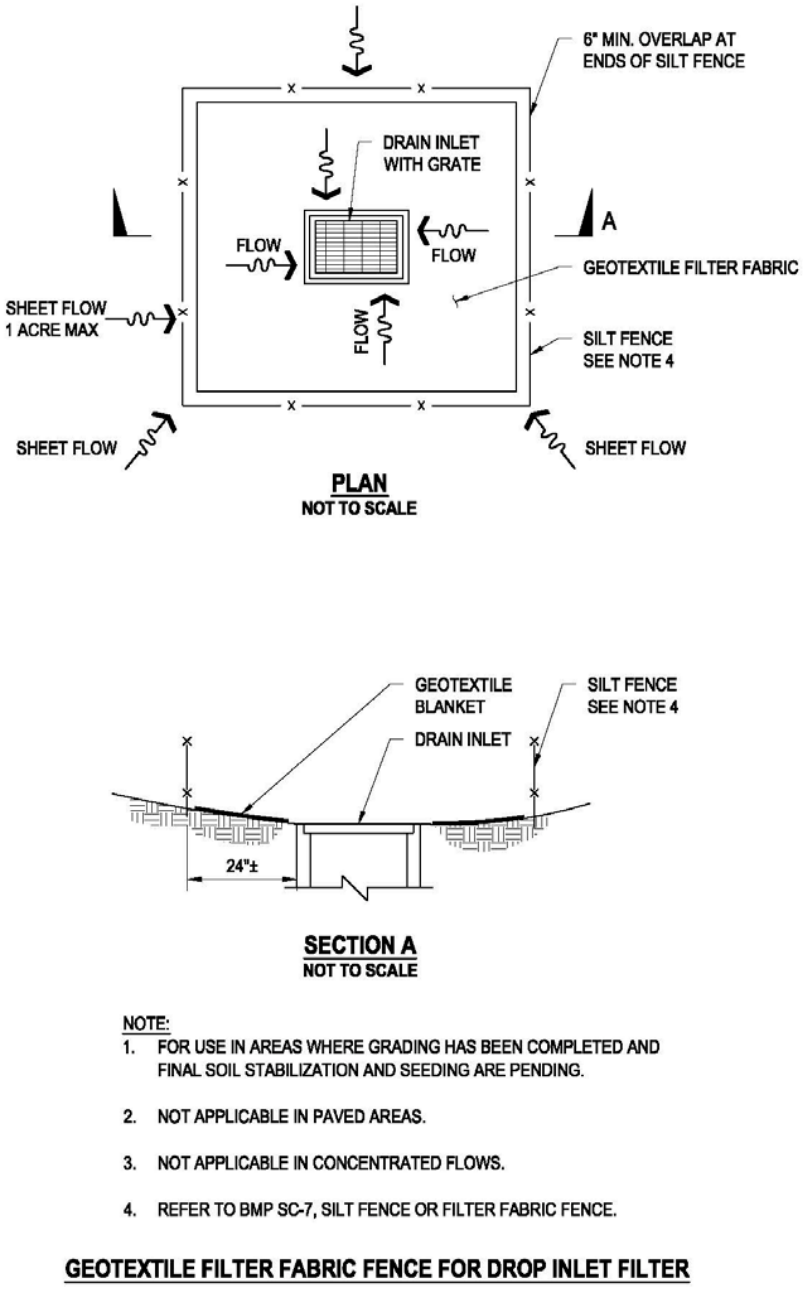


Figure 45-2. Example of a geotextile filter fabric fence for drop inlet filter

46 Sandbag Barrier

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

46.1 Description

Device used to intercept sediment-laden sheet flow, and allow sediment to settle prior to discharging off-site.

