Flood Control
Facility Maintenance
Best Management Practices

A Manual for Minimizing Environmental Impacts
from Stream and Channel Maintenance Activities

June 2000
EOA, Inc.
BASMAA Operational Permits Committee

BASMAA

Flood Control Facility Maintenance Best Management Practices

A Manual for Minimizing Environmental Impacts from Stream and Channel Maintenance Activities

June 2000

EOA, Inc.
Eisenberg, Olivieri & Associates
1410 Jackson Street
Oakland, CA 94612
Credits and Disclaimer

Acknowledgements
This manual and associated field guide were prepared for the San Francisco Bay Area Stormwater Management Agencies Association's (BASMAA) Operational Permits Committee (OPC) as a task of regional benefit.

Agencies that generously provided funding for this manual are:
Alameda County Public Works Agency
Contra Costa Clean Water Program
Santa Clara Valley Water District
and the
Marin County Flood Control District

Project Manager
Patrick E. Baker, CEP
Alameda County Public Works Agency

This manual was developed under the guidance of the BASMAA Operational Permits Committee (OPC). The OPC is comprised of representatives from the major flood control districts throughout the Bay Area. We are thankful for the comments, suggestions, and guidance provided by OPC members as well as regulatory staff of the U.S. Army Corps of Engineers, the State Water Resources Control Board, and the San Francisco Regional Water Quality Control Board during the creation of this document. We also appreciate the participation of staff of the California Department of Transportation, Lawrence Livermore National Laboratory, the California Department of Fish and Game and other agencies who have attended meetings or reviewed drafts of this manual. Special thanks to the California Department of Transportation and the California Stormwater Quality Task Force for allowing the use of several illustrative diagrams and drawings.

OPC Member Agencies
Alameda County Public Works Agency
Alameda County Zone 7 Water Agency
Contra Costa County Public Works Department
Fairfield-Suisun Sewer District/Fairfield-Suisun Urban Runoff Management Program
Marin County Flood Control District
San Mateo County Public Works
Santa Clara Valley Water District
Sonoma County Water Agency
Vallejo Sanitation and Flood Control District
Consultant Team
This document was prepared by
Eisenberg, Olivieri, & Associates, Inc.
1410 Jackson Street
Oakland, CA  94612
(510) 832-2852
Wendy Edde, Consultant Project Manager
Fred Jarvis, Quality Control Director
Cristina Lighthiser, Project Engineer

Unless otherwise specified, drawings were provided by
JM Design
Jean Matuska

Disclaimer
The contents of this manual are to be used only for general information and are not intended to be a standard of the Bay Area Stormwater Management Agencies Association. No reference made in this manual to any specific method, product, process, or service constitutes or implies an endorsement, recommendation, or warranty thereof by the authors, funding agencies, BASMAA, or its member agencies or consultants.

The authors, funding agencies, and BASMAA make no representation or warranty of any kind, whether expressed or implied, concerning the accuracy, product, or processes discussed in this publication and assume no liability. Anyone who uses this information assumes all liability arising from such use, including but not limited to, infringement of any patent or patents.

The activities described herein may require permits or approvals from local, state and/or federal regulatory agencies. Projects should be reviewed prior to the start of work to determine which regulatory approvals and permits are necessary and to secure those permits and approvals before the start of work.
Table of Contents

Section I  Introduction ..................................................................................... I-1
    Background and Purpose ..................................................................... I-1
    Target Audience ............................................................................... I-2
    Organization of BMP Manual ....................................................... I-3

Section II  Selecting Best Management Practices ................................. II-1
    Methods for Selection ..................................................................... II-1
    Matrix I: Selection by Type of Activity ...................................... II-2
    Matrix II: Selection by Management Problem ............................. II-5
    Matrix III: BMPs That Work Well Together ................................. II-8

Section III  Descriptions of Best Management Practices ....................... III-1

    CU:  Chemical Use
        CU-1 Certified Pesticide Applicator ...................................... III-CU-1.1
        CU-2 Pest Control Equipment Maintenance ........................ III-CU-2.1
        CU-3 Material Handling ..................................................... III-CU-3.1
        CU-4 Spill Prevention and Control ...................................... III-CU-4.1
        CU-5 Pesticide Application and Wind Conditions .............. III-CU-5.1
        CU-6 Pesticide Application and Aquatic Conditions .......... III-CU-6.1
        CU-7 Pesticide Application and Landscape Conditions ....... III-CU-7.1
        CU-8 Concrete Use and Disposal ......................................... III-CU-8.1

    EV:  Equipment and Vehicles
        EV-1 Equipment and Vehicle Maintenance .......................... III-EV-1.1
        EV-2 Equipment and Vehicle Cleaning ............................... III-EV-2.1

    NR:  Natural Resource Protection and Restoration
        NR-1 Channel Protection and Restoration .......................... III-NR-1.1
        NR-2 Biotechnical Bank Stabilization ................................ III-NR-2.1
        NR-3 Project Planning/Scheduling ..................................... III-NR-3.1

    SC:  Sediment Control
        SC-1 Stockpiles and Sediment Disposal ............................... III-SC-1.1
        SC-2 Dredging .................................................................. III-SC-2.1
        SC-3 Sediment Basins ....................................................... III-SC-3.1
        SC-4 Straw or Sand Bag Barriers ........................................ III-SC-4.1
        SC-5 Sediment Traps ......................................................... III-SC-5.1
        SC-6 Silt Fence .................................................................. III-SC-6.1

    SS:  Soil Stabilization
        SS-1 Erosion Control Blankets, Mats, and Geotextiles .... III-SS-1.1
        SS-2 Dust Control .......................................................... III-SS-2.1
Flood Control Maintenance BMP Manual

SS-3  Temporary Stream Crossing.............................III-SS-3.1
SS-4  Construction Road Entrance Stabilization..........III-SS-4.1

**VDM: Vegetation and Debris Management**
- VDM-1  Preservation of Existing Vegetation ..............III-VDM-1.1
- VDM-2  Removal of Existing Vegetation ................III-VDM-2.1
- VDM-3  Revegetation After Soil Disturbance ..........III-VDM-3.1
- VDM-4  Debris Removal ....................................III-VDM-4.1

**VR: Velocity Reduction**
- VR-1  Brush or Rock Filter ................................III-VR-1.1
- VR-2  Check Dams ...........................................III-VR-2.1
- VR-3  Slope Roughening or Terracing..................III-VR-3.1
- VR-4a Permanent Outlet Protection ......................III-VR-4.1
- VR-4b Temporary Outlet Protection ......................III-VR-4.8
- VR-5  Storm Drain Inlet Protection ......................III-VR-5.1

**WD: Water Diversion**
- WD-1  Earth Dike .............................................III-WD-1.1
- WD-2  Slope Drain ..........................................III-WD-2.1
- WD-3  Temporary Drains and Swales .....................III-WD-3.1
- WD-4  Dewatering Nuisance Water .......................III-WD-4.1
- WD-5  In Channel Flow Diversion Systems .............III-WD-5.1

**Section IV**  Evaluating the Performance of Best Management Practices..IV-1

**Section V**  References and Additional Resources ......................V-1

**Appendices**

**Appendix A**  Field Guide for Flood Control Facility Maintenance Best Management Practices

**Appendix B**  Conversions: Metric to English Units

**Appendix C**  Photodocumentation Methods
### Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASMAA</td>
<td>Bay Area Stormwater Management Agencies Association</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
</tr>
<tr>
<td>BMP</td>
<td>Best Management Practices</td>
</tr>
<tr>
<td>CU</td>
<td>Chemical Use</td>
</tr>
<tr>
<td>EV</td>
<td>Equipment and Vehicles</td>
</tr>
<tr>
<td>fps</td>
<td>Feet per second</td>
</tr>
<tr>
<td>ha</td>
<td>Hectare</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>NR</td>
<td>Natural Resources Protection and Restoration</td>
</tr>
<tr>
<td>OES</td>
<td>California State Office of Emergency Services</td>
</tr>
<tr>
<td>OPC</td>
<td>Operational Permits Committee</td>
</tr>
<tr>
<td>SC</td>
<td>Sediment Control</td>
</tr>
<tr>
<td>SS</td>
<td>Soil Stabilization</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>VDM</td>
<td>Vegetation and Debris Management</td>
</tr>
<tr>
<td>VR</td>
<td>Velocity Reduction</td>
</tr>
<tr>
<td>WD</td>
<td>Water Diversion</td>
</tr>
</tbody>
</table>
Section I

Introduction
INTRODUCTION

Background and Purpose

San Francisco Bay Area flood control maintenance staff are responsible for ensuring that flood control facilities are maintained to provide the level of flood protection for which they were constructed to protect the public’s investment, and/or to comply with regulations of the federal flood insurance program. In addition, channel stabilization activities occur to protect public and private infrastructure and property consistent with a flood control agency’s jurisdiction. As a result of carrying out these activities, natural resources are affected and subject to regulatory oversight by state and federal agencies. To promote a common understanding over the necessity to implement stream and channel maintenance activities and to avoid or reduce impacts to natural resources. Members of the Bay Area Stormwater Management Agencies Association’s (BASMAA’s) Operational Permits Committee (OPC) identified the need for a guidance manual that specifically addresses stream and channel maintenance activities. The purpose of this Flood Control Facility Maintenance Best Management Practices (BMP) Manual and associated field guide is to provide guidance for maintenance field staff, engineers, and planners. The manual and field guide should assist staff in selecting and implementing best management practices and devices that avoid or minimize impacts to natural resources while allowing for stream and channel maintenance activities to proceed with minimal regulatory requirements. The manual may also be used to help prepare regulatory permit applications.

BMP Manual. The BMP manual is designed to be a desk reference that describes and illustrates appropriate flood control maintenance best management practices and devices for both minimal-impact activities and more intensive maintenance activities. The manual can be used for: improving general maintenance activities; complying with the Regional Water Quality Control Board’s minimal threat activities regional general permit currently being developed; and, preparing regulatory permit and approval applications.

Sketches and figures are included in the BMP description section to illustrate the descriptions as appropriate. Information was collected from several sources, referenced at the end of each description. The manual was reviewed and approved by the Bay Area Stormwater Management Agencies Association’s (BASMAA’s) Operational Permits Committee, consisting of flood control agency representatives and regulatory personnel from throughout the San Francisco Bay Area.

The BMPs described herein are guidelines, not requirements. Some BMPs will not be appropriate for certain situations. Consider the applicability and limitations the measures in relation to the specific site before deciding whether to implement the BMP.
Not yet comprehensive, this manual is considered a work in progress. The OPC’s sincere hope is that the manual will be expanded and revised in later editions based upon further experience with the practices described and the maintenance activities and methods covered. Feedback is encouraged (see Section IV for more details.)

**BMP Field Guide.** The compact reference guide is designed to be a handy field guide that includes index tables and memory-jogging descriptions of the Best Management Practices.

**Permits and Approvals.** Please be aware that permits and/or approvals from federal, state, or local regulatory agencies, may be required to perform work described in this manual. Be sure to research and obtain any necessary permit or approvals before starting work. In addition, these best management practice guidelines may not be applicable during emergency situations. Regulatory requirements such as permit conditions, always take precedence over the guidelines described in this manual.

**Target Audience**

The target audience for this manual are flood control maintenance staff, including project planners and field staff. The BMP manual is meant to be a desktop guide with detailed information. The associated field guide is designed for use in the field, as a reminder of available BMPs.

**Organization of BMP Manual**

The manual is divided into five sections, as follows.

**Section I: Introduction.** This section provides information on the background and purpose of the BMP manual and field guide, the target audience, and the organization of the manual.

**Section II: Selecting Best Management Practices.** This section provides three matrices that allow for a quick reference to help find appropriate BMPs for specific projects or objectives.

**Section III: Descriptions of Best Management Practices.** This section forms the majority of the manual, and is split into eight subsections: Natural Resource Protection and Restoration, Vegetation and Debris Management, Chemical Use, Equipment and Vehicles, Water Diversion, Velocity Reduction, Soil Stabilization, and Sediment Removal/Control. Each subsection contains information describing the BMPs in that section. Descriptions include objectives, applicability, limitations, approach and standards, necessary requirements and references for each BMP.
Section I
INTRODUCTION

Section IV: Evaluating the Performance of Best Management Practices. This manual is meant to be a living document, and this section provides a method to evaluate the performance of individual BMPs. The section includes a form for evaluating the BMPs that can be collected and returned to the BASMAA Operational Permits Committee for future improvement.

Section V: References and Additional Resources. This section includes a complete list of references cited in the manual and a list of additional sources of pertinent information.

Appendix A: Field Guide for Flood Control Facility Maintenance Best Management Practices. This appendix contains a handy guide for use in the field to help select appropriate BMPs.

Appendix B: Conversions: Metric to English Units. This appendix provides formulas for, and a table of conversions to English units.

Appendix C: Photodocumentation Methods. This appendix provides techniques for proper photodocumentation, a method used to monitor whether the best management practices are working effectively.
SELECTING BEST MANAGEMENT PRACTICES

Methods for Selection

The selection of a BMP or a combination of BMPs to use for a particular project depends on the specific job objectives and site characteristics. Site characteristics that may influence BMP selection included project site size and topography; the type of activities involved; the type of channel or waterway; the equipment, vehicles, and/or chemicals that will be used; the time of year and day; nearby land uses; and the location of sensitive species, if any. Costs and maintenance requirements also affect BMP selection.

Three matrices are provided here to assist flood control personnel determine which BMPs are appropriate for specific jobs. The first matrix provides appropriate BMPs for the type of maintenance activity being performed. The second matrix provides suggested BMPs based on the water quality and pollution prevention problems that would be addressed. The third matrix provides a list of BMPs that work well with one another.

Flood control personnel should examine the applicability, limitations, and requirements of each BMP under consideration before making final determinations. These characteristics are discussed in detail in Section III.
Matrix I: Selection by Type of Activity

<table>
<thead>
<tr>
<th>If Your Project Involves...</th>
<th>Select from These BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Projects</td>
<td>EV-1 Equipment and Vehicle Maintenance</td>
</tr>
<tr>
<td></td>
<td>EV-2 Equipment and Vehicle Cleaning</td>
</tr>
<tr>
<td></td>
<td>NR-3 Project Planning/Scheduling</td>
</tr>
<tr>
<td>Debris Removal</td>
<td>CU-8 Concrete Use and Disposal</td>
</tr>
<tr>
<td></td>
<td>Nr-3 Project Planning/Scheduling</td>
</tr>
<tr>
<td></td>
<td>VDM-2 Removal of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-3 Revegetation After Soil Disturbance</td>
</tr>
<tr>
<td></td>
<td>VDM-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VDM-4b Temporary Outlet Protection</td>
</tr>
<tr>
<td>Erosion Repair/Prevention</td>
<td>CU-1 Certified Pesticide Applicator</td>
</tr>
<tr>
<td></td>
<td>CU-7 Pesticide Application and Landscape Conditions</td>
</tr>
<tr>
<td></td>
<td>NR-1 Channel Protection and Restoration</td>
</tr>
<tr>
<td></td>
<td>NR-2 Biotechnical Bank Stabilization</td>
</tr>
<tr>
<td></td>
<td>NR-3 Project Planning/Scheduling</td>
</tr>
<tr>
<td></td>
<td>SC-4 Straw or Sand Bag Barriers</td>
</tr>
<tr>
<td></td>
<td>SS-1 Erosion Control Blankets, Mats, and Geotextiles</td>
</tr>
<tr>
<td></td>
<td>SS-2 Dust Control</td>
</tr>
<tr>
<td></td>
<td>SS-3 Temporary Stream Crossing</td>
</tr>
<tr>
<td></td>
<td>SS-4 Construction Road Entrance Stabilization</td>
</tr>
<tr>
<td></td>
<td>VDM-1 Preservation of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-2 Removal of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-3 Revegetation After Soil Disturbances</td>
</tr>
<tr>
<td></td>
<td>VDM-4 Debris Removal</td>
</tr>
<tr>
<td></td>
<td>VR-1 Brush or Rock Filter</td>
</tr>
<tr>
<td></td>
<td>VR-2 Check Dams</td>
</tr>
<tr>
<td></td>
<td>VR-3 Slope Roughening or Terracing</td>
</tr>
<tr>
<td></td>
<td>VR-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-4b Temporary Outlet Protection</td>
</tr>
</tbody>
</table>
### Section II

**SELECTING BMPs**

<table>
<thead>
<tr>
<th>If Your Project Involves...</th>
<th>Select from These BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sediment Removal/Sediment Control</strong></td>
<td></td>
</tr>
<tr>
<td>NR-3 Project Planning/Scheduling</td>
<td></td>
</tr>
<tr>
<td>SC-1 Stockpiles and Sediment Disposal</td>
<td></td>
</tr>
<tr>
<td>SC-2 Dredging</td>
<td></td>
</tr>
<tr>
<td>SC-3 Sediment Basins</td>
<td></td>
</tr>
<tr>
<td>SC-4 Straw or Sand Bag Barriers</td>
<td></td>
</tr>
<tr>
<td>SC-5 Sediment Traps</td>
<td></td>
</tr>
<tr>
<td>SC-6 Silt Fence</td>
<td></td>
</tr>
<tr>
<td>SS-2 Dust Control</td>
<td></td>
</tr>
<tr>
<td>SS-4 Construction Road Entrance Stabilization</td>
<td></td>
</tr>
<tr>
<td>VDM-1 Preservation of Existing Vegetation</td>
<td></td>
</tr>
<tr>
<td>VDM-3 Revegetation after Soil Disturbance</td>
<td></td>
</tr>
<tr>
<td>VR-1 Brush or Rock Filter</td>
<td></td>
</tr>
<tr>
<td>VR-2 Check Dams</td>
<td></td>
</tr>
<tr>
<td>VR-3 Slope Roughening or Terracing</td>
<td></td>
</tr>
<tr>
<td>VR-5 Storm Drain Inlet Protection</td>
<td></td>
</tr>
<tr>
<td><strong>Structure Repair</strong></td>
<td></td>
</tr>
<tr>
<td>CU-3 Material Handling</td>
<td></td>
</tr>
<tr>
<td>CU-4 Spill Prevention and Control</td>
<td></td>
</tr>
<tr>
<td>CU-8 Concrete Use and Disposal</td>
<td></td>
</tr>
<tr>
<td>EV-1 Equipment and Vehicle Maintenance</td>
<td></td>
</tr>
<tr>
<td>EV-2 Equipment and Vehicle Cleaning</td>
<td></td>
</tr>
<tr>
<td>NR-3 Project Planning/Scheduling</td>
<td></td>
</tr>
<tr>
<td>SS-3 Temporary Stream Crossing</td>
<td></td>
</tr>
<tr>
<td>SS-4 Construction Road Entrance Stabilization</td>
<td></td>
</tr>
<tr>
<td>VDM-1 Preservation of Existing Vegetation</td>
<td></td>
</tr>
<tr>
<td>VDM-2 Removal of Existing Vegetation</td>
<td></td>
</tr>
<tr>
<td>VDM-3 Revegetation After Soil Disturbance</td>
<td></td>
</tr>
<tr>
<td>VR-4a Permanent Outlet Protection</td>
<td></td>
</tr>
<tr>
<td>VR-4b Temporary Outlet Protection</td>
<td></td>
</tr>
</tbody>
</table>
### If Your Project Involves...