46.2 Applications

- Along the site perimeter.
- Along streams and channels.
- Utility trench barriers in channels.
- Across swales and small catchments.
- Diversion dike or berm.
- Below toe of exposed slopes.
- Temporary sediment trap.
- Around stockpiles.
- Weigh down inlet protection devices

46.3 Installation and Implementation

- Install bags end-to-end along a level contour.
- Turn ends of sandbag barrier up slope to prevent flow around ends.
- May be used in combination with soil stabilization controls up slope.
- Stack sandbags cross-sectionally in a pyramid formation if bags are to be stacked higher than 2 bags. If additional reinforcement is used, then stack sandbags in a brick wall formation.
- Materials for sandbag barrier shall comply with the following:
- Sandbag shall be woven polypropylene or polyamide fabric with ultraviolet protection to avoid rapid deterioration of fabric.
- Bag dimensions can vary but must be able to withstand anticipated flows.

- Fill material shall consist of non-cohesive, permeable material free of fines from clay and deleterious material.
- Sandbag barriers are allowed to be used in-stream provided that they will not become flood hazards, sandbag contents do not leak into the stream bottom, and they are removed once the project is completed.

46.4 Considerations

- Drainage area shall not exceed 5 acres.
- Avoid installing at locations which may compromise traffic safety.
- Burlap material shall not be used for sandbags.
- Does not filter sediment.
- Bags degrade when exposed to sunlight.
- Not adequate for long-term projects.
- Depending on application, installation may require an adequate amount of manpower.
- Not ideal for concentrated flows.

46.5 What to Inspect

- Has sediment accumulated?
- Does the sandbag have tears or rips?
- Are sandbags evenly spaced to weigh down inlet protection?
- Does the sandbag need to be replaced or reoriented?
- Is there evidence of erosion undermining the sandbag barrier?
- Is water bypassing the sandbag barrier?

46.6 Maintenance

- Reshape or replace sandbags as necessary.
- Remove and properly dispose of sediment, which has accumulated to a depth of 6 inches.
- Remove sandbags if they are no longer in use. If the area needs to be stabilized, do so immediately after removal.

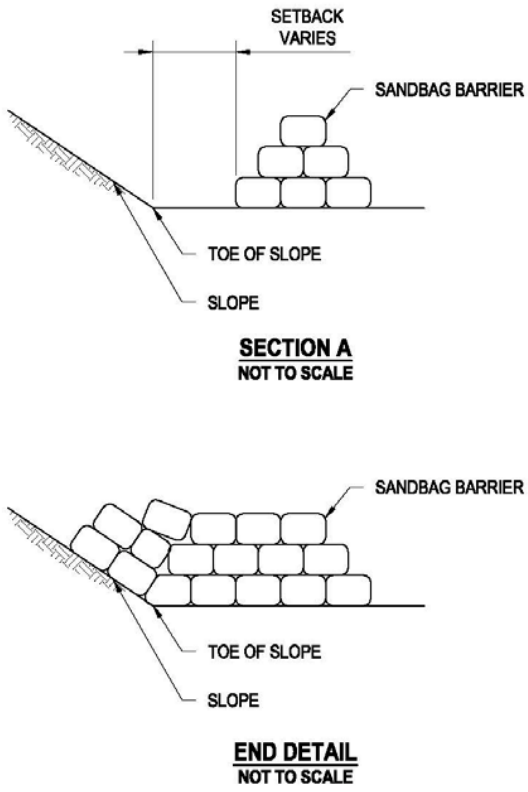
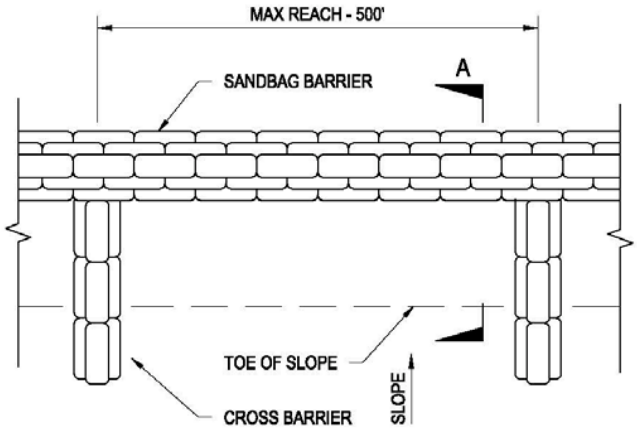