<table>
<thead>
<tr>
<th>Vegetation Management</th>
<th>Select from These BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU-1</td>
<td>Certified Pesticide Applicator</td>
</tr>
<tr>
<td>CU-2</td>
<td>Pest Control Equipment Maintenance</td>
</tr>
<tr>
<td>CU-3</td>
<td>Material Handling</td>
</tr>
<tr>
<td>CU-4</td>
<td>Spill Prevention and Control</td>
</tr>
<tr>
<td>CU-5</td>
<td>Pesticide Application and Wind Conditions</td>
</tr>
<tr>
<td>CU-6</td>
<td>Pesticide Application and Aquatic Conditions</td>
</tr>
<tr>
<td>CU-7</td>
<td>Pesticide Application and Landscape Conditions</td>
</tr>
<tr>
<td>NR-1</td>
<td>Channel Protection and Restoration</td>
</tr>
<tr>
<td>NR-2</td>
<td>Biotechnical Bank Stabilization</td>
</tr>
<tr>
<td>NR-3</td>
<td>Project Planning/Scheduling</td>
</tr>
<tr>
<td>VDM-1</td>
<td>Preservation of Existing Vegetation</td>
</tr>
<tr>
<td>VDM-2</td>
<td>Removal of Existing Vegetation</td>
</tr>
<tr>
<td>VDM-3</td>
<td>Revegetation After Soil Disturbance</td>
</tr>
</tbody>
</table>
## Matrix II: Selection by Management Problem

<table>
<thead>
<tr>
<th>If Your Objective is...</th>
<th>Select from These BMPs</th>
</tr>
</thead>
</table>
| **Vegetation/Habitat Protection** | CU-1 Certified Pesticide Applicator  
CU-2 Pest Control Equipment Maintenance  
CU-3 Material Handling  
CU-4 Spill Prevention and Control  
CU-5 Pesticide Application and Wind Conditions  
CU-6 Pesticide Application and Aquatic Conditions  
CU-7 Pesticide Application and Landscape Conditions  
CU-8 Concrete Use and Disposal  
NR-1 Channel Protection and Restoration  
NR-2 Biotechnical Bank Stabilization  
NR-3 Project Planning/Scheduling  
SC-1 Stockpiles and Sediment Disposal  
SC-2 Dredging  
SS-1 Erosion Control Blankets, Mats, and Geotextiles  
SS-3 Temporary Stream Crossing  
VDM-1 Preservation of Existing Vegetation  
VDM-2 Removal of Existing Vegetation  
VDM-3 Revegetation after Soil Disturbance  
VDM-4 Debris Removal  
VR-1 Brush or Rock Filter  
VR-3 Slope Roughening or Terracing |
| **Water Control/ Diversion** | CU-6 Pesticide Application and Aquatic Conditions  
CU-7 Pesticide Application and Landscape Conditions  
NR-3 Project Planning/Scheduling  
SC-3 Sediment Basins  
SC-4 Straw or Sand Bag Barriers  
SC-5 Sediment Traps  
SC-6 Silt Fence  
SS-3 Temporary Stream Crossing  
VDM-2 Removal of Existing Vegetation  
VDM-4 Debris Removal  
VR-1 Brush or Rock Filter  
VR-2 Check Dams  
VR-4a Permanent Outlet Protection  
VR-4b Temporary Outlet Protection  
VR-5 Storm Drain Inlet Protection |
### SELECTING BMPs

<table>
<thead>
<tr>
<th>If Your Objective is…</th>
<th>Select from These BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suspended Sediment</strong></td>
<td>NR-3</td>
</tr>
<tr>
<td></td>
<td>SC-1</td>
</tr>
<tr>
<td></td>
<td>SC-2</td>
</tr>
<tr>
<td></td>
<td>SC-3</td>
</tr>
<tr>
<td></td>
<td>SC-4</td>
</tr>
<tr>
<td></td>
<td>SC-5</td>
</tr>
<tr>
<td></td>
<td>SC-6</td>
</tr>
<tr>
<td></td>
<td>SS-4</td>
</tr>
<tr>
<td></td>
<td>VDM-4</td>
</tr>
<tr>
<td></td>
<td>VR-1</td>
</tr>
<tr>
<td></td>
<td>VR-2</td>
</tr>
<tr>
<td></td>
<td>VR-5</td>
</tr>
<tr>
<td><strong>Dust</strong></td>
<td>CU-3</td>
</tr>
<tr>
<td></td>
<td>CU-8</td>
</tr>
<tr>
<td></td>
<td>NR-3</td>
</tr>
<tr>
<td></td>
<td>SS-1</td>
</tr>
<tr>
<td></td>
<td>SS-2</td>
</tr>
<tr>
<td></td>
<td>VDM-1</td>
</tr>
<tr>
<td></td>
<td>VDM-3</td>
</tr>
<tr>
<td></td>
<td>VDM-4</td>
</tr>
<tr>
<td><strong>Chemical Use</strong></td>
<td>CU-1</td>
</tr>
<tr>
<td></td>
<td>CU-2</td>
</tr>
<tr>
<td></td>
<td>CU-3</td>
</tr>
<tr>
<td></td>
<td>CU-4</td>
</tr>
<tr>
<td></td>
<td>CU-5</td>
</tr>
<tr>
<td></td>
<td>CU-6</td>
</tr>
<tr>
<td></td>
<td>CU-7</td>
</tr>
<tr>
<td></td>
<td>CU-8</td>
</tr>
<tr>
<td></td>
<td>NR-3</td>
</tr>
<tr>
<td></td>
<td>VDM-2</td>
</tr>
<tr>
<td><strong>Creosote and</strong></td>
<td>CU-3</td>
</tr>
<tr>
<td><strong>Preservative Use</strong></td>
<td>CU-4</td>
</tr>
<tr>
<td></td>
<td>CU-6</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## SELECTING BMPs

<table>
<thead>
<tr>
<th>If Your Objective is...</th>
<th>Select from These BMPs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cement/ Concrete Use</strong></td>
<td></td>
</tr>
<tr>
<td>CU-3</td>
<td>Material Handling</td>
</tr>
<tr>
<td>CU-4</td>
<td>Spill Prevention and Control</td>
</tr>
<tr>
<td>CU-8</td>
<td>Concrete Use and Disposal</td>
</tr>
<tr>
<td>EV-1</td>
<td>Equipment and Vehicle Maintenance</td>
</tr>
<tr>
<td>EV-2</td>
<td>Equipment and Vehicle Cleaning</td>
</tr>
<tr>
<td>NR-2</td>
<td>Biotechnical Bank Stabilization</td>
</tr>
<tr>
<td>NR-3</td>
<td>Project Planning/Scheduling</td>
</tr>
<tr>
<td><strong>Vehicles in Channel</strong></td>
<td></td>
</tr>
<tr>
<td>CU-2</td>
<td>Pest Control Equipment Maintenance</td>
</tr>
<tr>
<td>CU-4</td>
<td>Spill Prevention and Control</td>
</tr>
<tr>
<td>CU-8</td>
<td>Concrete Use and Disposal</td>
</tr>
<tr>
<td>EV-1</td>
<td>Equipment and Vehicle Maintenance</td>
</tr>
<tr>
<td>EV-2</td>
<td>Equipment and Vehicle Cleaning</td>
</tr>
<tr>
<td>NR-1</td>
<td>Channel Protection and Restoration</td>
</tr>
<tr>
<td>NR-3</td>
<td>Project Planning/Scheduling</td>
</tr>
<tr>
<td>SS-3</td>
<td>Temporary Stream Crossing</td>
</tr>
<tr>
<td>SS-4</td>
<td>Construction Road Entrance Stabilization</td>
</tr>
<tr>
<td>VDM-1</td>
<td>Preservation of Existing Vegetation</td>
</tr>
<tr>
<td>VDM-2</td>
<td>Removal of Existing Vegetation</td>
</tr>
<tr>
<td>VDM-4</td>
<td>Debris Removal</td>
</tr>
<tr>
<td><strong>Post Construction Erosion</strong></td>
<td></td>
</tr>
<tr>
<td>CU-1</td>
<td>Certified Pesticide Applicator</td>
</tr>
<tr>
<td>NR-2</td>
<td>Biotechnical Bank Stabilization</td>
</tr>
<tr>
<td>NR-3</td>
<td>Project Planning/Scheduling</td>
</tr>
<tr>
<td>SS-1</td>
<td>Erosion Control Blankets, Mats, and Geotextiles</td>
</tr>
<tr>
<td>VDM-1</td>
<td>Preservation of Existing Vegetation</td>
</tr>
<tr>
<td>VDM-3</td>
<td>Revegetation After Soil Disturbance</td>
</tr>
<tr>
<td>VR-3</td>
<td>Slope Roughening or Terracing</td>
</tr>
</tbody>
</table>
Matrix III: BMPs That Work Well Together

<table>
<thead>
<tr>
<th>If You’re Considering This BMP…</th>
<th>Consider These BMPs Also…</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU-2 Pest Control Equipment Maintenance</td>
<td>CU-4 Spill Prevention and Control</td>
</tr>
<tr>
<td></td>
<td>EV-1 Equipment and Vehicle Maintenance</td>
</tr>
<tr>
<td></td>
<td>EV-2 Equipment and Vehicle Cleaning</td>
</tr>
<tr>
<td>CU-3 Material Handling</td>
<td>CU-4 Spill Prevention and Control</td>
</tr>
<tr>
<td>CU-8 Concrete Use and Disposal</td>
<td>VR-1 Brush or Rock Filter</td>
</tr>
<tr>
<td>EV-1 Equipment and Vehicle Maintenance</td>
<td>CU-4 Spill Prevention and Control</td>
</tr>
<tr>
<td>NR-1 Channel Protection and Restoration</td>
<td>NR-3 Project Planning/Scheduling</td>
</tr>
<tr>
<td>NR-2 Biotechnical Bank Stabilization</td>
<td>VDM-1 Preservation of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-2 Removal of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-3 Revegetation after Soil Disturbance</td>
</tr>
<tr>
<td>SC-1 Stockpiles</td>
<td>EV-2 Equipment and Vehicle Cleaning</td>
</tr>
<tr>
<td></td>
<td>SC-4 Straw or Sand Bag Barriers</td>
</tr>
<tr>
<td></td>
<td>SC-5 Sediment Traps</td>
</tr>
<tr>
<td></td>
<td>SC-6 Silt Fence</td>
</tr>
<tr>
<td></td>
<td>SS-1 Erosion Control Blankets, Mats, and Geotextiles</td>
</tr>
<tr>
<td>SC-2 Dredging</td>
<td>NR-3 Project Planning/Scheduling</td>
</tr>
<tr>
<td>SC-3 Sediment Basins</td>
<td>SC-1 Stockpiles and Sediment Disposal</td>
</tr>
<tr>
<td></td>
<td>VDM-2 Removal of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-4 Debris Removal</td>
</tr>
<tr>
<td></td>
<td>VR-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-4b Temporary Outlet Protection</td>
</tr>
</tbody>
</table>
## SELECTING BMPs

<table>
<thead>
<tr>
<th>If You’re Considering This BMP…</th>
<th>Consider These BMPs Also…</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-4 Straw and Sand Bag Barriers</td>
<td>NR-1 Channel Protection and Restoration</td>
</tr>
<tr>
<td></td>
<td>NR-2 Biotechnical Bank Stabilization</td>
</tr>
<tr>
<td></td>
<td>SC-3 Sediment Basins</td>
</tr>
<tr>
<td></td>
<td>SC-6 Silt Fence</td>
</tr>
<tr>
<td></td>
<td>SS-2 Dust Control</td>
</tr>
<tr>
<td></td>
<td>VDM-3 Revegetation After Soil Disturbance</td>
</tr>
<tr>
<td></td>
<td>VR-2 Check Dams</td>
</tr>
<tr>
<td>SC-5 Sediment Trap</td>
<td>SC-1 Stockpiles and Sediment Disposal</td>
</tr>
<tr>
<td></td>
<td>SS-1 Erosion Control Blankets, Mats, and Geotextiles</td>
</tr>
<tr>
<td></td>
<td>SS-2 Dust Control</td>
</tr>
<tr>
<td></td>
<td>SS-3 Temporary Stream Crossing</td>
</tr>
<tr>
<td></td>
<td>SS-4 Construction Road Entrance Stabilization</td>
</tr>
<tr>
<td></td>
<td>VDM-4 Debris Removal</td>
</tr>
<tr>
<td></td>
<td>VR-1 Brush or Rock Filter</td>
</tr>
<tr>
<td></td>
<td>VR-2 Check Dams</td>
</tr>
<tr>
<td></td>
<td>VR-3 Slope Roughening or Terracing</td>
</tr>
<tr>
<td></td>
<td>VR-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-4b Temporary Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-5 Storm Drain Inlet Protection</td>
</tr>
<tr>
<td></td>
<td>WD-1 Earth Dike</td>
</tr>
<tr>
<td></td>
<td>WD-2 Slope Drain</td>
</tr>
<tr>
<td></td>
<td>WD-3 Temporary Drains and Swales</td>
</tr>
<tr>
<td></td>
<td>WD-4 Dewatering Nuisance Water</td>
</tr>
<tr>
<td>SC-6 Silt Fence</td>
<td>SC-1 Stockpiles and Sediment Disposal</td>
</tr>
<tr>
<td>SS-2 Dust Control</td>
<td>SS-4 Construction Road Entrance Stabilization</td>
</tr>
<tr>
<td></td>
<td>VDM-3 Revegetation After Soil Disturbance</td>
</tr>
<tr>
<td>SS-3 Temporary Stream Crossing</td>
<td>SC-5 Sediment Traps</td>
</tr>
<tr>
<td></td>
<td>SC-6 Silt Fence</td>
</tr>
<tr>
<td></td>
<td>SS-4 Construction Road Entrance Stabilization</td>
</tr>
<tr>
<td></td>
<td>WD-1 Earth Dike</td>
</tr>
<tr>
<td></td>
<td>WD-3 Temporary Drains and Swales</td>
</tr>
<tr>
<td></td>
<td>WD-4 Dewatering Nuisance Water</td>
</tr>
<tr>
<td></td>
<td>WD-5 In Channel Flow Diversions Systems</td>
</tr>
<tr>
<td>If You’re Considering This BMP…</td>
<td>Consider These BMPs Also…</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>---------------------------</td>
</tr>
</tbody>
</table>
| SS-4 Stabilized Unpaved Roads and Entrances | VDM-2 Removal of Existing Vegetation  
VDM-4 Debris Removal |
| VDM-4 Debris Removal | EV-1 Equipment and Vehicle Maintenance  
EV-2 Equipment and Vehicle Cleaning  
NR-3 Project Planning/Scheduling  
SC-1 Stockpiles and Sediment Disposal  
VDM-1 Preservation of Existing Vegetation  
VDM-2 Removal of Existing Vegetation  
VDM-3 Revegetation After Soil Disturbance  
VR-1 Brush or Rock Filter  
WD-1 Earth Dike  
WD-2 Slope Drain  
WD-3 Temporary Drains and Swales |
| VR-1 Brush or Rock Filter | VR-2 Check Dams |
| VR-2 Check Dams | VR-1 Brush or Rock Filter |
| VR-3 Slope Roughening or Terracing | SS-1 Erosion Control Blankets, Mats, and Geotextiles  
VDM-2 Removal of Existing Vegetation |
| VR-4 Outlet Protection | SC-4 Straw or Sand Bag Barrier  
SS-1 Erosion Control Blankets, Mats, and Geotextiles |
| WD-1 Earth Dike | SC-3 Sediment Basins  
SC-5 Sediment Traps  
VDM-3 Revegetation After Soil Disturbance  
VR-4a Permanent Outlet Protection  
VR-4b Temporary Outlet Protection  
WD-2 Slope Drain |
## SELECTING BMPs

<table>
<thead>
<tr>
<th>If You’re Considering This BMP…</th>
<th>Consider These BMPs Also…</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WD-2 Slope Drain</strong></td>
<td>SC-3 Sediment Basins</td>
</tr>
<tr>
<td></td>
<td>SC-5 Sediment Traps</td>
</tr>
<tr>
<td></td>
<td>VR-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-4b Temporary Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>WD-1 Earth Dike</td>
</tr>
<tr>
<td></td>
<td>WD-3 Temporary Drains and Swales</td>
</tr>
<tr>
<td><strong>WD-3 Temporary Drains and Swales</strong></td>
<td>SC-3 Sediment Basins</td>
</tr>
<tr>
<td></td>
<td>SC-5 Sediment Traps</td>
</tr>
<tr>
<td></td>
<td>VDM-1 Preservation of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-2 Removal of Existing Vegetation</td>
</tr>
<tr>
<td></td>
<td>VDM-3 Revegetation After Soil Disturbance</td>
</tr>
<tr>
<td></td>
<td>VR-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-4b Temporary Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>WD-1 Earth Dike</td>
</tr>
<tr>
<td></td>
<td>WD-2 Slope Drain</td>
</tr>
<tr>
<td><strong>WD-4 Dewatering Nuisance Water</strong></td>
<td>VR-1 Brush or Rock Filter</td>
</tr>
<tr>
<td></td>
<td>VR-2 Check Dams</td>
</tr>
<tr>
<td></td>
<td>VR-3 Slope Roughening or Terracing</td>
</tr>
<tr>
<td></td>
<td>VR-4a Permanent Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-4b Temporary Outlet Protection</td>
</tr>
<tr>
<td></td>
<td>VR-5 Storm Drain Inlet Protection</td>
</tr>
<tr>
<td><strong>WD-5 In-Channel Flow Diversion Systems</strong></td>
<td>CU-4 Spill Prevention and Control</td>
</tr>
<tr>
<td></td>
<td>EV-1 Equipment and Vehicle Maintenance</td>
</tr>
<tr>
<td></td>
<td>SC-3 Sediment Basins</td>
</tr>
<tr>
<td></td>
<td>SC-4 Straw or Sand Bag Barriers</td>
</tr>
<tr>
<td></td>
<td>SC-5 Sediment Traps</td>
</tr>
<tr>
<td></td>
<td>SC-6 Silt Fence</td>
</tr>
<tr>
<td></td>
<td>WD-2 Slope Drain</td>
</tr>
<tr>
<td></td>
<td>WD-4 Dewatering Nuisance Water</td>
</tr>
<tr>
<td><strong>Every BMP</strong></td>
<td>NR-3 Project Planning/Scheduling</td>
</tr>
</tbody>
</table>
Section III

Descriptions of Best Management Practices
Organizations

This section describes in detail the individual Best Management Practices. The BMPs are divided into eight categories.