Figure 46-1. Example of a sandbag barrier



PLAN
NOT TO SCALE

NOTES:
1. CONSTRUCT THE LENGTH OF EACH REACH SO THAT THE CHANGE IN BASE ELEVATION ALONG THE REACH DOES NOT EXCEED 1/2 THE HEIGHT OF THE LINEAR BARRIER.
2. IN NO CASE SHALL THE REACH LENGTH EXCEED 500 FEET.
3. PLACE SANDBAGS TIGHTLY.
4. DIMENSIONS MAY VARY TO FIT FIELD CONDITIONS.
5. SANDBAG BARRIER SHALL BE A MINIMUM OF 3 BAGS HIGH.
6. THE END OF THE BARRIER SHALL BE TURNED UP SLOPE.
7. CROSS BARRIERS SHALL BE A MIN OF 1/2 AND A MAX OF 2/3 OF THE HEIGHT OF THE LINEAR BARRIER.
8. SANDBAG MATERIAL MUST CONFORM TO ASTM D3786 AND ASTM D4355.
9. SANDBAG BARRIERS ARE ALLOWED IN -STREAM PROVIDED THAT THEY WILL NOT BECOME FLOOD HAZARDS, SANDBAG CONTENTS DO NOT LEAK, AND THEY ARE REMOVED ONCE THE PROJECT IS COMPLETED.

SANDBAG BARRIER

Figure 46-2. Example of a sandbag cross barrier

47 Brush or Rock Filter

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

47.1 Description

Filter berms constructed of brush or rock placed across a level contour area where sheet flow may occur to trap sediment and reduce flow velocity.

47.2 Applications

- Check dams across construction roads with mild slopes.
- Below the toe of slopes.
- Along the site perimeter, streams, or channels.
- Around temporary spoil areas.
- Downstream of small cleared areas.
- Sediment traps at culvert or pipe outlets.

47.3 Installation and Implementation

- Use stones between 0.75 to 3 inches in diameter or brush wrapped in geotextile filter fabric. Brush from site clearing may be used. Place across areas of sheet flow.
- Installation of rock filter berms with geotextile filter fabric should be used when possible.
- A brush filter berm can be made of brush, small tree limbs, grass, leaves or other waste material from clearing and grubbing.
- Brush filter berms must be 2 to 5 feet in height to detain storm water. The base width of the berm must be 5 to 10 feet with a shape that is either a triangle or slightly rounded.
- Install filter 5 to 7 feet from toe of slope to allow ponding.
- Larger rocks must be placed as the base of the berm. Smaller rocks must be placed on the uphill side to form a natural filter.
- Place larger rocks without fines in a gabion to stabilize areas of concentrated flow.

- Use larger stones placed in staked and woven wire sheathing if stones are used across an area of concentrated flow.
- Construct along a level contour.
- Provide an area behind berm for detention and sedimentation.
- Geotextile filter fabric, rope, or wire mesh screen can be used to keep the shape of the berm intact.
- Install the geotextile filter fabric into a 6-inch-deep trench uphill from berm.
- Secure filter fabric with staples, stakes, or rope to protect the brush from being displaced from wind or a storm.

47.4 Considerations

- Adequate detention area behind berm is necessary to prevent flooding upstream.
- Drainage area shall not exceed 5 acres.
- Removal of stone berms may be difficult, resulting in limited usefulness in landscaped areas.
- Must not be used in continuously flowing streams.
- Ponding may occur if not sized properly.

47.5 What to Inspect

- Has rock or brush been displaced?
- Is ponding occurring in undesired areas?
- Is there evidence of erosion or sheet flow?
- Is the height and width of the device appropriate for the flow?

47.6 Maintenance

- Reshape berm and replace any missing or dislodged stone or brush.
- Remove and dispose of sediment on upstream site of filter upon reaching a depth of 6 inches.
- Replace geotextile filter fabric when tears and rips limit effectiveness.