Specific BMPs include the following.

<table>
<thead>
<tr>
<th>Category/Code</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CU:</td>
<td>Chemical Use</td>
<td></td>
</tr>
<tr>
<td>CU-1</td>
<td>Certified Pesticide Applicator</td>
<td>III-CU-1.1</td>
</tr>
<tr>
<td>CU-2</td>
<td>Pest Control Equipment Maintenance</td>
<td>III-CU-2.1</td>
</tr>
<tr>
<td>CU-3</td>
<td>Material Handling</td>
<td>III-CU-3.1</td>
</tr>
<tr>
<td>CU-4</td>
<td>Spill Prevention and Control</td>
<td>III-CU-4.1</td>
</tr>
<tr>
<td>CU-5</td>
<td>Pesticide Application and Wind Conditions</td>
<td>III-CU-5.1</td>
</tr>
<tr>
<td>CU-6</td>
<td>Pesticide Application and Aquatic Conditions</td>
<td>III-CU-6.1</td>
</tr>
<tr>
<td>CU-7</td>
<td>Pesticide Application and Landscape Conditions</td>
<td>III-CU-7.1</td>
</tr>
<tr>
<td>CU-8</td>
<td>Concrete Use and Disposal</td>
<td>III-CU-8.1</td>
</tr>
<tr>
<td>EV:</td>
<td>Equipment and Vehicles</td>
<td></td>
</tr>
<tr>
<td>EV-1</td>
<td>Equipment and Vehicle Maintenance</td>
<td>III-EV-1.1</td>
</tr>
<tr>
<td>EV-2</td>
<td>Equipment and Vehicle Cleaning</td>
<td>III-EV-2.1</td>
</tr>
<tr>
<td>NR:</td>
<td>Natural Resource Protection and Restoration</td>
<td></td>
</tr>
<tr>
<td>NR-1</td>
<td>Channel Protection and Restoration</td>
<td>III-NR-1.1</td>
</tr>
<tr>
<td>NR-2</td>
<td>Biotechnical Bank Stabilization</td>
<td>III-NR-2.1</td>
</tr>
<tr>
<td>NR-3</td>
<td>Project Planning/Scheduling</td>
<td>III-NR-3.1</td>
</tr>
<tr>
<td>SC:</td>
<td>Sediment Control</td>
<td></td>
</tr>
<tr>
<td>SC-1</td>
<td>Stockpiles and Sediment Disposal</td>
<td>III-SC-1.1</td>
</tr>
<tr>
<td>SC-2</td>
<td>Dredging</td>
<td>III-SC-2.1</td>
</tr>
<tr>
<td>SC-3</td>
<td>Sediment Basins</td>
<td>III-SC-3.1</td>
</tr>
<tr>
<td>SC-4</td>
<td>Straw or Sand Bag Barriers</td>
<td>III-SC-4.1</td>
</tr>
<tr>
<td>SC-5</td>
<td>Sediment Traps</td>
<td>III-SC-5.1</td>
</tr>
<tr>
<td>SC-6</td>
<td>Silt Fence</td>
<td>III-SC-6.1</td>
</tr>
<tr>
<td>SS:</td>
<td>Soil Stabilization</td>
<td></td>
</tr>
</tbody>
</table>
## Section III

### BMP DESCRIPTIONS

<table>
<thead>
<tr>
<th>BMP Code</th>
<th>BMP Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-1</td>
<td>Erosion Control Blankets, Mats, and Geotextiles</td>
<td>III-SS-1.1</td>
</tr>
<tr>
<td>SS-2</td>
<td>Dust Control</td>
<td>III-SS-2.1</td>
</tr>
<tr>
<td>SS-3</td>
<td>Temporary Stream Crossing</td>
<td>III-SS-3.1</td>
</tr>
<tr>
<td>SS-4</td>
<td>Construction Road Entrance Stabilization</td>
<td>III-SS-4.1</td>
</tr>
<tr>
<td>VDM-1</td>
<td>Preservation of Existing Vegetation</td>
<td>III-VDM-1.1</td>
</tr>
<tr>
<td>VDM-2</td>
<td>Removal of Existing Vegetation</td>
<td>III-VDM-2.1</td>
</tr>
<tr>
<td>VDM-3</td>
<td>Revegetation After Soil Disturbance</td>
<td>III-VDM-3.1</td>
</tr>
<tr>
<td>VDM-4</td>
<td>Debris Removal</td>
<td>III-VDM-4.1</td>
</tr>
<tr>
<td>VR-1</td>
<td>Brush or Rock Filter</td>
<td>III-VR-1.1</td>
</tr>
<tr>
<td>VR-2</td>
<td>Check Dams</td>
<td>III-VR-2.1</td>
</tr>
<tr>
<td>VR-3</td>
<td>Slope Roughening or Terracing</td>
<td>III-VR-3.1</td>
</tr>
<tr>
<td>VR-4a</td>
<td>Permanent Outlet Protection</td>
<td>III-VR-4.1</td>
</tr>
<tr>
<td>VR-4b</td>
<td>Temporary Outlet Protection</td>
<td>III-VR-4.8</td>
</tr>
<tr>
<td>VR-5</td>
<td>Storm Drain Inlet Protection</td>
<td>III-VR-5.1</td>
</tr>
<tr>
<td>WD-1</td>
<td>Earth Dike</td>
<td>III-WD-1.1</td>
</tr>
<tr>
<td>WD-2</td>
<td>Slope Drain</td>
<td>III-WD-2.1</td>
</tr>
<tr>
<td>WD-3</td>
<td>Temporary Drains and Swales</td>
<td>III-WD-3.1</td>
</tr>
<tr>
<td>WD-4</td>
<td>Dewatering Nuisance Water</td>
<td>III-WD-4.1</td>
</tr>
<tr>
<td>WD-5</td>
<td>In Channel Flow Diversion Systems</td>
<td>III-WD-5.1</td>
</tr>
</tbody>
</table>

For each BMP, the following information is provided:

- BMP Category
- BMP Code and Titles
- Graphic Illustration(s)
- BMP Objectives (identified as bulleted items in the box next to the Description).
- Description
- Applicability
- Approach and Standards
- Limitations
- Maintenance, Costs, and Training Requirements
- References
Other Considerations

The specific design details presented in this section are meant to be used as guidance only. In using these BMPs, flood control personnel should consider site-specific characteristics, such as terrain and micro-climate, in selecting and adapting the BMPs. Sizing and design criteria for each of these BMPs may be standardized for local areas, and are beyond the scope of this manual. Consult your local flood control and other appropriate municipal agencies to determine if such criteria have been developed before you size specific BMPs.

Permits and/or approvals from various regulatory agencies likely will be necessary prior to implementing several of the BMPs listed here. Be sure to conduct a thorough review of and obtain the necessary permits and approvals before starting work.
Chemical Use
Description

As required by law, each person performing pest control activities should be certified by the State of California. Those personnel who apply Class I pesticides must obtain a qualified applicator certificate (QAC). Those personnel who purchase Type I or Type II pesticides or who oversee the application of such pesticides, shall obtain a qualified application license (QAL).

Applicability

➢ This applies to all sites where pest control activities are necessary.

Approach and Standards

• Ensure that all qualified applicators are currently certified by the State of California and receive regular training, which includes internal training by the flood control agency.
• Internal training by the flood control agency may be sufficient to qualify staff to apply less-toxic types of pesticides (e.g. Rodeo and Roundup.)
• Prior to the use of any pesticides, obtain a pesticide use recommendation from a licensed pest control advisor trained in integrated pest management.
• Use pesticides with a low environmental persistence, whenever appropriate.
• Prescribe pesticide rates at the lowest possible effective level.
• Encourage qualified applicators to obtain a pest control advisor (PCA) license.
• Perform all pest control activities in a careful and effective manner.
• Exercise reasonable precautions to avoid contamination of the environment.
• Follow the product label instructions for proper application and disposal of the product.
Chemical Use

- Triple rinse empty pesticide containers and use the rinsewater as product. Upon rinsing, follow the label for proper disposal of the empty pesticide containers.
- Follow any other applicable performance standards of the local municipal stormwater programs.

Limitations

If a qualified applicator certificate or license is refused, revoked, or suspended by the director, an agency could be prevented from performing any pest control activities involving the use of pesticides until that time a certified qualified applicator is available.

Requirements

Maintenance

- Maintain records of applicator licensing and renewals.
- Ensure that applicators continue their education on proper pest control and integrated pest management practices.

Costs

Costs exist for applicator licensing, renewal, and training.

Training

Make sure that applicators continue with pesticide training as required by the California Code of Regulations.

References


Use only pest control equipment that is in good repair, safe to operate, and suitable for the proper application of pesticides. Regularly maintain equipment to meet these criteria.

This applies to all equipment used for pest control activities.

Refer to BMPs EV-1, EV-2 and CU-4 for further information related to this BMP.

Acquire and maintain the most recent and accurate application equipment to ensure that only the amount of pesticide specified is applied to the target area.

Calibrate equipment prior to use to ensure the correct amount of chemical is applied.

Detoxify spray equipment between applications.

Use off-site facilities or commercial washing businesses as much as possible to wash equipment and to prevent pesticides from entering the flood control channel.

Use secondary containment, such as a drip pan or drop cloth, to catch spills or leaks when removing or changing liquids.

Equip each service rig and piece of application equipment that handles pesticides and draws water from an outside source with an air-gap separation, reduced pressure principle backflow prevention device, or double check valve assembly. First ensure that the backflow protection is acceptable to both the water purveyor and the local health department.

Operational Permits Committee
III-CU-2.1
EOA, Inc.
June 2000
Chemical Pest Control Use Equipment Maintenance

Limitations

- The ability to send pest control equipment on or off site may be a time limitation.
- Obtaining clearance from the local water purveyor and the health department for backflow protection may be time-intensive if not properly planned.

Requirements

Maintenance

- Keep ample supplies of spill cleanup materials on-site.
- Inspect equipment and maintenance areas on a regular schedule and repair equipment as necessary.

Costs

- Cleaning or repairing equipment at a commercial business can be economical because it eliminates the need for a separate operation at your site.
- Other costs depend on the rate of repairs or of upgrading the application equipment.

Training

- Keep employees updated on the most recent, accurate methods to repair or improve new or existing application equipment, and maintenance techniques that promote pollution prevention.
- Train employees in proper maintenance and spill clean up procedures.
- Train employees on the proper calibration of equipment.

References


Description

Methods to ensure that all chemicals, including pesticides, are handled in a safe manner that protects the applicator and eliminates the potential to pollute stormwater runoff.

Applicability

- This applies to all sites where chemical handling occurs.
- Refer to BMP CU-4 for additional information related to this BMP.

Approach and Standards

- Use less-toxic products when available and appropriate.
- If preparing chemicals, mix small batches at a time to avoid creating excess material that would require storage or disposal.
- Follow manufacturers’ instructions regarding chemical uses, protective equipment, ventilation, and flammability.
- Follow the chemical label for the exact rate, mixing and application of herbicides.
- Do not mix or load chemicals where a spill would be likely to enter a storm drain inlet, or channel.

Limitations

No limitations.

Requirements
Maintenance

- Ensure that mixing tools function properly. Repair or replace tools for mixing as needed.

Costs

Using proper mixing techniques is a potential cost savings. Mixing pesticides in small batches avoids creating excess material that would require storage or disposal.

Training

- Staff must be trained in the safe use of chemicals and proper mixing techniques to prevent accidental leaks, spills and hazards.

- Applicators must be trained in estimating proper rate, mixing, and application of pesticides.

References


Description

Practices designed to prevent or reduce the discharge of chemicals to flood control channels and the storm drain system.

Applicability

→ This applies to all sites where chemicals are stored or used.

Approach and Standards

• Locate the storage area for fuels, lubricants, and chemicals away from the channel and the storm drain system.
• Use double-walled containment for chemical containers to prevent runon from adjacent areas as well as runoff from the material storage area. Place items on a pallet when possible.
• During the period between October 15 and April 15, all chemical storage areas, including equipment fluids, need an impermeable cover to prevent contact with rainfall. Easy access to an impermeable cover should be available during the dry months for use in case of rainfall.
• Be present when pesticides are delivered.
• Store pesticides in an individual storage unit separate from other types of chemicals.
• Keep pesticide storage at a maintenance or construction site to a minimum, storing only the amount needed and, for only as long as it is needed.
• Try to keep chemicals in their original containers, or keep them well labeled.
• Contact the local hazardous waste department for disposal alternatives for specific chemical and wastes.
• Have proper storage instructions posted at all times in an open and conspicuous location and keep an ample supply of appropriate spill clean up material near storage areas.

Source: BASMAA
Chemical Use

- Immediately clean up spills and properly dispose of contaminated soils and clean-up materials as follows:
  - Sweep dry spills instead of washing or hosing them down.
  - Use an absorbent material to clean up wet spills on impervious surfaces.
  - Dig up wet spills on all exposed soils and properly dispose of them.
- Use only a reputable, licensed company to clean up large spills and dispose of contaminated materials.
- Notify the State Office of Emergency Service (OES) and other regulatory agencies as appropriate when a hazardous spill occurs.

Limitations

- Storage units must meet building and fire code requirements.
- Space limitations may preclude indoor storage requirements.
- Appropriate maintenance personnel should identify appropriate practices for the specific materials used or stored on site.

Requirements

Maintenance

- Keep inventories accurate and up-to-date for all stored materials.
- Keep an ample supply of spill clean-up materials near the storage area.
- Inspect regularly for leaks, spills, and external corrosion of material containers.
- Keep storage area clean and well organized.
- Repair or replace containment structures and covers as needed to keep them properly functioning.
- Inspect fueling areas and storage tanks on a regular basis.
- Update spill prevention and control plans and stock appropriate clean up materials whenever changes occur in the types of chemicals on site.

Costs

- Costs will vary depending on the size of the storage area, the types, amounts, and variety of materials involved, and the necessary controls.
- Costs include staff time for proper labeling and inventory.

Training

- Train employees in emergency spill procedures.
Chemical Spill Prevention & Control

- Train employees in proper materials storage.
- Train employees on the locations of spill kits on crew trucks and at other agency locations.

References


Description

Methods for taking into consideration a site’s wind conditions to determine when and how best to apply pesticides.

Applicability

➢ This applies to all sites where pesticides are sprayed.

Approach and Standards

• Avoid spray drift by having spray crews begin work early in the day when wind velocities tend to be lower.
• Carry anemometers to track wind speed and cease spray operations before wind speeds reach ten (10) miles per hour.
• Stop spraying if environmental conditions cause drift or volatilization of the pesticide.
• Add drift control agents to spray tanks as needed to prevent off-target drift.
• Select areas suitable for spraying based on the wind conditions at the time of spraying.
• Follow the product label instructions for proper application and disposal of the product.

Limitations

No limitations.
Requirements

Maintenance

Repair or replace tools for assessing wind conditions (e.g. anemometer) as needed for proper functioning.

Costs

- Material costs include those for drift control agents, as well as the cost of devices to measure wind speed.
- Refraining from spraying during the wrong wind conditions can save costs with respect to the amount of pesticides used. However, delays in pesticide application could cause extra staff costs.

Training

Train pest control staff on measuring wind conditions and judging whether or not to apply pesticides to the site. This training is vital to preventing pollutants from entering the channel or becoming a drift nuisance.

References


Flood Control Maintenance BMP Manual

Section III - CU-6

Chemical Pesticide Application and Aquatic Conditions

Description

Practices to avoid build-up of pesticides in flowing water and to protect aquatic resources from the adverse effects of pesticide application.

Applicability

➢ This applies to all sites where pest control activities are necessary.

Approach and Standards

• Perform work when tides are favorable to prevent off target movement.
• Make aquatic applications from the downstream end of a project to the upstream end to avoid a buildup of product in the flowing water.
• Apply only those herbicides, algaecides, and surfactants that are registered for use in channel bottoms, regardless of whether water is present at the time.
• Use only USEPA-approved herbicides in channels or in areas where spray could come in contact with aquatic life.
• Do not apply herbicides during rainfall or imminent rainfall when the herbicide may runoff the target plant.
• Consult the California Department of Fish and Game to determine the need for any seasonal restrictions on the use of herbicides in a water body or channel reach.
• Follow the product label instructions for proper application and disposal of the product.

Creosote

• As per California Department of Fish and Game regulations, for any new structures or for any repairs to or replacements of any existing structures coated with creosote, the structure must be properly wrapped with plastic to prevent creosote from coming into contact with water. Creosote can be continually leached if in contact with water.
The plastic wrapping should extend up the structure (typically pilings) to the level necessary so that no water will contact and thereby leach the creosote. The California Department of Fish and Game recognizes pressure-treated woods as an acceptable alternative to creosote. However, hand-applied wood treatment materials that are currently on the market can also leach into the water, and are not acceptable. Therefore, only factory pressure treatments are currently acceptable.

Limitations

- Requires planning.
- The amount of maintenance required to keep creosote-coated structures properly wrapped with plastic may make creosote not cost-effective to use.

Requirements

Maintenance

- Maintain accurate and up-to-date records of herbicides, algaecides, and surfactants that are registered for use in channel bottoms.
- Track weather forecasts.
- Regularly inspect and repair plastic coverings on creosote-coated structures.

Costs.

- Staff time due to unplanned delays may be an extra cost.
- Staff time for installation, inspection, and repair of plastic shielding on creosote-coated structures. Materials cost for the plastic.

Training.

Train and update pest control staff on the types of impacts of available herbicides, algaecides, surfactants and pesticides. Train staff to use proper application methods, and to judge when to spray due to weather, or seasonal restrictions. This training is vital to keeping pollutants from entering the channel. Train staff on the regulations regarding creosote use.

References

Chemical Pesticide Application and Aquatic Conditions

Rugg, Michael, California Department of Fish and Game, personal communication at BASMAA Operational and Permits Committee, September 14, 1999.

Rugg, Michael, California Department of Fish and Game, personal communication, March 13, 2000.
Description

Specific land application techniques for ensuring safe pesticide dosage for local vegetation and soil types and for preventing excess runoff from sloped channel banks.

Applicability

➢ This applies to all sites for which pesticides are applied.

Approach and Standards

• Use integrated pest management practices whenever possible.
• Use new pesticides on small scale test plots first to determine the efficacy of the products on local vegetation types and soils, and the minimum safe dosage to control certain weeds.
• Apply applications, in a manner to avoid excess material from being carried off-site or into the channel.
• Follow the product label instructions for proper application and disposal of the product.

Limitations

Time and space are necessary for performing trial applications on small scale test plots.
Chemical Pesticide Application and Landscape Conditions

Requirements

Maintenance

For future use, maintain accurate records of new products that are found to work most effectively on local vegetation types and soils.

Costs

- Staff costs may exist for tilling the soil and preparing and caring for test plots.
- Time, staff, and material costs exist for testing new products on a small scale for effectiveness on local vegetation and soil types.
- Techniques assure that the minimum safe dosage of pesticides is applied on a large scale. Taking this preliminary step can save costs, depending on specific site characteristics.

Training

- Train pest control staff to analyze land conditions and judge whether or not to spray; this is vital to preventing pollutants from entering the channel.
- Train staff to maintain and evaluate accurate records.
- Train staff on how to properly prepare and analyze test plots.

References

Chemical Use

Section III - CU-8
Concrete Use and Disposal

Description

Implement use, washout, and disposal practices for concrete activities that prevent concrete leaching discharge to flood control channels, waterways, and storm drain systems.

Applicability

- Replacement or construction of concrete piers or pilings.
- Construction or maintenance projects where concrete is used and where concrete dust and debris result from demolition activities.
- Any time concrete may contact water. Before cured, concrete can leach into the water and affect the pH of water.

Approach and Standards

General

- To the degree possible, avoid mixing extra concrete on site.
- When washing concrete to remove fine particles and expose the aggregate, do not wash the fines into the channel, street, or storm drain. Collect and return the fines to the aggregate base stockpile or dispose of properly.
- Minimize water use by having a positive shutoff on the washout hose.
- Designate concrete disposal areas.
- Store dry bulk and bagged cement, mortar, sand, and concrete materials under cover, away from the channel and the storm drains.
Washouts

• Designate areas to be used for washout of transit mix trucks and other vehicles and equipment used to transport, move, and/or work concrete.
• Locate on site washout areas at least 50 feet from any storm drain inlets, drainage facilities, or channels. Contain runoff from this area by constructing a temporary pit or berm area large enough to contain the liquid and solid waste generated during washout procedures.
• Washout locations may be flagged with lath or surveyors tape or designated as necessary to insure that truck drivers utilize proper areas.
• Perform washout of concrete trucks in designated areas only. Do not allow excess concrete to be dumped on site, except in designated areas.
• Wash wastes into a temporary pit where the concrete can set, be broken up, and then disposed of properly. Dispose of hardened concrete on a regular basis.

Concrete Use In and Near Waterways

• When sawcutting or sanding, ensure concrete dust does not enter waterway.
• Use sheeting or otherwise isolate concrete that is used in channels (e.g., for piers, etc.) for generally 2.5 weeks to one month to allow time for curing. Concrete has a cure time of approximately one month. Concrete that has not been cured can increase the pH of the water. Concrete should be isolated until it no longer poses a threat to the pH levels.

Limitations

• Space and staff time is needed to designate and set up a washout area.
• The replacement of structures that are made of concrete and are in contact with stream water would violate California Department of Fish and Game Code § 5650 without proper BMPs.
• Requires planning.

Requirements

Maintenance

• Monitor weather and wind direction to ensure concrete dust is not entering storm drains or channels.
Chemical Use

- Where appropriate, construct sediment traps or other types of sediment detention devices downstream of demolition activities.
- Monitor on-site concrete waste storage and disposal procedures at least weekly.
- Regularly monitor materials used to isolate concrete located in inundated channels or waterways. Once the concrete cures, promptly remove the sheeting or other isolation materials.

Costs

- Material costs for sheeting or isolation materials, and staff time costs for monitoring can incur.

Training

- Instruct drivers and equipment operators on proper concrete disposal and equipment washout practices.
- Educate employees, subcontractors, and suppliers on concrete waste storage and disposal procedures.
- Designate a staff member, aware of the potential environmental consequences of improperly handled concrete and concrete wastes, to oversee and enforce concrete management procedures.
- If using a temporary pit, dispose of hardened concrete on a regular basis.
- Instruct staff on California Department of Fish and Game statutes, and on proper installation, monitoring, and removal of isolation materials for protection during curing of concrete placed in waterways.

References


Rugg, Mike, California Department of Fish and Game, personal communication, BASMAAA OPC meeting, September 14, 1999.

Equipment and Vehicles
Source: BASMAA

Description

Methods to prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment maintenance by conducting these activities off-site or in a designated area designed to contain spills and prevent runon or runoff.

Applicability

- This applies to all equipment and vehicle maintenance activities associated with flood control maintenance.
- Refer to BMP CU-4 (spill prevention and control) for more information related to this BMP.

Approach and Standards

- Keep vehicles and equipment clean. Do not allow excessive build-up of oil or grease.
- Maintain vehicles and equipment, and conduct fueling off-site or in a designated, protected area where vehicle fluids and spills can be handled more easily.
- If maintenance must occur on-site, use designated areas located away from drainage courses to prevent the run-on of stormwater and the runoff of spills. Clearly designate the service area with berms, sandbags, or other barriers.
- For vehicles that use hydraulic equipment (e.g., excavators, loaders), consider using vegetable-based hydraulic oil, which is biodegradable.
- Quantities of equipment fluids greater than 55 gallons should be provided with secondary containment that is capable of containing 110% of the primary container(s).
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids. Store fluids in appropriate containers with covers, and properly recycle or dispose of them off-site.

Pollution Prevention

Pollution Control
For long-term projects, use portable tents or covers over maintenance areas during the rainy season, October to April. Make sure fluid containers are properly stored in covered areas.

- Store cracked batteries in a non-leaking secondary container and remove from the site.
- Place a stockpile of spill clean-up materials where it will be readily accessible.
- Use absorbent materials on small spills located on impervious surface rather than hosing down the spill. On pervious surfaces such as soils, dig up wet spills and properly dispose of the material rather than burying it. Collect and dispose of the absorbent materials properly and promptly.
- Regularly inspect on-site vehicles and equipment for leaking oil and fluids.
- Check incoming vehicles and equipment for leaking oil and fluids (including delivery trucks, and employee and subcontractor vehicles). Do not allow leaking vehicles or equipment on-site.
- As appropriate, properly label containers with a “Hazardous Waste” label and properly recycle or dispose of hazardous waste off-site.

**Limitations**

Not allowing leaking vehicles or equipment on-site may cause delays in construction.

**Requirements**

**Maintenance**

- Maintain waste fluid containers in leak-proof condition.
- Keep ample supplies of spill cleanup materials on-site.
- Inspect on-site and off-site vehicle and equipment maintenance areas regularly.

**Costs**

- Costs associated with this BMP will depend on the age, use, and amount of preventative maintenance of the equipment and vehicles used.
- Cleaning equipment at a commercial business can be economical by eliminating the need for a separate operation at your site.
- Lower hazardous waste management costs by eliminating or reducing the amount of hazardous wastes.
- Separate wastes for easier recycling and lower disposal costs.

**Training**

- Train employees in proper maintenance techniques that promote pollution prevention.
• Train employees in spill clean up procedures.

References


Frame, Robert (San Mateo County Public Works), personal communication to Billi Romain (BASMAA), June 7, 2000.

Description

Practices to prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning by using off-site facilities whenever possible, or by conducting these operations in designated, protected areas.

Applicability

➢ This applies to all equipment and vehicles that are used for flood control activities and that require cleaning.

Approach and Standards

• Whenever possible, wash vehicles and equipment off-site where wash waters may be disposed of properly.
• When vehicle and equipment cleaning must occur on-site, and the operation cannot be located with treatment facilities and discharge to a sanitary sewer, the outside cleaning area should have the following characteristics:
  ✓ Located away from storm drain inlets, drainage facilities, or channels.
  ✓ Bermed to contain wash waters and to prevent runon and runoff.
  ✓ Configured wash area with a sump to allow collection and disposal of wash water.
  ✓ Discharge water as dust control or to a pervious surface.
  ✓ Wash waters shall not be discharged or allowed to flow to storm drains or channels.
  ✓ Use the on-site cleaning area only when necessary.
• Refer to CU-8 for concrete or cement washout.
Equipment & Vehicle Cleaning

- Use as little water as possible to avoid having to install erosion and sediment controls for the wash area.
- Use phosphate-free, biodegradable soaps and then use the least amount necessary.
- Do not permit steam cleaning, unless the area is equipped with filtering devices. Do not permit the use of soap, solvents, or degreasers on-site. These particular items generate significant pollutant concentrations.

**Limitations**

- Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades.
- Some municipalities may require pretreatment and monitoring of wash water discharges to the sanitary sewer. Contact the local wastewater authority for permission and direction prior to initiating cleaning activities.

**Requirements**

**Maintenance**

- Inspect regularly for erosion and sedimentation of the wash areas.
- Regularly service sumps associated with wash areas.

**Costs**

- Cleaning equipment at a commercial business can be economical by eliminating the need for a separate operation at your site.
- Staff time to create vehicle wash area, maintain sump, contact proper authorities.
- Material costs for berms, sumps, biodegradable soap, and aggregate, concrete or asphalt base.

**Training**

- Train employees on the proper disposal of wash waters.
- Educate employees and subcontractors on pollution prevention measures.
Sump with discharge to sewer or with hatch for pump out.

Washing area

Pave washing area with concrete, asphalt or stabilize with aggregate base.

Gravel

Entrance and exit to the wash area. Width as needed to accommodate equipment.

Straw bale barrier or sand bag barrier for containment berm

Pavement or stabilized base

Original grade

Source: Caltrans, 1997.
References


Natural Resource Protection and Restoration
Description

Practices to protect or provide suitable habitat for fish, amphibians, and wildlife dependent on the riparian area.

Applicability

- Channels and stream work.

Channel restoration is likely to have a strong, positive effect on wildlife protection.

Approach and Standards

**All Channels.**

- Schedule work to avoid wildlife breeding or nesting seasons (see BMP NR-3).
- Regrade the channel bottom at the end of work to as close to original conditions as possible in order to restore the riffle and pool configuration of the channel bottom.
- Release flow after work is completed at a reduced velocity to minimize erosion or the washing of fish or amphibians downstream. Consult with a creek naturalist, hydrologist or appropriately trained personnel prior to release to determine appropriate flow velocity if substantial quantities of water have been impounded.
- As appropriate, spawning gravel should be carefully removed and stored in areas where maintenance activities will not impact the gravel. The gravel should be replaced as close to original conditions as possible upon completion of the maintenance activities.
- Off-site gravel should not be used to create spawning areas without approval by appropriate regulatory agencies and biologists.
- Perform bank repairs in the dry season (see BMP NR-3).
- Keep site and channel disturbance to the minimum necessary to accomplish the repairs.
• Perform work from the top of the bank whenever possible. The operation of equipment in the channel should be kept to a minimum.
• Keep disturbance to any existing setback areas to the minimum necessary to accomplish the repair.

Natural Channels.
• Where feasible, leave wood in place to provide habitat.
• As long as they remain stable, allow undercut banks to remain in place for fish habitat.

Limitations
• Appropriate repairs may need to be performed during wet or breeding seasons.
• Practices need to allow for sufficient channel capacity to meet flood control requirements.

Requirements

Maintenance
• In natural channels, periodically inspect the stability of undercut banks. Undercut banks on engineered channels are considered unstable.
• Secure storage areas and care of spawning gravel during maintenance activities.

Costs
• Staff time for monitoring stability of undercut banks
• Potential additional staff time for performing work from the top of bank, regrading channel bottom to natural state upon disturbance, and protecting and returning spawning gravel.

Training
• Training needs are minimal. Staff should be trained in the reasons for and using the practices that minimize impacts.
• A trained biologist / creek naturalist / hydrologist / environmental planner or other appropriate personnel is recommended to conduct staff training on channel protection and restoration techniques.

References

Contra Costa County Flood Control District, personal communication, Cece Sellgren, March 2000.
Marin County Flood Control District, written communication, March 2000.

Description

Practices to protect or provide suitable habitat for fish, amphibians, and wildlife dependent on the riparian area. This measure provides a soft bank repair technique immediately adjacent to the flood control channel or work areas when possible for wildlife use and erosion control. A “soft” repair is a type of bank protection structure incorporating biological materials like seeds, plants, plant parts such as root wads, or a combination of vegetation and inert materials such as brush mats or sills, wattles, fascines, or branch packing or layering.

Applicability

➢ Channels and streams requiring bank repairs.

Approach and Standards

- Incorporate the services of qualified staff (e.g., engineer, planner, revegetation specialist) or a biotechnical consultant to create a plan to use soft bank repair techniques for the early stages of erosion under proper hydraulic conditions.
- If hydraulic conditions allow, retain a natural bank or use a biotechnical repair rather than or along with a hard-scape repair.
- In-kind repairs should be performed where possible and feasible, or biotechnical repairs should be considered and implemented if feasible.
- See also vegetation BMPs (VDM-1 through VDM-3).

Limitations

• Wildlife Protection
• Habitat Protection
• Erosion Control
• Slope and Channel Protection
Hydraulic conditions must be appropriate to allow for biotechnical repairs.
- Proper training in biotechnical repairs is necessary.
- Requires monitoring until vegetation is well established.

**Requirements**

**Maintenance**

- Vegetation maintenance, possibly including irrigation, until established.
- Regular monitoring required.
- In long term, biotechnical bank stabilization may require less overall maintenance by flood control personnel.

**Costs**

- Costs in staff time for planning, installation, monitoring, and if vegetation restoration is required.
- Regular monitoring and maintenance of vegetation until established.

**Training**

- Requires staff adequately trained in biotechnical bank stabilization to create repair plan.
- Training needs regarding biotechnical repairs including suitable locations, types of appropriate repairs, installation, monitoring, and maintenance.

**References**


Description

Plan channel maintenance projects to minimize potential for erosion and to protect special status species.

Applicability

➢ All flood control maintenance activities.

Approach and Standards

• Avoid disturbance to habitat during the nesting and/or breeding seasons. Wildlife surveys should be performed in areas where work is to be performed to confirm the absence of listed species or species of concern. Alert maintenance staff to the presence of any sensitive species in the area.
• Avoid or minimize soil or sediment disturbing activities during the rainy season between October 15 and April 15 unless approval to work within this period is received from regulatory agencies.
• Schedule major land disturbing activities during the dry season between April 15 and October 15. Work in channels during the dry season or in dewatered conditions if flowing water is present (see WD-5).
• Monitor the weather forecasts for rainfall and prepare the site if significant rain is imminent. If rain is forecast, have all materials that are needed to prepare the site for rain be readily available on site.
• When rainfall is predicted, adjust the schedule to allow for the implementation of erosion and sediment controls, such as vegetation or physical controls, on all disturbed areas prior to the onset of rain.
• Erosion may be caused during the dry season, by unseasonal rainfall, wind, and vehicle tracking. Maintain site stabilization year round and keep sediment trapping devices in operational condition.
Schedule work to minimize the extent of site disturbance at any one time.

Incorporate staged seeding and revegetation of channel banks as work progresses.

Install and maintain sanitary facilities on jobs that last multiple days.

**Limitations**

- Emergency work may require repairs during rain events.
- If the project is large and causes a significant impact to neighborhoods, it may be necessary to coordinate efforts between local governments and citizens. Work hours may be restricted to between 8 a.m. to 5 p.m.
- Tidal activities may restrict work hours. Consult a tide table applicable to the project site area to schedule work at low tide.

**Requirements**

**Maintenance**

- Routinely verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- When changes are warranted, amend the sequence in advance to anticipate problems and maintain control.

**Costs**

- No additional costs are necessary for materials.
- Costs due to staff time delays can be minimized with proper planning.
- Additional staff time may be necessary to coordinate with neighborhoods, agencies, and stakeholders.
- Additional mobilization costs for staged seeding and revegetation may be incurred.

**Training**

- Design staff and maintenance staff should be trained in planning and scheduling.
- Personnel with a background in biology may be necessary to determine typical nesting and breeding times and locations of sensitive species.
- All employees should receive annual pollution prevention training and contractors should receive training before the job is started.
- The construction crew should be trained in the requirements of all permits obtained for the project.
- Educate employees, subcontractors, and suppliers on sanitary/septic waste storage and disposal procedures.
References


Sediment Control
Description

Practices to protect channel water from re-deposition of removed sediments or from erosion of material stockpiles such as soil, sand, waste concrete, waste asphalt, or materials smaller in diameter than 4.75 mm.

Applicability

- Channels and streams requiring sedimentation removal.
- Stockpiles of soil, sand, or materials smaller than 4.75 mm in diameter.
- Stockpiles of waste concrete or asphalt.

Approach and Standards

- For removing sediment, use a hydraulic or barge-mounted dredge to reduce the impacts to vegetation and wildlife on channel banks.
- Remove sediment to an upland site or landfill. If the stockpiled material is appropriate, it can be used to repair levee or maintenance roads, as road base material, or other reuse needs. Sediment should not be used to fill waters of the United States unless the responsible party that uses the material has all of the appropriate permits and approvals.
- Sediment should not be removed outside of the San Francisco Bay watershed to prevent the further spread of exotic species such as mitten crabs. Trucks should be cleaned before leaving the job site (see BMP EV-2).
- Create a stockpile for wet sediments at or nearby the removal site to allow for drying before disposal.
- Temporary storage stockpiles should be located so that runoff will not discharge to surface water outside of the active work area. The stockpiles could be located so that runoff is directed towards sediment traps in the active work area.
In wet areas where a stockpile is not feasible, trucks may be lined with an impervious material such as plastic. Alternatively, the trucks could drain excess water by slightly tilting their loads and allowing the water to drain out to a sediment basin. Water should not drain directly to channels or city streets without proper water quality control measures in effect.