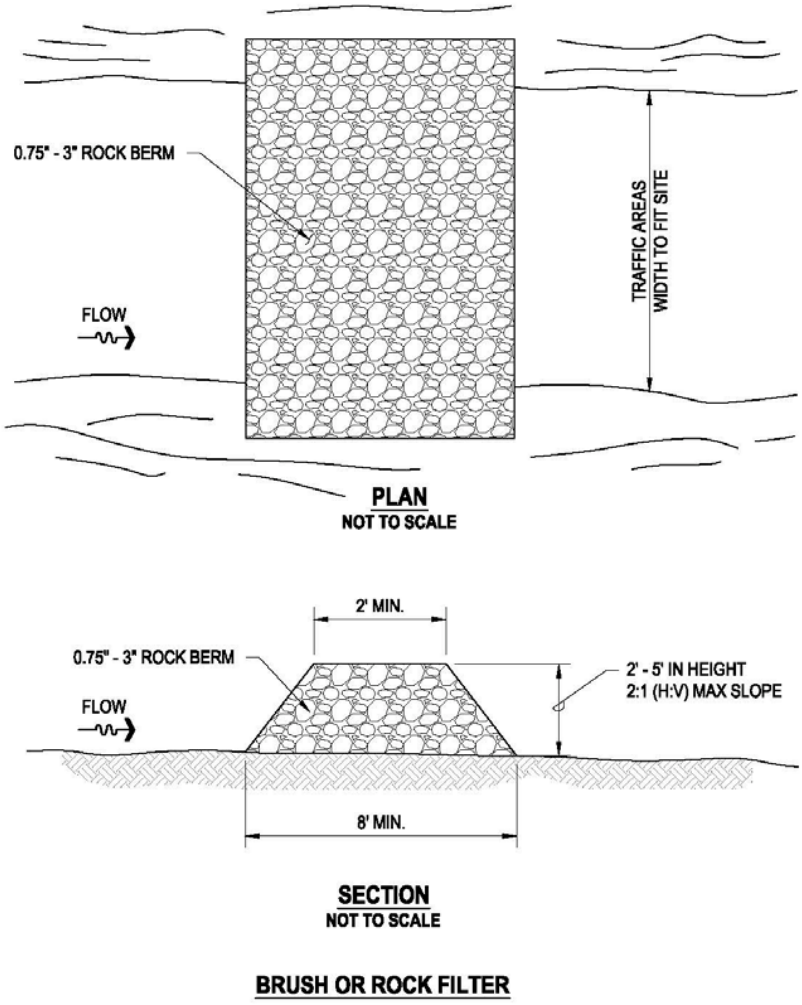


Figure 47-1. Example of a brush or rock filter

48 Construction Road and Parking Lot Stabilization

Image Source: State of Hawaii Department of Transportation, Highways Division, *Construction Best Management Practices Field Manual,* 2021.

48.1 Description

Stabilization and maintenance of temporary construction roads and parking areas after grading to minimize erosion and dust from vehicular traffic.

48.2 Applications

- Temporary construction roads.
- Parking areas for construction equipment and vehicles.
- On-site vehicular routes.
- Areas where sediment tracking may be a problem during wet weather.
- Areas where dust may be a problem during dry weather.
- Areas adjacent to bodies of water.
- Along steep grades or areas where additional traction is necessary.

48.3 Installation and Implementation

- Grade roadway to follow topographic contours to reduce erosion and divert surface water off the roadway.
- Roadway grade shall not exceed 15%.
- Properly grade roadway to prevent runoff from leaving site.
- Stabilize the temporary construction roads and parking areas with aggregate, asphalt cement, or concrete.

Table 48-1 Summary of materials used for temporary construction roads and parking areas

Allowable Materials	Not Allowable Materials
• Aggregate • Concrete • Asphalt cement • Compacted base course	• Cold mix asphalt • Uncompacted and compacted asphalt cement grindings • Crushed concrete • Concrete-treated Base

48.4 Considerations

- Although allowed under certain circumstances by the 2005 Hawaii Standard Specifications for Road and Bridge Construction, whenever possible, avoid chemicals stabilization methods, which may contribute to soil pollution and increase runoff.
- Construction traffic management may be subject to air quality control measures. Contact the local air quality management agency for more information.
- Roadway grade and site conditions.