Do not stockpile dredged sediments or silt removed from sediment basins in an area where runoff can redeposit sediment in the channel.

At the off-site disposal area, all drainage outlets at the site should be protected from sediment laden runoff from the stockpiles by using one or some combination of the following BMPs:

- Cover stockpiles with plastic sheeting in a manner to prevent rainfall from having contact with the stockpiled materials. Securely attach the plastic sheeting to the stockpile.
- Cover the entire stockpile with an erosion control blanket(s). The erosion control blanket(s) should be installed as per the manufacturer’s directions (see BMP SS-1).
- Surround the downslope/downstream area of the stockpile with silt fences or hay bales (see BMP SC-7 or SC-5, respectively) as needed to reduce turbidity.
- Divert all storm water runoff from the stockpile to a sediment trap or sediment basin (see BMP SC-6).
- Remnants of any stockpiles should be swept up using dry sweeping methods, rather than hosed away.

Individual site characteristics may require different combinations of the best management practices described above.

**Limitations**

- None.

**Requirements**

**Maintenance**

- Stockpiles should be located so as not to flow to channels or storm drain inlets without being treated first. Regularly inspect and maintain plastic or blanket coverings, sediment traps, silt fences, and hay bale dikes, as necessary.

**Costs**

- Costs in staff time for inspection and maintenance.
Costs for materials (blankets, plastic, fencing, hay bales, etc.).

Training

- Train employees on correct placement of stockpiles, exotic species threats, and correct placement of and maintenance of erosion control blankets, hay bale barriers, sediment traps, silt fences, and plastic coverings.

References

**Description**

Practices to protect water quality from channel dredging.

**Applicability**

- Channels and streams requiring sediment removal.

**Approach and Standards**

- For removing sediment, use a hydraulic or barge-mounted dredge to reduce the impacts to vegetation and wildlife on channel banks.
- Perform wildlife and vegetation surveys prior to dredging to determine that the project area is free from sensitive species.
- Desilt culverts in later summer after birds have finished nesting, or as recommended by a qualified biologist who has performed a survey for nesting birds and amphibians (see also BMP NR-3).
- Monitor water quality upstream and downstream of the dredging site to check that sedimentation downstream is minimized and to meet the standards of the municipal NPDES storm water, waste discharge requirements, or other appropriate permits.
- Dredge small channels with an excavator from the access road on one side of the channel.
- Remove sediment in large channels from one side only in alternate years to minimize impacts on vegetation and wildlife.
- Dredge larger projects in a checkerboard pattern to reduce impacts on the vegetation and wildlife.

**Limitations**

- Some channels may be too small to incorporate all of the practices described.
- Planning is necessary to avoid nesting and breeding times.
**Requirements**

**Maintenance**

- Conduct monitoring and adjust procedures as necessary.

**Costs**

- Costs in staff time for monitoring.

**Training**

- Minimal training necessary. A trained biologist may be necessary to perform wildlife surveys.

**References**

Description

Practices to protect water quality by controlling sediments through the use and proper operation and maintenance of sediment basins. Sediment basins are designed to slow velocity and temporarily retain water to allow sediments to settle out. The basin is created by excavation or by constructing an embankment across a waterway or low drainage area. The basin allows storm water runoff to collect, and detain that water to allow sediments to settle out before being discharged. Sediment basins are temporary structures.

Applicability

- Use in association with dikes, temporary channels, and/or pipes being used to divert storm water from disturbed areas into the basin and from undisturbed areas around the basin.
- Outlets of disturbed watersheds 10 acres or greater.
- As necessary, outlets within smaller disturbed watersheds with concentrated flow or in areas with erosive soils.
- Any maintenance project that disturbs areas during the rainy season.
- Areas where a basin could prevent sediment-containing runoff from entering drainage ways or channels.
- Locations where permanent detention basins will be located.

This measure will likely have a significant impact reducing sediment; and may have a significant impact, depending on specific site characteristics in reducing heavy metals, oxygen demanding substances, and pathogens.

Approach and Standards

Installation

- Locate basins:
  - Where a low embankment can be built across a swale or excavation
  - Where failure would not cause loss of life or property;
  - In locations that allow for maintenance access and include room for protected sediment removal and stockpiling areas.
Section III - SC-3

Sediment Removal

Sediment Basins

- Size sediment basins using the following recommendations provided by the San Francisco Bay Regional Water Quality Control Board (1998):

1) \[ Q = CIA \]
   Where,
   \[ Q = \text{Flow expected from the site in cubic feet per second} \]
   \[ C = \text{Coefficient of runoff (typically between 0.4 to 0.7), depending on the imperviousness of the contributing area} \]
   \[ I = \text{Expected rainfall, in inches per hour} \]
   \[ A = \text{Contributing area in acres} \]

2) \[ A_s = \frac{1.2Q}{V_s} \]
   Where,
   \[ A_s = \text{Surface area of settling basin with 2-feet of minimum depth} \]
   \[ Q = \text{Flow as calculated above} \]
   \[ V_s = \text{Settling velocity of particles, in feet per second} \]
   \[ A = \text{Contributing area in acres} \]

<table>
<thead>
<tr>
<th>Particle Size (mm)</th>
<th>Particle Description</th>
<th>Settling Velocity ( V_s ) (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>Coarse sand</td>
<td>0.19</td>
</tr>
<tr>
<td>0.2</td>
<td>Medium sand</td>
<td>0.067</td>
</tr>
<tr>
<td>0.1</td>
<td>Fine sand</td>
<td>0.023</td>
</tr>
<tr>
<td>0.05</td>
<td>Coarse silt</td>
<td>0.0062</td>
</tr>
<tr>
<td>0.02</td>
<td>Medium silt</td>
<td>0.00096</td>
</tr>
<tr>
<td>0.01</td>
<td>Fine silt</td>
<td>0.00024</td>
</tr>
<tr>
<td>0.005</td>
<td>Clay</td>
<td>0.00006</td>
</tr>
</tbody>
</table>

- Build the sediment basin before the wet season and construction activities begin. In the Bay Area, the wet season is generally defined as October 15 through April 15.
- Clear areas under embankments, structural works, and sediment basins. Strip the areas of vegetation (see BMPs VDM-2 and VDM-4).
- Ensure the basin length to width ratio is greater than 3:1 (L:W).
- Provide baffles to prevent the short-circuiting of inlet flows that would reduce residence time.
- Place the basin inlet to maximize the distance from the basin outlet.
- Use rock or vegetation to protect the inlet and slopes from erosion.
- Consider using a forebay built upstream of the basin to remove debris and larger particles.
- Use corrugated metal or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser for the principal outlet. This will prevent floating debris from flowing out of the basin or from clogging the system. Make sure the principal outlet is designed to handle the inflow design storm.
Sediment Basins

- Locate the outlet structure on a firm and smooth foundation. The base should be anchored securely with concrete, etc. to prevent the base from floating.
- Connect the riser pipe using a watertight connection, to the horizontal pipe (barrel) that extends through the embankment to the toe of the fill. Provide anti-seep collars on the horizontal barrel.
- Clearly mark the basin's cleanout level on the riser pipe.
- Include an emergency spillway to handle flows that are not contained by the principal spillway. The spillway should be comprised of an open earthen or vegetated channel on top of undisturbed material (not fill), or constructed of non-erodible riprap.
- Place outlet protection at the pipe outlet (see BMP VR-4).
- Install a safety fence around the basin suitable for keeping children out of the basin.
- For removing sediment, use a hydraulic or barge-mounted dredge to reduce the impacts to vegetation and wildlife on channel banks.
- If any contaminated material or hazardous material is excavated, or needs to be transported or disposed of, follow the regulations of the following agencies: United States Department of Transportation, United States Environmental Protection Agency; California Environmental Protection Agency; Department of Toxic Substances Control; and California Division of Occupational Safety and Health Administration.

Limitations

- Some sites may not be situated in areas that allow for easy removal of sediments from the top of the banks.
- Erosion controls should be considered before sediment controls.
- Sediment and detention basins require a large enough surface area to allow for sediment settling. The basins need to be designed with enough length to prevent reduced residency time from short-circuiting.
- Multiple basins should be used for drainage areas greater than 100 acres (40 ha).
- Basin design should be created by a registered professional civil engineer and approved by the overseeing regulatory agency.
- Requires fencing to protect children.
- Do not locate sediment basins in streams.
- Standing water could provide suitable habitat for mosquitoes or other pests to breed.
- Frequent sediment removal can be labor-intensive and costly.


Requirements

Maintenance

- Conduct routine inspections of sediment and detention basins; make corrective repairs and perform maintenance including desilting as necessary. Inspect the basins before and after rain storms, and weekly through the wet season. Inspect sediment traps at least every 24 hours during extended storms.
- Dewater sediment basins or plug the outlet before beginning desilting operations.
- Work from the top of the banks when possible. Off-haul all materials once removed.
- Do not stockpile silt from sediment basins onsite where they can drain to the waterway.
- Require siltation removal on both a routine and corrective basis to promote effective stormwater pollutant removal efficiencies for wet or dry detention ponds, infiltration devices, and sediment basins.
- Observe or sample inlets and outlets frequently for total suspended solids to make sure the erosion control measures and sediment basins are working correctly.
- Examine the banks of the basin for structural soundness and any seepage.
- Examine the outlet structure and spillway for obstructions or damage, and repair as necessary.
- Check the outlet area for erosion and repair and stabilize as necessary.
- When the storage areas are one-third full, remove the sediment. Protect the sediment removed from the basin and stockpiled appropriately (see BMP SC-1).
- For most dry sediment basins, rakes, shovels, sickles and machetes may be all that is necessary for maintenance. Basins should be designed to allow access from heavy equipment as well, however. For wet basins, necessary maintenance equipment may include access vehicles, dump trucks, bulldozers, and dredging/excavation equipment.
- Necessary staffing includes a minimum of two people per crew for health and safety reasons, and a program manager who should be easily assessable to provide necessary direction.

Costs

- Frequent sediment removal can be costly and require intensive labor requirements. These costs can be reduced if ponds are properly designed so that accumulated sediments are easily removed.
- Costs for waste material removal, transport, and disposal.
- Material costs may be incurred for the following equipment: vehicles, dump trucks, bulldozers, trackhoes, excavators, mowers, weed trimmers, sickles, machetes, shovels, rakes, personal protective equipment including goggles, dust masks, coveralls, boots, and gloves.
In 1992, the USEPA estimated that the average annual cost for installation and maintenance of a sediment basin sized less than 50,000 cubic feet and designed to be used for 2 years was $0.40 per cubic foot, or $700 per drainage acre. For basins sized greater than 50,000 cubic feet, the USEPA estimated a cost of $0.20 per cubic foot, or $350 per drainage acre (SWQTF, Construction BMP Handbook, March 1993).

Training

- Necessary training includes proper excavation and maintenance procedures, and proper waste disposal procedures.
- Registered Professional Civil Engineer necessary for design.

Sediment Basin Outlets:

Source: Caltrans, 1997.
Sediment Removal

Section III - SC-3

Sediment Basins

Source: Caltrans, 1997.

References


Straw or Sand Bag Barriers

Description

Temporary devices consisting of straw, bio-degradable fiber, or sandbags that are placed to direct flow as to intercept sheet flow runoff and settle sediment behind the barriers while slowly allowing water through.

- Straw bales are temporary barriers that are entrenched and anchored end to end across the toe of a slope.
- Fiber rolls are porous rolls (or rolled blankets (see BMP SS-2)) comprised of bio-degradable fibers that are stuffed in photodegradable open weave netting. They allow water to filter through while trapping sediment, slowing runoff, and reducing sheet erosion.
- Sand or gravel bags also detain sediment-laden runoff from disturbed areas, and releases the water as sheet flow while retaining the sediment. In addition, sand bags can also be used as check dams in small ditches (see BMP VR-2).

Applicability

All
- Along the perimeter of a site.
- In flood control channels where a sediment removal project is in progress, barriers may be used in conjunction with other BMPs.

Straw Bale Dikes
- Beneath flat, disturbed areas that are likely to be subject to sheet and rill erosion.

Fiber Rolls
Sediment Removal

- Along the face of exposed and erodible slopes to shorten the length of the slope.
- At the grade breaks where slopes become steeper.
- In drainage swales to slow flows.
- Along streambanks to help with stabilization and revegetation (see BMPs VDM-3, NR-1, and NR-2).

Sand or Gravel Bags
- Across channels as a barrier to protect maintenance trenches or to provide temporary crossings for construction equipment.
- Parallel to roads to keep sediment off paved areas.
- For diverting or directing flow to, or for constructing a sediment basin (see BMP SC-3).
- When extended construction timelines limits the use of silt fences (BMP SC-6) or straw bale barriers.
- When construction/maintenance site conditions or scheduling requires relocation of barriers to meet changing field conditions and priorities.
- Upflow of storm drain inlets along roads at a 45 degree angle from the sidewalk curb to divert flow, slow flow velocity, and pond and filter runoff. Gravel preferred.

Approach and Standards

Straw Bale Dikes
- Place on 2% (50:1) or flatter slopes preferably. If the slope exceeds 10% (10:1), then the length of the slope upstream of the barrier should be less than 50 feet (15 m).
- Keep the drainage area upstream of the straw bale barriers to 0.25 ac/100 ft (0.3 ha/100 m).
- Keep the slope length that drains to the barrier to 100 ft or less (30 m).
- Do not place hay bales directly at the toe of the slope; allow between six inches and five feet of space for water to pool and sediment to accumulate.
- Make sure the straw bales are properly entrenched at least four inches into the soil and staked. Otherwise they will shift, become ineffective, and could cause undercutting and gully formation.

Fiber Rolls
- Follow the manufacturer’s recommendations for installation.
- Fine grade the subgrade by hand-removing large stones or other debris or soil chunks that would inhibit direct contact of the soil with the fiber roll.
- Contour a concave key trench 2 to 4 inches (50 to 100 mm) deep along the installation route.
Sediment Removal

Straw or Sand Bag Barriers

→ Place soil excavated in the trenching uphill or flow side of the roll to prevent undercutting of the roll by runoff or flow.
→ Install the fiber rolls into the key trench and stake both sides of the roll within 6 feet of each end and every six inches. Use 1 inch by 2 inch by 23 inch stakes.
→ Drive stakes in on alternating sides of the roll for flat areas. In sloped area, stakes can be driven directly through the center of the roll.
→ If more than one fiber roll is placed in a roll, place securely next to one another to provide a tight joint. Do not overlap.
→ For a temporary, steeply-sloped access road that will no longer be used, install fiber rolls across the road. Curve the very ends of the fiber roll uphill slightly to avoid erosion runoff around the ends.

Sand or Gravel Bags

- Use sand bags of geotextile fabric, not burlap.
- Fill sand bags with ¾ inch rock or ¼ inch pea gravel.
- Place several layers of sand bags, over-lapping the bags and packing them together tightly.

Limitations

Straw Bale Dikes

- Must be properly entrenched or can cause undercutting and gully erosion.
- Use should be limited to construction or maintenance activities that can be completed in less than three months.
- Should not be used in paved areas; areas subject to concentrated flow or channel flow; or in live streams.
- Can be used as inlet protection only if it is staked-in behind the curbs.

Fiber Rolls

- Do not use for long or medium slopes, or for slopes that are steeper than 3:1 (horizontal to vertical).
- Do not use in areas where flow is concentrated more than 1 cfs.
- Primary purpose is not sediment control.

Sand or Gravel Bags

- Limit the upstream drainage area to 5 acres (2 ha.)
- Labor-intensive installation necessary.
- Do not use to detain concentrated flows.
- Use gravel bags rather than sand bags near inlets.

Requirements
Flood Control Maintenance BMP Manual

Section III - SC-4

Sediment Removal

Straw or Sand Bag Barriers

Maintenance

All

• Repair or replace any split, torn, unraveling, or slumping materials.
• Inspect prior to and after rain events.
• Maintain as necessary.

Straw Bale Dikes

• Inspect daily during rain events.
• Remove sediment when it reaches one-third of the barrier height.
• Remove the dikes when no longer necessary.

Fiber Rolls

• Typically can be left in place; no need to remove. If not badly worn, rolls can be removed and reused.
• Inspect at least daily during prolonged rain events.

Sand or Gravel Bags

• Remove sediment when it is one-third of the height of the barrier.
• Repair as necessary.
• Remove the barrier when no longer needed.

Costs

• Costs in staff time for construction, monitoring, and repairs.
• Sediment and device removal and disposal costs. Fiber rolls have no device removal costs.
• Material costs for sand or gravel and burlap, hale bales, or fiber rolls.

Training

• Minimal training necessary but important for proper installation and maintenance.
**Straw Bale Barriers:***

Not more than one bale high.

Embed 100 mm

Compacted backfill (typ)

**BEDDING DETAIL**

Source: Caltrans, 1997.

---

**TYPICAL STRAW BALE BARRIER**

Fill gaps between bales with straw.

Place straw bales in a single row, lengthwise along the contour with ends of adjacent bales tightly abutting each other.

Wire, nylon or polypropylene string, placed horizontally.

Angle first stake toward previously laid bale.

Source: Caltrans, 1997.
Sand Bag Barriers:

NOTES:
1. Stack sand bags in at least three vertical rows abutting each other in a staggered arrangement.
2. For each additional vertical row, add an additional row to the width.

Source: Caltrans, 1997.
Section III - SC-4
Sediment Removal
Straw or Sand Bag Barriers

Alternative Figures for Sand Bag Illustrations:


References


Contra Costa County Public Works Department, personal communication with Cece Sellgren, March 16, 2000.
Description

A device consisting of a small basin that has a controlled release structure to retain larger size sediment. The trap is created by excavating, or by building an earthen embankment, straw bale check dam, or gravel bag barrier across the drainage path. The trap can be used as a complement device for upstream erosion control measures and downstream sediment basins (see BMPs SS-1 through SS-4; VR-1 through VR-5; and WD-1 through WD-4).

Applicability

- Construction or maintenance projects involving disturbed areas during the wet season (typically October 15 through April 15).
- Areas where sediment-laden runoff may enter a watercourse or storm drain system.
- For small drainage areas (<less than 5 acres (2 ha)).
- As a complement device for initial treatment before entering a sediment basin.
- For nuisance groundwater (see also WD-4).

Approach and Standards
Flood Control Maintenance BMP Manual

Section III - SC-5

Sediment Removal

Sediment Trap

- Size sediment traps using the following recommendations provided by the San Francisco Regional Water Quality Control Board (1998):
  
  1) \( Q = CIA \)
  
  Where,
  
  \( Q = \) Flow expected from the site in cubic feet per second
  
  \( C = \) Coefficient of runoff (typically between 0.4 to 0.7), depending on the imperviousness of the contributing area
  
  \( I = \) Expected rainfall, in inches per hour
  
  \( A = \) Contributing area in acres

  2) \( A_s = \frac{1.2Q}{V_s} \)

  Where,
  
  \( A_s = \) Surface area of settling basin with 2-feet of minimum depth
  
  \( Q = \) Flow as calculated above
  
  \( V_s = \) Settling velocity of particles, in feet per second
  
  \( A = \) Contributing area in acres

<table>
<thead>
<tr>
<th>Particle Size (mm)</th>
<th>Particle Description</th>
<th>Settling Velocity ( V_s, ) (fps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>Coarse sand</td>
<td>0.19</td>
</tr>
<tr>
<td>0.2</td>
<td>Medium sand</td>
<td>0.067</td>
</tr>
<tr>
<td>0.1</td>
<td>Fine sand</td>
<td>0.023</td>
</tr>
<tr>
<td>0.05</td>
<td>Coarse silt</td>
<td>0.0062</td>
</tr>
<tr>
<td>0.02</td>
<td>Medium silt</td>
<td>0.00096</td>
</tr>
<tr>
<td>0.01</td>
<td>Fine silt</td>
<td>0.00024</td>
</tr>
<tr>
<td>0.005</td>
<td>Clay</td>
<td>0.00006</td>
</tr>
</tbody>
</table>

- Construct the traps before the wet season and construction activities begin.

- Locate basins:
  
  ➔ Where a low embankment can be built across a swale or excavation
  
  ➔ Where failure would not cause loss of life or property;
  
  ➔ In locations that allow for maintenance access and include room for protected sediment removal and stockpiling areas.

- Design trap with a length to width ratio greater than 3:1 (L:W), or include baffles to prevent short circuiting of the inlet flow.

- Locate trap inlets to maximize the travel distance to the outlet.

- Protect trap outlet from erosion by using rocks or vegetation.

- Construct the outlet in one of the following ways to allow for easier dewatering of the trap:
  
  ➔ Use corrugated metal or reinforced concrete riser pipe with dewatering holes that are encased in gravel to prevent floatables (debris) from flowing out or clogging the system.

  ➔ Build a crushed stone outlet section of the embankment at the trap’s low point. The crushed stone section should serve as a spillway outlet for flood flows without
the danger of erosion. The bottom section should allow a method to dewater the trap between rain events.

Limitations

- Larger surface areas needed to allow for sediment settling.
- Not appropriate for drainage areas larger than 5 acres (2 ha).
- Only large and medium sized particles can be removed by sediment traps.
- Upstream erosion control is necessary in conjunction with the sediment traps.
- Do not located in live streams.
- Requires protective fencing to prevent access by children.

Requirements

Maintenance

- Throughout the wet season, inspect the traps at least weekly. Inspect the traps before, after, and at least every 24 hours during rainfall events.
- Inspect the banks for seepage and structural soundness.
- Examine the outlet structure and spillway for damage or obstructions and repair as necessary.
- Check the outlet area for erosion and repair if necessary.
- Remove sediment that has accumulated when the volume has reached one-third the original trap volume.
- Properly stockpile and/or dispose of sediment and debris collected from the trap (see also BMP SC-1, VDM-4).

Costs

- Costs in staff time for construction, monitoring, and repairs.
- Removal and disposal costs.
- Material costs for rocks or vegetation.

Training

- Minimal training necessary.

Sediment Traps:
Source: Caltrans, 1997.

NOTES:
1. Typical trap design shown will handle 12.7 mm of
   of runoff over a 24 hour period.
2. Settling volume: 130 m$^3$ per hectare of drainage area.
3. Sediment storage volume: 65 m$^3$ per hectare of drainage area.

Source: Caltrans, 1997.
**Flood Control Maintenance BMP Manual**  
**Section III - SC-5**  
**Sediment Removal**  
**Sediment Trap**

**NOTE:**  
Size spillway to convey peak design flow.

**Typical Open Spillway**

Source: Caltrans, 1997.

**Embarkment Section Thru Riser**

Source: Caltrans, 1997.
References


Description

A temporary device consisting of permeable fabric that is placed to intercept sheet flow runoff. The silt fencing slows and ponds the runoff, which allows the sediments to settle. The water is then released slowly through the permeable fabric.

Applicability

- Along (not across) streams and channels.
- Along the perimeter of a site.
- Below the toe of exposed or erodible slopes.
- Downslope of exposed soils.
- Around soil stockpiles (see BMP SC-1).

Approach and Standards

- Construct each fence along a level contour to prevent failure via the creation of rills and gullies.
- Keep drainage area upstream of the silt fence to less than 0.25 ac./100 ft (0.3 ha/100m) of fence.
- Keep the length of slope that drains to any point along the fence to 100 feet (30 m) or less.
- Limit the length of any single fence to 500 ft. (150 m.).
- Turn the last 6 feet of the face up slope in a “J” or “L” shape so that ponding can occur.

- Do not connect fence segments, but overlap segments of the fence by at least one foot to ensure complete coverage.
• Do not place silt fences in areas that are not suitable for temporary ponding or sediment deposition.
• Do not place silt fences across streams or other drainages that have concentrated flows, as it will lead to undercutting, gully formation and fence failure.
• To strengthen the fence, add gravel backfill on the up-slope side, making sure that the filter fabric is buried deeper than the gravel backfill. In addition, hay bales can be placed behind the filter fabric on the downslope side to strengthen the fence. Up to three hay bales can be place atop of one another as long as they are properly staked to the ground.
• To anchor the fence, rope can be attached to the fence stakes and anchored into the up-slope soil with another stake.

Installation of Fence
• Bury, or key in, filter fabric at least 6 inches below the ground surface and 6 inches across, and then back fill with dirt or gravel.
• Allow 2 to 5 feet at the toe of the slope for sediment to accumulate.
• Make sure that the silt fence is aligned along natural contours to prevent flow diversion.

Limitations
• Do not use for flow diversion.
• Do not use in areas (streams, channels, etc.) where flow is concentrated.
• Requires frequent maintenance.

Requirements

Maintenance
• Inspect prior to and after rain events.
• Remove sediment when accumulations have covered one-third of the fence height.
• Repair any portions of the fence that have been undercut.
• Repair or replace any split, torn, slumping or weathered filter fabric.
• Properly remove and dispose of the silt fence when no longer needed.

Costs
• Costs in staff time for construction, monitoring, and repairs.
• Sediment and device removal and disposal costs.
• Material costs for rocks, filter fabric, and stakes.
Training

- Minimal training necessary but important for proper installation and maintenance.


References
Sediment Removal

Section III - SC-6

Silt Fence


Soil Stabilization
**Description**

Erosion control blankets are biodegradable or synthetic blankets that are used to stabilize disturbed soils, especially on slopes. Erosion control blankets and mats protect the soil from rain, surface runoff, and wind caused erosion, and can enhance infiltration, decrease soil compaction, and increase protection of seeds from predators.

**Applicability**

- Channels with flows from 2-feet per second to 4-feet per second (0.6 m/s to 1.2 m/s).
- Channels which will be vegetated and for which the flow velocity is greater than appropriate for the channel.
- Disturbed areas and slopes where mulch needs to be anchored. Blankets or mats can work in areas where crimping or tackifying are not adequate. Steep slopes, steeper than or equal to 1:2 (Vertical/Horizontal).
- Areas and slopes where the danger of erosion is high.
- Slopes adjacent to sensitive areas like streams, wetlands, channels.
- Disturbed areas where plants are slow to mature and provide protection.

Biodegradable and easy-to-install, erosion control blankets are effective measures to reduce erosion and to encourage vegetation growth.

**Approach and Standards**

- When choosing the materials consider cost, effectiveness, acceptability (i.e., environmental compatibility, regulatory acceptability, and visual impact), vegetation enhancement, installation, and operation and maintenance requirements. Considerations of vegetation enhancement should include native plant compatibility, germination and growth rates, moisture retention, temperature modification, open space or coverage, and nutrient uptake.
• Properly prepare the site to make sure the blanket/mat has complete contact with the soil. Sites can be prepared by grading and shaping the installation area; removing all rocks, dirt clods, vegetation, etc.; preparing the seedbed by loosening the top 2- to 3-inches (50-75 mm) of soil; and applying soil amendments as directed by soil tests, the seeding plan, and manufacturer’s recommendations.
• Before installing the blanket, seed the area. All areas disturbed during installation will need to be re-seeded. For turf-reinforcement application, seeding is often performed after mat installation.
• Anchors can include U-shaped wire staples, metal geotextile stake pins or triangular wooden stakes. Wire staples should be at least 11 gauge; metal stake pins should be at least 0.188 in. (5 mm) diameter steel with a 1.5 in. (40 mm) steel washer at the pin head. Drive wire staples and metal stakes flush to soil surface. All anchors should be at least 6- to 18-inches (150-450 mm) long, longer for loose soils, and should resist pull-out.
• Follow the manufacturer’s installation recommendations.

Channel Installations:
• Dig initial anchor trench 1-foot deep by 6 inches wide (300 mm by 150 mm) across the channel at the downslope end of the project area.
• Dig intermittent check slots 6-inches deep and 6-inches wide (150 mm by 150 mm) across the channel at 25- to 30-foot intervals (8- to 10-m) along the channel.
• Cut longitudinal channel anchor slots 4-inches deep and 4-inches wide (100 mm by 100 mm) along each side of the installation to bury edges of matting. When possible, extend the matting/blanket 2-to 3-inches (50 mm to 75 mm) above the crest of the channel side slopes.
• Begin at downstream end and in the center of the channel. Place the starting end of the first roll in the anchor trench and secure at 12-inch (300 mm) intervals. The matting/blanket should be initially upside down in the anchor trench.
• As with the first roll, position the next rolls in the anchor trench so that they overlap the preceding roll by at least 3 inches (75 mm).
• Anchor the initial ends of the mats at 2-inch intervals (50 mm) and backfill with soil. Compact the soil.
• Unroll the center strip of matting/blanket upstream. Stop at the next check slot or terminal anchor trench. Unroll adjacent mats/blankets upstream as was done with the center strip. Maintain a 3-inch (75 mm) overlap.
• Fold and secure all rolls and matting so they are snug in all the transverse check slots. Lay the mat/blanket in the bottom of the slot and fold it back against itself. Anchor the two layers of the mat/blanket at 12-inch (300 mm) intervals. Backfill and compact the soil.
• Continue rolling the other mat/blanket widths upstream to the next check lot or anchor trench.
Soil Stabilization

Operational Permits Committee
June 15, 2000 DRAFT 2

• For non-critical installations, an alternative method is to place two rows of anchors on 6-inch (100 mm) centers at 25-30 foot (8-10 meters) intervals instead of the excavated check slots.
• If necessary, splice the blanket/mat ends to overlap like shingles, by a minimum of 12 inches (300 mm) apart on 12-inch intervals.
• Place the edges of the outside mats/blankets in the longitudinal slots, anchor with staples, backfill and compact the soil.
• Anchor, backfill and compact the upstream end of the mat/blanket in a 12 by 6-inch (300 by 150 mm) terminal trench.
• Secure the mat to the ground using U-shaped wire stables, geotextile pins, or wooden stakes.
• Seed and fill the turf reinforcement matting with soil if needed.

Slope Installations:
• At the top of the slope, anchor the blanket in a 6-inch deep by 6-inch wide trench. Backfill the trench and tamp dirt over the blanket.
• Unroll the blanket down the slope in the same direction that water would flow down the slope. Do not place the blanket horizontally across the slope.
• Overlap the edges of the rolls by 2 to 3 inches (50 mm to 75 mm). Staple the blanket down every 3 feet (1-meter).
• When splicing blankets, place blankets end over end in shingle style with 6 inches (150 mm) overlapping. Staple down the overlapped area about 1-foot (300 mm) apart.
• Blankets should be placed loosely, not stretched, and be stapled down enough to best keep direct soil contact.

Limitations

• High material and labor costs.
• Requires proper site preparation (e.g. smooth grading) to make sure the blanket or matting has enough contact with the soil. Rocky areas are not suitable for rolled blankets.
• Areas where final vegetation will be mowed are not suitable for rolled blankets because the staples can get caught in the mower.
• The use of non-biodegradable plastic sheeting should be kept to covering stock piles, or for temporarily covering small graded areas, because it is easily torn and vandalized and needs to be removed and properly disposed. Plastic sheeting does not allow for any infiltration, which heightens the probability for increased flows and erosion problems downhill and downstream.

Requirements
Maintenance

- Inspect after installation, before and after significant rain, and periodically throughout construction.
- Inspect for erosion and undermining. Perform immediate repairs as necessary.
- For washouts or breakage, repair the damage to the channel or slope (e.g., rills, gullies), before re-installing the blanket.
- When choosing materials, consider the differences in requirements for maintenance frequency, and need for fertilization, and irrigation. Also, consider the durability, longevity, ease of installation and safety as these will contribute to maintenance requirements.

Costs

- Erosion control blankets are more expensive than other forms of erosion control as they have high material and labor costs.
- When choosing the material consider material costs, preparation costs, installation costs, and any add-on costs. Also consider the maintenance frequency and needs for fertilization and irrigation as these contribute costs as well.

Training

- Minor training on appropriate installation and inspection is needed.

Placement of Erosion Control Blankets In Channels:

Note: These techniques work for small channels with low velocities only.
Anchoring Blankets and Mats:

BRING NETTING DOWN TO A LEVEL BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 6" AND STAPLE AT 12" INTERVALS.


WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATTING OVER THE BERM AND ANCHOR IT BEHIND THE BERM WITH A 12" ANCHOR TRENCH.

Anchoring Blankets and Mats:

- **INITIAL CHANNEL ANCHOR TRENCH**
  - NTS
  - Stake at 1 m to 1.5 m intervals
  - Check slot at 8 m intervals
- **TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH**
  - NTS
  - 75 mm overlap
  - Channel bottom
- **INTERMITTENT CHECK SLOT**
  - NTS
  - 150 mm
  - 150 mm
- **LONGITUDINAL ANCHOR TRENCH**
  - NTS
  - 100 mm x 100 mm anchor shoe
  - 100 mm

**NOTES:**
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.

Source: Caltrans, 1997.
Installation of Blankets and Mats:

Source: Caltrans, 1997.
References


Description

Dust control measures are used to keep the amount of airborne dust particles to a minimum to reduce erosion and airborne pollutants during the time between site disturbance and paving or revegetation. Dust control measures may include chemical or other measures (e.g. vegetation, mulch, stone, gravel).

Applicability

- To control dust from construction and maintenance vehicles and equipment at a work site.
- All construction and maintenance sites with exposed soils, as needed.
- Windy or wind-prone areas.
- Sites with silt and clay soils, which are prone to dust.
- Material stockpiles.
- Disturbed areas with or without traffic.
- Demolition areas.
- Unpaved roads.

Approach and Standards

- Schedule the maintenance activities to minimize the amount and time an area is exposed.
- Exposed soils can be quickly stabilized by using vegetation, mulch, spray-on adhesives (see also discussions of chemical measures, below), sprinkling water, or covering the area with stone or gravel (see also Limitations, below).
- Create and stabilize entry and exit points before starting construction or maintenance work (See BMP SS-4).
- Direct most maintenance traffic to stabilized roadways as possible (see BMP SS-4).
- Levee traffic should not exceed 10 mph.
• Identify the direction of prevailing winds, and adjust the project as possible to minimize the generation of dust.
• Use street sweepers to keep dust down on paved roadways that are used by maintenance trucks, especially those that transport silt from dredging sites.
• Cover trucks that haul soils to prevent the generation of dust during transportation.
• All soil transportation should be conducted in accordance with the California Vehicle Code.
• Water is the most commonly used inorganic chemical applied to reduce the dust level. The recommended application rate is generally 0.125 gal/yard² (0.6 L/m²) every 20 to 30 minutes as necessary. Recycled water can be used as appropriate.
• Other inorganic chemicals used for dust control include salts, silicates, and surfactants. Organic chemicals used for dust control include copolymers, petroleum products, lignin sulfonate, vegetable oils, and spray-on adhesives. See the Regional Board’s Erosion and Sediment Control Field Guide (1998) for complete selection information and recommended application rates for each of the various methods.
• Quickly clean sediments on paved roads by sweeping (not washing).
• Stabilize unpaved roads, parking, and staging areas and reduce the speed and number of trips on unpaved roads (see also, BMP SS-4).
• Revegetate and mulch (see also, BMP VDM-3).
• Sweep off trucks before they enter the street.
• In dump trucks, lightly wet down the soil before transport.

Site Preparation for Chemical Dust Control Measures:
• Use a blade to smooth soil surface; crown or slope surface to avoid creation of ponds.
• Compact soils, if necessary.
• Pre-wet the soil evenly at 0.03- to 0.3 gal/yard² (0.14-1.4 L/m²).
• Apply chemical solutions under pressure, and overlap the solution 6-12 inches (100-300 mm).
• Curing will occur immediately to four hours after application. After the chemical has cured, compact the area.
• Future treatments should be applied at a 50% application rate before the last treatment becomes inactive.
• If the humidity is low, chemicals can be reactivated by rewetting using 0.1- to 0.2 gal/yard² (0.5- to 0.9 L/m²).