48.5 What to Inspect

- Is there sediment buildup within aggregate?
- Is there dust generated from vehicles traveling on construction roads?
- Is the proper aggregate type and size being used?
- Is there geotextile under the coarse aggregate?
- Is there evidence of tracking on public roads?

48.6 Maintenance

- Periodically apply additional aggregate to refresh void spots on construction roads and parking areas.
- Remove sediment on the aggregate periodically to minimize polluted runoff.
- Temporary construction roads may require frequent dust control.
- Reshape roadway as needed for drainage and runoff control.

49 Stabilized Construction Entrance/Exit

49.1 Description

Designated areas for entry and/or exit from a construction site to reduce the amount of sediment tracked off-site by construction vehicles.

49.2 Applications

Stabilized construction entrances/exits shall be used at all points where access to a construction site from paved roads is required.

49.3 Installation and Implementation

- Restrict vehicle use to properly designated entrance/exit points.
- Grade the stabilized entrance/exit to prevent runoff from discharging off-site. Construct stabilized entrance/exit on level ground where possible.
- Provide ample turning radii, when applicable.
- Coarse aggregate, that are free of fine material, shall be 3 to 6 inches in diameter. The use of crushed concrete and asphalt concrete millings/grindings are not allowed.

- Depth of aggregate shall be 12 inches or as recommended by the Soils Engineer. Contractor is responsible to design stabilized construction entrance/exit to support heaviest vehicles and equipment that will use it.
- Place geotextile filter fabric beneath the 12-inch- deep layer of aggregate.
- Dimensions shall be a minimum of 50 feet in length and 30 feet in width. If project site layout will not accommodate minimum dimensions, install additional BMPs to remove sediment from the vehicles prior to entering/exiting the site.
- Alternative commercial construction entrance/exit products may be used in lieu of aggregate if approved by the Engineer and installed per manufacturer's specifications.
- Installation of a stabilized entrance/exit is required if ground-disturbing activity will occur and exiting the construction site onto paved roads and sidewalks is needed.
- A tire wash can be incorporated with a stabilized construction entrance/exit to assist with the removal of sediment from construction vehicles.
- The tire wash must be designed for the anticipated traffic load and located a minimum of 50 feet from a state water.
- Automatic shutoff nozzles must be used to avoid wasting water.
- The wash waters must be retained on the project site and drain to a properly constructed sediment trap or similar device.
- Sediment tracked onto adjacent roadways or paved areas shall be removed by the end of the same day that the tracking occurred or immediately when sediment is tracked more than 50 feet from the construction entrance/exit, whichever occurs sooner.
- Use dry methods to remove the sediment from the adjacent roadways or paved areas. This includes, but is not limited to, mechanical street sweepers, brooms, shovels, vacuums, or other similarly effective methods. The sediment collected shall be removed or stabilized on-site.
- The pavement shall not be cleaned by washing down the street into any storm water conveyance (unless it's connected to a sediment basin, sediment trap, or similarly effective control), storm drain inlet, or state water.
- Limit points of entry onto the construction site to minimize possible areas of tracking.

49.4 Considerations

- Surface aggregate shall be periodically replenished.
- If the construction exit is not preventing sediment from being tracked onto the pavement, consider increasing the dimensions of the entrance, and/or installing a tire wash.
- A sediment trapping device is required if a tire wash is used in conjunction with the stabilized construction entrance/exit.
- The speed of the construction truck through the tire wash is crucial to the effectiveness of the cleaning. The slower the truck moves through the wash, the better the cleaning.
- A turnout or doublewide exit should be used to prevent entering vehicles from driving through the tire wash area.
- Sediment accumulates between the aggregate and reduces the effectiveness of the construction entrance/exit.