Limitations
• The type and amount of stone and gravel application, and chemical application may be limited in stream channel areas—check with appropriate regulatory agencies first.
• Most dust control measures are temporary and require reapplication. (Spray-on adhesives have the longest life-span—they can perform for three to four years; while copolymers can last 1 to 2 years. Both form a crust.)
• Some dust control measures (e.g., petroleum products) may cause environmental harm.
• Water generally lasts less than one day because it evaporates quickly. Overwatering could cause erosion.
• Salts such as calcium chloride (\(\text{CaCl}_2\)) or sodium chloride (\(\text{NaCl}\)) can be corrosive and are not very effective when the humidity is low. Another salt, magnesium chloride (\(\text{MgCl}_2\)) works at higher temperatures and lower humidity than \(\text{CaCl}_2\), but it can be more costly. Salts can leach in heavy rains.
• Lignin Sulfonate can be slippery.
• Petroleum and vegetables oils should not be used as they can seep into the soil or move into the drainage. In addition, vegetable oils have limited availability, may become brittle, and may limit the binding ability of soil grains as the oils coat the grains.
• Chemical treatments that make the soil water repellant will increase runoff (e.g. vegetable oils, copolymers, petroleum products, spray-on adhesives).
• Certain chemicals may contain solvents that require proper handling.
• Limit the application of asphalt as a mulch tack or chemical mulch as it could migrate to the drainage.

Requirements

Maintenance

• Inspect wind-prone areas, and areas exposed to vehicle traffic daily.
• When soil stabilizers are used, inspect after rain events as well, and reapply soil stabilizers as needed.

Costs

Material costs for soil stabilizers and application vehicles vary. Staff time for application and inspection also depends on the chemical stabilizer used. Silicates and petroleum products appear to be the most expensive.

Training

• A full understanding of the chemicals chosen, and their potential impacts and reapplication requirements are important.

References
Flood Control Maintenance BMP Manual

Section III - SS-2

Soil Stabilization

Dust Control


Description

Temporary stream crossings are used to allow vehicles to cross a drainage or stream without entering the water, to protect sensitive areas by minimizing impacts to the stream bottom and to reduce erosion. Temporary stream crossings include culverts, fords (for dry streambeds/washes only) and bridges. Culverts are used for perennial and intermittent stream crossings. They are fairly easy to build and can support heavy equipment. Fords can be used for directly crossing dry washes and ephemeral streams during the dry season in arid areas. Bridges should be used if the stream has high volumes or velocities, steep slopes or where the channel is protected via regulations from the other types of temporary stream crossings. Bridges provide the least impact to the stream bed and water flow.

Applicability

- Maintenance or construction sites where equipment or vehicles will cross a drainage or waterway frequently, including dry channels which could be significantly disturbed by maintenance or construction traffic.
- For crossings where the length of time that the crossing is needed is less than one year.
- For sites where other alternatives are not favorable or feasible. For example, for areas where alternate routes are too long, too narrow, or lack soil strength.

This measure is likely to reduce erosion.

Approach and Standards

- Provide erosion controls and stabilize disturbed areas before and during installation and removal of the structure.
- Select a crossing site where the probability of erosion occurring is minimal.
- Have the crossing design approved by a registered civil or structural engineer who has understanding of the stream flows and soil strength at the crossing site, and knowledge of hydraulic and construction loading needs.
The Caltrans Highway Design Manual has requirements for culvert and bridge crossings.

The design flow and safety factors should consider over-topping, flow backups, and washout risks.

The crossing area including the roadway, nearby work areas and stream bottom should be made stable enough to hold up under the design flow without erosion.

During construction of the crossing, install sediment traps just downstream of the temporary crossing to capture sediments.

Once the crossing is properly in place, no sediment should be flowing downstream. Place plastic or other impermeable material on other sides of temporary crossings and coffer dams to minimize erosion.

When the culvert is installed, place filter fabric downstream to minimize erosion from the water flowing through the culvert.

When treating the surface of the crossing, avoid using hazardous materials such as oil.

Create and remove the crossing during the dry season to minimize impacts to the stream. This will also reduce the cost.

Build the crossing near the natural elevation of the streambed to prevent upstream flooding.

The surface flow from the approach road should be diverted using a swale or dike (see BMPs WD-1, WD-3).

Should be used in conjunction with other erosion and sediment control BMPs (e.g., BMP SS-4, SC-6).

Size temporary culvert and bridge crossings for at least a 10-year storm.

Limitations

Activities to install and remove the structure will disturb the waterway.

Dewatering or temporary stream diversion techniques (e.g., bypass pipes and pump; temporary diversion channels) may be necessary (see BMPs WD-4 and WD-5).

Stream crossings may constrict flood flows, cause backups and washouts.

Requires permits or approvals including, but not limited to, U.S. Army Corps of Engineers (404 Permit), Regional Water Quality Control Board (401 Water Quality Certification), and California Department of Fish and Game (Streambed Alteration Agreement), and possibly consultation with the United States Fish and Wildlife Service and National Marine Fisheries Service.

Temporary fords should not be used during the wet season or for perennial streams as they can make erosion worse in streams with flows.

May be expensive considering the temporary nature of the crossing.

Temporary culverts can cause erosion if they become clogged.

Requirements
Maintenance

- Conduct inspections at least weekly and after every major rain event.
- Inspectors should examine for channel blockages, and sediment or trapped debris in culverts or behind the fords; erosion of abutments, displacement of riprap, channel scour, or piping in the soil; and any weakening of the structure (e.g., cracks in the structure, undermining of the foundation or abutments).
- General maintenance should include removal of sediments from behind the fords, under bridges, and in the culverts; and replacement of aggregate that is washed away from the culvert inlets and outlets.
- At the end of its useful life, the temporary crossing should be removed.

Costs

Fords are the least expensive temporary crossing to construct. Bridges are typically the most expensive of the temporary crossings to design and build. According to the California Storm Water Quality Task Force, temporary bridge crossings can range from $45-$95 per square feet (SWQTF, 1993).

Training

- A registered civil engineer should approve the crossing design.
- Design and construction skills are necessary as appropriate. Staff should be trained to recognize signs of erosion and structural instability.
Stream Crossings Using Culverts:

Ford Crossing:

Source: Caltrans, 1997.
Bridge Crossing:

NOTE:
Surface flow of road diverted by swale and/or dike.

TYPICAL BRIDGE CROSSING
NOT TO SCALE

Source: Caltrans, 1997.
References


Description

Measures to prevent construction equipment or vehicles from tracking sediments out of a work site onto paved roadways. Measures for the entrance include placement of a stabilized pad of gravel aggregate over a filter cloth at locations where vehicle traffic exits a construction site onto a paved area. The stabilization noticeably reduces the amount of sediment (dust, mud) tracked off-site. A washrack can be used as well to remove caked-on sediment.

Applicability

- All areas where equipment or vehicles exit from a construction or unpaved maintenance road onto a paved road (public right-of-way, street, alley, sidewalk, or parking area).

Construction entrance stabilization measures have a moderate effect on reducing the amount of sediment tracking. The measure will also likely reduce the amount of nutrients, toxic materials, and oil and grease tracked from the road entrance onto paved roads, thus minimizing the runoff of these materials to the storm drain system.

Approach and Standards

- Construct site entrances and exits on level ground if possible.
- Use washed, well-graded gravel or crushed-rock from 1-3 inches in size, for the entrance/exit aggregate to prevent tracking of rocks onto the roadway. Smaller stones could be tracked onto the paved roadway.
Alternately, Class II aggregate base (maximum 1.5-inch rock) can be used if a street sweeper is available to periodically remove the material tracked onto the paved street. Track walk the aggregate base to minimize the amount of material that will be tracked.

- The stones should be 6-inches deep or the depth recommended by a soils engineer.
- Minimum length should be 50-feet; minimum width should be 30-feet. For smaller maintenance roads on local creeks, width can be reduced to 20-feet.
- Provide enough turning radii, or driveway return, at the entrance (see also BMPs VDM-2, VDM-4).
- Properly grade entrance to prevent runoff from leaving unpaved site.
- Unpaved road access measures should be combined with street sweeping on the public, paved right-of-way.
- If necessary, adjust gates to allow for increased road height.

**Limitations**

- Requires maintenance throughout the life of the site entrance.
- Can be expensive to construct.
- Street sweepers cannot move 2-3 inch rock. Therefore, if rocks greater than 2 inches are used at access points and get tracked onto the street, manual cleanup is necessary.

**Requirements**

**Maintenance**

- The stabilized construction exit should be inspected after each rainfall, and at least monthly.
- Gravel should be replaced when voids in the surface area are noticeable.
- Any sediment deposited on the paved roadways should be removed using dry cleaning methods, such as sweeping, as soon as possible but at least at the end of each working day.
- Upon completion of construction or infrequent maintenance, gravel and filter fabric should be removed.

**Costs**

- According to the US EPA (1992), the average annual cost for installation and maintenance of the stabilized construction entrance is $1,500 an entrance without wash rock; and $2,200 an entrance with wash rock.
- Cost to adjust gates to allow for increased road height, if necessary.
Training

- Training needs are minimal. Staff should be trained to reduce speeds on unpaved maintenance roads, and to use washrack if necessary. As appropriate, staff should be trained to properly design and construct stabilized site entrances and exits, and unpaved roads.


Soil                             Construction Road
Stabilization                     Entrance Stabilization

Operational Permits Committee     III-SS-4.4
June 2000


References


Vegetation and Debris Management
Description

Methods to minimize soil erosion in and near flood control channels by preserving existing vegetation.

Applicability

- Areas within a maintenance site where no construction activity occurs, or where construction activity is phased to occur at a later date.
- Sensitive areas where natural vegetation exists and should be preserved, such as: steep slopes and watercourses.
- Areas where local, state, or federal government require vegetation preservation.
- Areas where preserving vegetation can be particularly beneficial. These areas include flood plains, stream banks, steep slopes, and other areas where erosion control would be difficult to establish, install, and maintain, or areas where there are critical resources downstream.

Approach and Standards

Planning

- Make efforts to preserve existing vegetation during project planning, and before site disturbance begins.
- Decide which vegetation will remain on the site based on the following criteria: compatibility with the proposed project, aesthetic value, susceptibility to disease or rot, environmental value, wildlife benefits, whether vegetation is or is not native, relationship to other vegetation, erosion control capabilities, and space needed.
- In natural channels with adequate channel capacity, leave overhanging vegetation and emergent wetland vegetation that colonizes deposition bars in order to maintain...
Flood Control Maintenance BMP Manual  
Vegetation and Debris 
Management  
Section III - VDM-1

Vegetation and Debris Preservation of Existing Vegetation

healthy creek life. This technique reduces channel capacity and should be used only as appropriate.

- Preserve low growing vegetation that will not cause major resistance to storm flows.
- Prepare landscaping plans, which retain as much existing vegetation as possible and describe proper care of this vegetation before, during, and after construction. Propose landscaping plans which do not include plant species that compete with the existing vegetation.

On-Site Activities

- Existing vegetation to be preserved on the site should be protected from mechanical and other injury while the maintenance project occurs. Define a setback area from vegetation to be preserved and protect the area with berms, fencing, signs, etc. The setback area size should be based on the location, species, size, age and potential impact of adjacent maintenance and construction activities or permanent improvements.
- Flag or mark trees to remain in place. Stake off root system limits (drip lines of trees). Some counties limit construction within 5 feet of the tree drip line. Fence off the area to be preserved.
- Where grading under trees is necessary, excavation and fill should be limited to one foot within the drip lines.
- In natural channels, create tree wells and retaining walls (permanent), which help preserve existing vegetation, large enough to protect the root system.
- For the native oak trees, allow no trenching or irrigation within the drip lines of the tree, since both these activities are detrimental to tree preservation.
- Temporary roadways should be located to minimize damage to shrub and tree stands, and should follow natural contours to reduce cutting and filling.
- Do not locate construction traffic routes, spoil piles, etc., where significant adverse impacts on existing vegetation may occur.
- If any damage is done unintentionally to the area of existing vegetation, repair the damage immediately.

Limitations

- Requires planning.
- May limit area available for construction activities.
- Would not apply to areas of flood control channels where U.S. Army Corps of Engineers or the Natural Resources Conservation Service requires that channels be kept clear of most vegetation to provide for designated flood flows.
- For sites with diverse topography, it may be difficult or expensive to save existing trees.
Requirements

Maintenance

- Inspection and maintenance requirements for protection of vegetation are low.
- During construction, maintain the limits of grading or disturbance at all times.
- Ensure that irrigation and maintenance of native trees or vegetation conforms to specifications on the landscape plan.
- Maintain the existing grade around vegetation. Raising the grade can suffocate the roots, and lowering the grade may expose roots.
- Ensure that site-specific vegetation management plans or habitat conservation plans clearly specify maintenance activities that will facilitate or preserve a targeted vegetation cover type or a succession of cover types over time.

Costs

- In general, there is little cost associated with preserving existing vegetation if properly planned during the project design. Maintaining existing vegetation may yield aesthetic wildlife and water quality benefits.
- In general, costs are limited to staff time and materials for cordonning off vegetation to be preserved. Additional costs required if tree wells and retaining walls are created.

Training

- Train appropriate staff to minimize disturbance to vegetation that is to remain in place.
- Train staff on how to identify target and non-target, native and non-native species, and desirable riparian and terrestrial plants, at the start of a job.
- Train appropriate staff to understand where and how to preserve existing vegetation. Vegetation management planning for the preservation of existing vegetation requires planning, which involves design staff and maintenance staff.

References


Vegetation and Debris Preservation of Existing Vegetation

Description

Vegetation removal techniques to preserve the channel’s flood control functions; create a stable channel environment, where the need to perform vegetation removal is minimal; and provide safe access for maintenance equipment, fire protection vehicles and pedestrians.

Applicability

- Areas where construction will occur and could be damaging to existing vegetation, structures, or equipment.
- Areas where flow is obstructed or is diverted against a bank.
- Where necessary for public safety.
- Refer to BMP NR-3 for more information related to this BMP.

Approach and Standards

- As appropriate, use small, motorized rubber-tracked vehicles with hydraulic lift mounted platforms to aid in cutting and removing vegetation from flood control channels.
- Use hand operated equipment (e.g. loppers, hand saws, chain saws, weed eaters, and other tools) to remove or trim vegetation where it is feasible.
- Have a vegetation specialist available for maintenance crews to consult with when removing or trimming vegetation on flood control district property.
- Where applicable, consider using mowers operated from the access road to cut vegetation on channel banks instead of spraying with herbicides.
- If herbicides are used, use herbicides that are approved for water use, and only in the lowest amounts that are effective. Consider minimizing the effects on aquatic life when deciding whether to remove treated vegetation or mowing it to decompose in place.
Vegetation and Debris Removal of Existing Vegetation

• If possible, save removed native vegetation to replant after construction or to plant immediately in other areas.
• Keep equipment away from trees to be preserved to avoid trunk damage caused by equipment scarring the trunk, and to prevent soil compaction near roots (see also VDM-1).
• Consider potential wind damage to adjacent vegetation from exposure to increased wind velocities, as appropriate, before removing vegetation.
• Only vegetation that is noxious, or that could obstruct channel flows, should be removed. Herbaceous layers are components of riparian habitat and provide erosion protection. If noxious vegetation is removed, replant the area with native vegetation. Do not remove stumps.
• Willows require the following treatment:
  ✓ Never top live willows. This encourages shrubby growth.
  ✓ Only remove willows from a channel bed if they are obstructing flow or diverting water against a bank.
• Remove non-native vines or plants that inhibit the growth of native riparian trees.
• To favor stream shading, retain large trees on the east side of north-south flowing streams and on the south side of east-west flowing streams.
• Recycle useful vegetation, (i.e., cut willows can be used to revegetate an eroding bank).

Limitations

• Requires planning.

Requirements

Maintenance

• Monitoring and progress evaluations are essential components of vegetation management programs.
• During construction, the limits of grading or disturbance should be clearly marked at all times.
• Removal of trees or vegetation should conform to the vegetation plan.

Costs

• The cost of using mowers opposed to herbicides is in dispute. Some sources indicate that using mowers to control excess growth, instead of herbicides, could potentially reduce costs, while other sources state that mower use is extremely expensive. The Santa Clara Valley Water District (February 2000) indicates that mechanical
Vegetation and Debris Removal of Existing Vegetation

Vegetation removal (mowing, discharge, etc.) costs five times more than herbicide controls, in part because it must be performed more often.

- Purchase or upkeep of additional hand-operated equipment and rubber-tracked vehicles with hydraulic lift mounted platform, may be required.
- Costs would increase with the hiring of a vegetation specialist.
- If a lot of vegetation is removed, costs for vegetation disposal and for replanting useful vegetation would increase.
- Extra costs are incurred for vegetation that is removed, saved, and replanted.

Training

- Train vegetation removal crews in the correct methods for pruning and vegetation removal.
- Staff should be trained to remove vegetation with the least amount of impact to existing vegetation that is to be preserved. Vegetation management planning for the removal of vegetation requires planning, which involves the design staff as well as the maintenance staff.
- A vegetation expert may be required for some projects.

References


Description

Methods to properly revegetate sites after site disturbance to reduce bank erosion potential.

Applicability

- Areas within a site where no further construction or maintenance activities will occur.
- Sensitive areas where natural vegetation existed prior to disturbance (especially steep slopes, watercourses, and building sites in wooded areas).
- Areas where local, state, or federal government requires preservation or mitigation.

Approach and Standards

Vegetation

- The project site should be revegetated as soon as feasible after construction.
- Use native Bay Area plants and grasses in revegetation projects.
- Revegetation should be regularly monitored for survival for at least three years.
- Take cuttings and seeds from existing native vegetation before disturbance and cultivate. Use to replant so plants are genetically similar and acclimated to the specific area.
- Revegetate at ratio of at least 1½:1. Overplanting is recommended because some initial mortality is expected.
- If soil moisture is deficient, new vegetation should be supplied with supplemental water until firmly established.
- Cut or mow grasses to encourage the establishment and spread of grass.

Mulch

- Erosion Control
- Sediment Control
- Habitat/Wildlife Protection
• Use mulch, composed of bark, other wood products, straw, or erosion-control blankets, to form a protective blanket over the seeds and hold them in place and retain soil moisture. Erosion control blankets must be applied to planting areas where slopes are 2:1 or steeper.

• The choice of mulch should be based on the size of the area, site slopes, surface conditions such as hardness and moisture, weed growth, and availability of mulch materials.

• Type of mulch, binders, and application rates should be as recommended by the manufacturer.

**Limitations**

• Requires planning, and long-term monitoring.

• For sites with diverse topography, satisfactory revegetation can be difficult and expensive.

• May need area to cultivate cuttings and seeds to be used for revegetation efforts.