49.5 Maintenance

- Clean dirt, mud, or other material tracked onto the road, sidewalk, or other paved area by the end of the same day in which the trackout occurs.
- Remove aggregate, separate and dispose of sediment, when no longer in use.
- Perform street sweeping as needed. Washing of the roads to address sediment trackout is not permitted
- Adjust street sweeping schedule as needed.
- Replenish surface aggregate periodically.
- Remove accumulated sediment from the construction entrance/exit.
- Upon project completion, all construction entrances/exits shall be removed by the contractor and stabilized in accordance with the 2005 Hawaii Standard Specifications for Road and Bridge Construction and Special Provisions, or other regulatory requirements.

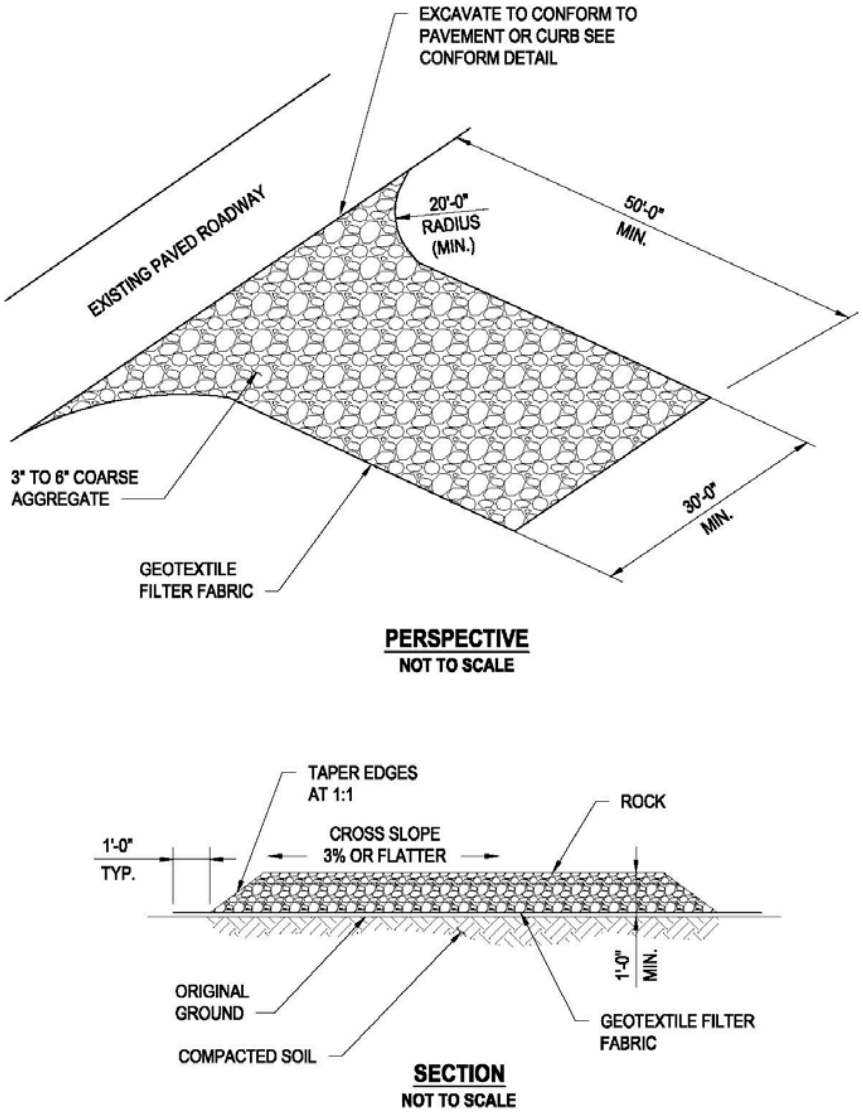
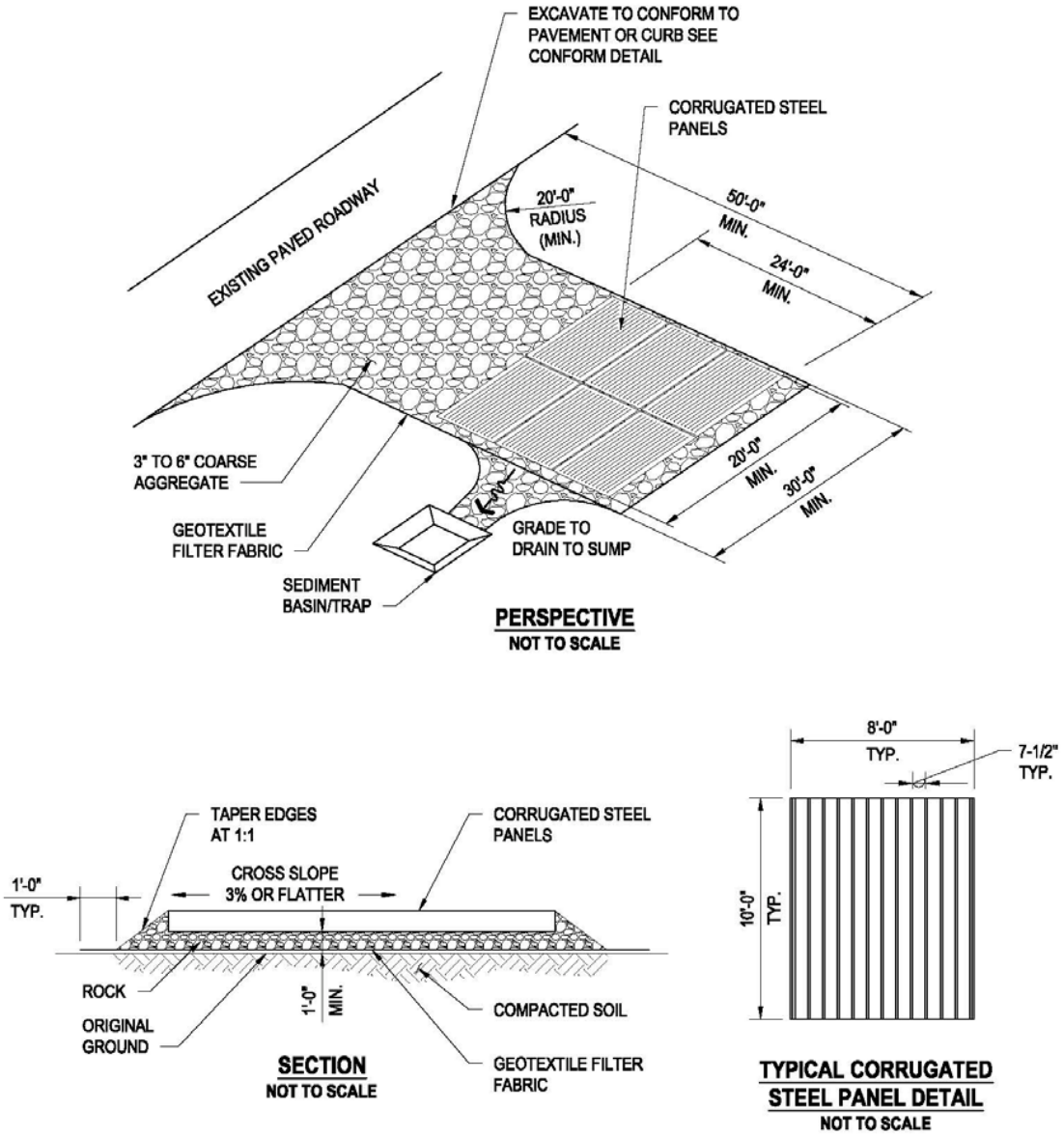


Figure 49-1. Example of stabilized construction entrance



STABILIZED CONSTRUCTION ENTRANCE WITH CORRUGATED STEEL PLATES

NOTES:
1. GEOTEXTILE FILTER FABRIC MUST BE INSTALLED BENEATH THE 12" DEEP LAYER OF AGGREGATE.

Figure 49-2. Example of stabilized entrance with corrugated steel plates