• Mulches tend to lower soil surface temperature, and may delay germination of some seeds.

• May require additional plantings or seeding if monitoring shows that revegetation efforts are not successful.

**Requirements**

**Maintenance**

• Cultivate cuttings and seeds.

• During construction, clearly mark the limits of grading or disturbance at all times.

• Ensure that irrigation or maintenance of native trees or vegetation conforms to specifications on the landscape plan.

• Perform monitoring for three to five years, as specified in the landscape or project mitigation plan.

• Inspect all seeded areas periodically for failures. If failures are found, reseed, fertilize, and mulch the areas within the planting season, using half of the original application rates.

• Inspect the mulch periodically and after rain for damage and deterioration.

• Maintain the longevity and integrity of the mulch until vegetation is established.
Costs

- Costs would result from hiring a vegetation specialist, and for performing ongoing monitoring.
- There could be an extra cost to cultivate cuttings and seeds and to irrigate and for additional planting or seeding.

Training

- A vegetation specialist may be necessary.
- Train vegetation crews in the correct methods for collecting cuttings and seeds, and for removing and replanting vegetation.
- Training should be provided on the use and maintenance of native Bay Area plants and grasses for revegetation projects.
- Train design and maintenance staff on planning for revegetation after construction.

References


Vegetation and Debris Management

Debris Removal

- Pollution Prevention
- Pollution Control
- Habitat & Wildlife Protection
- Erosion Control
- Public Safety

Description

Methods for removing debris from channels to minimize pollution, protect habitat/wildlife, provide for public safety, and minimize erosion.

Applicability

- This applies to any flood control channel activity that generates by-products, residuals, or wastes.
- Refer to BMPs EV-1, EV-2, NR-3, and VDM-2 for more information related to this BMP.

Approach and Standards

- As appropriate, use small rubber tracked vehicles in the channel bottom to carry debris to the designated collection point. Avoid using heavy equipment in the channel bottom for debris removal as much as possible.
- When possible, pick up debris with equipment operated from the top of the bank or access road.
- Deposit woody debris or vegetation collected from the channel in areas that will not cause storm-related problems (e.g., away from storm drain inlets, drainage facilities, and other watercourses).
- When necessary divert runoff that comes into contact with solid waste into appropriate control measures such as trash racks in order to remove waste and debris. (See BMPs WD-1, WD-2, WD-3).
- Manage construction by-products, residuals, and other wastes by stockpiling and properly removing (see BMP SC-1). Leave the site cleaner than before the work started by removing all litter, construction containers, and other work related materials.
Vegetation and Debris Management

- Consider leaving stumps in place after trees are cut to create essential creek habitat. If leaving the stump in place, position and anchor the stump into the bank to minimize movement. For fallen trees, stumps can be left if the bark is stabilized (when trees fall, their root structure tears out of the bank and can contribute to bank stabilization).

- Only remove from creeks or channels downed wood that is loose and can be washed downstream or that obstructs flow or diverts flow into a bank. Downed wood could potentially protect tree roots from being undermined.

- Salvage or recycle useful vegetation debris, packaging, and surplus building materials when practical. For example, native trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas (see BMPs VR-1, and VDM-3). Wood pallets, cardboard boxes, and construction scraps can also be recycled.

- Collect trash and rubbish regularly around the project site, daily during rainy and windy conditions.

Limitations

- Temporary stockpiling of certain construction wastes may necessitate extra drainage-related controls during the wet season (see BMP SC-1).

Requirements

Maintenance

- Maintenance workers should perform daily good housekeeping at work site.
- Replace or exchange leaking dumpsters.
- Properly cover stockpiled material to avoid erosion of the stockpile.
- As appropriate, properly cover sediment trapping devices like the berm of a silt fence, to avoid sediment transport.
- Arrange for adequate debris disposal schedules to ensure that dumpsters or drop boxes do not overflow.
- Securely cover dumpsters or drop boxes used to collect debris at night and during rainy weather.

Costs

Additional staff time and disposal costs may be necessary depending on the site. Actual additional costs are not known.
Vegetation and Debris Management

Debris Removal

Training

- Instruct employees on identification of solid waste and hazardous waste.
- Train employees on how to respond to hazardous waste found at work sites.
- Educate employees on solid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures.
- Train communities on the detrimental effects of dumping debris and garbage in creeks and urban flood control channels.

References


Velocity Reduction
**Description**

An erosion and sediment control method used to slow runoff that allows sediments to settle out before the water leaves the site. Rock filter berms are created on level contours to detain and cause ponding of sheet flow to promote sedimentation. A brush barrier, or brush mat, is created of brush that is wrapped in filter cloth and attached to the toe of the slope. Brush and rock filters must be properly anchored to trap sediment and reduce runoff velocity.

**Applicability**

Brush and rock filters can be used:
- As check dams, if properly anchored (see BMP VR-2);
- Below the toe of slopes;
- Along streams and channels;
- Around spoil areas or below other small cleared areas;
- At sediment traps for culvert and pipe outlets.

The filters are likely to have a significant effect on reducing the sediment load.

**Approach and Standards**

- Rock filters should use rock sized ¾ to 3 inches in diameter. In areas with greater volume or velocity of water, use larger rocks, and place them in a woven wire sheath that is staked to the ground.
- Filters should be placed on level ground, in areas of sheet or rill flow.
- Allow enough area behind the berm for runoff to pond, allowing settling of sediment.
- Brush collected during site clearing can be used to create a brush filter.
Limitations

- Should not be placed on slopes.
- Limited suitability for runoff coming from slopes greater than 5%.
- Removal may be difficult, especially in landscaped areas.
- Should not be used in drainage areas greater than 5 acres.
- Sufficient space is needed for ponding so flooding does not occur.

Requirements

Maintenance

- Filters should be inspected, and repaired if necessary, at least monthly and after each rainfall.
- Sediments should be removed when sediment depth reaches 12 inches or 1/3 of berm height.

Costs

- Staff time for construction, monthly inspection, maintenance, and removal.
- Capital cost of brush filter can be low to moderate if brush from site-clearing is used.
- Capital cost of rock filters can be more expensive since off-site materials and hand construction are necessary.

Training

- Training needs are minimal. Staff should be trained in proper siting, construction, and maintenance of brush or rock filters.

Note: If “crushed” rock is used with fines then the “filter” will become a “berm,” i.e., impermeable. Use drain rock for filter.
References


Description

A small dam placed across swales or drainage ditch channels to slow concentrated stormwater flows. Check dams can reduce erosion in the swale, drainage ditch, or channel and help sediment settle out behind the dam.

Applicability

Check dams can be used across swales or drainage ditches:

- Primarily in small, steep channels with velocities > 2 feet per second to control flow velocity.
- To reduce channel flow and prevent erosion in smaller, intermittent channels and temporary swales.
- To help in the temporary collection of sediment, especially if a sediment sump is also used upstream of the dam.
- During establishment of grass linings in the channel or drainage ditch.
- If the channels are temporary, and there would not be enough time for establishing erosion control linings.

Check dams are likely to have a significant effect on reducing the sediment load by decreasing velocity and preventing down-channel erosion.

Approach and Standards

- Create check dams with enough space and height to allow small pools to form between each one. The ponded water from a downstream check dam should reach the toe of the upstream check dam.
- Construct check dams to allow for safe overflow during, and to withstand the impacts of floods (>2 year storm events) without causing upstream flooding. Construct the dam so the center section is lower than the sides. With this construction, the dam will work like a weir during floods.
• In areas where sediment needs to be captured, a deep sump can be created just upstream of the check dam.
• Create check dams using rocks, logs, pea-gravel secured in sandbags, or other natural materials that can withstand the flow velocities. Check dams can also be created of rock or brush filters, if properly anchored (see BMP VR-1).
• Do not use straw bales or silt fences for check dams, as they tend to be easily washed away with high volumes or velocities of runoff.
• For rock check dams, use rock sized 8- to 12-inches, or large enough to stay in place provided the expected channel design flow. Place by hand or mechanically, but do not dump into the channel.
• For log check dams, use 4- to 6-inch diameter logs. Anchor by embedding the logs at least 18 inches into the soil.
• Ensure the dam is constructed completely across the channel or ditch to prevent washout. Secure the check dam against damage from significant floods.
• For channels with slopes less than 4 percent, if vegetation is planted to stabilize the channel, the check dam can be removed when the grass/vegetation is mature.
• For maximum velocity reduction, construct the dams so the toe of the upstream dam is at the same height as the top of the downstream dam.

Limitations

• For use only in small open channels that drain 10-acres or less.
• Should not be used in live streams as it can limit fish runs.
• Should not be used in grass-lined channels unless erosion is expected, because dam construction can damage the grass vegetation.
• The sedimentation removal in the small pools behind the dam is nominal due to the small detention time and probable scour during longer storms.
• Do not use in swales or ditches that have a base flow throughout at least some of the year because it can alter the habitat, cause ponding, and could limit the base flow.

Requirements

Maintenance

• Check dams should be inspected after each rainfall for sediment buildup behind the dam, and erosion around the dam.
• Sediments should be removed when sediment depth reaches 1/2 the sump depth or 1/3 the check dam height.
• Proper maintenance is important so that the check dams do not cause flooding or become washed out.
Costs

- Staff time for construction, inspection, maintenance, and removal.
- Capital costs can be low to moderate if on-site pea-gravel or brush from site-clearing is used.
- Capital costs of rocks or logs can be more expensive since off-site materials and hand construction are necessary.

Training

- Staff should be trained in the proper siting, construction, inspection, maintenance, and removal of check dams.

Note: Be sure to key in at the upper edges of the check dam, to prevent water from eroding the sides.
References


Description

Slopes that are graded smooth and have compacted soils can increase runoff and reduce the ability of vegetation to be re-established, resulting in slope erosion. These techniques create unevenness on bare soil to reduce runoff velocity, to trap sediment, and to increase water infiltration into the soil. Techniques include creating furrows across slopes, creating stair-steps or terracing of slopes, and tracking up and down a slope. Terracing is a permanent technique.

Applicability

- All disturbed slopes where the goal is to promote vegetation growth that facilitates long-term soil stabilization.
- Locations where roughening the surface will help seeding, planting, and mulching.
- Graded areas that have smooth or hard surfaces to slow down the surface flow.
- Long slopes, where the length should be shortened by terracing, as designed and approved by a registered civil engineer.

This measure is likely to have a significant impact to reduce erosion.

Approach and Standards

Tracking
- Use a bulldozer to track up and down a slope. The tracking provides grooves that will catch seeds and rainfall, which reduces the amount of runoff.
- Tracking should not be performed across the hill. Tracking should be performed up and down the slope to provide grooves that are horizontal to the slope.
Terracing

- Terrace long, smooth slopes to control runoff.
- Shorter slopes may be serrated to reduce runoff. The serrations should be between 6 and 15 inches apart; and 1 to 3 inches deep. The slope of the serrations should be 1:2 (vertical: horizontal) or flatter.
- For larger slopes, terracing cuts should be no larger than 30 feet in height from the base of the trough to the top of the bench. If fill material is used to make additional downslope terraces, fills should be no larger than 25 feet in height from the base of the trough to the top of the bench. The length between the bottom of the cut trough and the top of the fill bench should not exceed 6.5 feet.

Hay Waddles or Coconut Rolls

- Install hay waddles or coconut rolls into slopes to break up the run of the slope and to reduce the velocity of surface flow (see BMP SS-1).

Limitations

- Roughening can increase grading costs.
- Roughening can cause sloughing in certain soils.
- Roughening techniques need to be used with other temporary erosion control measures, such as seeding and mulching (see BMP VDM-2), to be effective at erosion control.
- Use of stair-step grading including terracing may not be appropriate for sandy, steep, or shallow soils.

Requirements

Maintenance

- Conduct inspections periodically to check slopes that have been seeded, planted, and/or mulched for rills and gullies, especially after storm events.
- Fill the rills and gullies a bit higher than the original grade, and reseed and mulch as soon as possible.

Costs

Variable, but minimal, costs are dependent on the site characteristics. Work can be performed as part of grading. Staff time necessary for monitoring and repairs.
Training

- Training needs are minimal. A full understanding of the techniques and proper inspection and maintenance methods is appropriate.

WATER, SOIL, AND FERTILIZER ARE HELD BY STEPS - PLANTS CAN BECOME ESTABLISHED ON THE STEPS.

STAIR STEPPING CUT SLOPES

GROOVING IS CUTTING FURROWS ALONG THE CONTOUR OF A SLOPE. IRREGULARITIES IN THE SOIL SURFACE CATCH RAINWATER AND PROVIDE SOME COVERAGE OF LIME, FERTILIZER AND SEED.

GROOVING SLOPES

NOTE:
Groove by cutting serrations along the contour. Irregularities in the soil surface catch rainwater, seed, mulch and fertilizer.

Source: Caltrans, 1997.
NOTES:
1. Vertical cut distance shall be less than horizontal distance.
2. Vertical cut shall not exceed 600 mm in soft material and 1 m in rocky material.

Source: Caltrans, 1997.
Section III - VR-3
Velocity Reduction
Slope Roughening or Terracing

References


Description

This measure provides a device made of rock, grouted riprap, or concrete rubble that is placed at outlets to channels and pipes to reduce the velocity of water exiting, and to retain the embankment near the inlets and outlets to pipe conveyances as a way to control erosion and scour. This practice protects inlets or outlets from developing plunge pools (small, eroded pools), and protects against scour and the resulting gully erosion at a culvert outlet. Erosion control fabric and hay waddes/coconut rolls can be installed in front of an outlet to provide additional velocity reduction and a softer appearance. (See BMPs, SS-1 and SC-5).

Applicability

This measure is intended to describe permanent outlet protection. Outlet protection for temporary dewatering activities need not be as detailed (see VR-4b).

Outlet Protection

- Outlets of pipes, drains, conduits or channels.
- Outlets at the bottom of mild to steep slopes.
- Outlets of channels that carry continuous water flows.
- Outlets that must handle short, intense water flows (e.g., flash floods).
- Areas where lined conveyances discharge to unlined conveyances.

Outlet Protection with Flared Culvert End Sections

- Outlets of slope drains and culverts, pipes, drains, and conduits.

Inlet Protection

- Inlets of slope drains and culverts can also use the flared culvert end section.
**Approach and Standards**

**Outlet Protection**

- Rock outlet protection is effective at limiting erosion when the rock is sized and placed appropriately. Increase rock size for high velocity flows. Use sound, durable, angular rock.
- Construct rock apron on zero grade.
- Align apron with the receiving stream and keep it straight throughout its length. If a curve is needed to fit the site conditions, place the curve in the upper section of the apron.
- When designing the outlet project, consider flow depth, roughness, gradient, side slopes, discharge rate and velocity. The discharge pipe size governs the rock depth and outlet protection length. Hydraulic calculations and velocities should be used to determine the total length of the device.
- Specifications based on USDA Soil Conservation Service (now Resource Conservation Service) are listed in the table below. For larger or higher flows, consult a registered civil engineer.
- Provide cutoff walls.

<table>
<thead>
<tr>
<th>Pipe Diameter</th>
<th>Discharge</th>
<th>Apron Length</th>
<th>Rip Rap D$_{50}$ Minimum Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>m$^3$/s</td>
<td>m</td>
<td>ft</td>
</tr>
<tr>
<td>300</td>
<td>0.14</td>
<td>3</td>
<td>9.8413.1</td>
</tr>
<tr>
<td></td>
<td>0.28</td>
<td>4</td>
<td>9.84</td>
</tr>
<tr>
<td>450</td>
<td>0.28</td>
<td>3</td>
<td>9.84</td>
</tr>
<tr>
<td></td>
<td>0.57</td>
<td>5</td>
<td>16.40</td>
</tr>
<tr>
<td></td>
<td>0.85</td>
<td>7</td>
<td>22.97</td>
</tr>
<tr>
<td></td>
<td>1.13</td>
<td>8</td>
<td>26.25</td>
</tr>
<tr>
<td>600</td>
<td>0.85</td>
<td>5</td>
<td>16.40</td>
</tr>
<tr>
<td></td>
<td>1.13</td>
<td>8</td>
<td>22.97</td>
</tr>
<tr>
<td></td>
<td>1.42</td>
<td>8</td>
<td>22.97</td>
</tr>
<tr>
<td></td>
<td>1.70</td>
<td>9</td>
<td>29.53</td>
</tr>
</tbody>
</table>

**Flared Culvert End Section**

- Construct at zero grade if possible.
- Ensure that pipe connections are water tight.

**Limitations**
Outlet Protection

- During high flows, loose rock may wash away.
- Outlet protection may have negative impacts on channel habitat. These impacts generally will be less than the impacts from erosion if no protection is provided, however.
- Sediments caught in the rock outlet protection device may be difficult to remove without removing the rocks.
- Grouted riprap can break apart in areas with freeze and thaw, or from hydrostatic pressure if there is not adequate drainage.
- Riprap aprons are best used as a temporary measure during construction.
- High inspection requirements during the rainy season.

Flared Culvert End Sections

- Flared culvert end sections are mostly used for hydraulic efficiency, but have some limited erosion control benefits.
- Make sure the device complies with local and state regulations.

Requirements

Maintenance

A fair amount of maintenance is necessary to ensure outlet protection devices and flared culvert end sections work properly.

Outlet Protection

- Inspect prior to the start of the rainy season, after rain events, and periodically during the rainy season.
- Inspect apron for displacement of the riprap and/or damage to the underlying fabric. Repair and replace as necessary.
- Inspect for scour beneath the riprap and around the outlet, and repair any damage immediately.
- Remove temporary devices as soon as the drainage area has been stabilized or at the end of construction.

Flared Culvert End Sections

- Inspect for debris and sediment build up; clean as necessary.
- Inspect for scour beneath and around the flared end, and repair as necessary.

Costs
Moderate capital expenditures required, while operation and maintenance costs are lower. Rock outlet protection is generally less expensive and easier to install than concrete aprons or energy dissipaters.

- Installation costs. Material costs for filter fabric, riprap, and flared culvert end sections, including materials necessary for repairs.
- Costs due to staff time for inspection and repairs.

**Training**
- A registered civil engineer is needed to design outlet protection for flows greater than 1.70 cubic meters per second.
Flood Control Maintenance BMP Manual
Section III - VR-4a
Velocity Reduction
Permanent Outlet Protection

4. ALL APRONS NEED ROCK CUTOFF WALLS (NOT SHOWN IN THESE FIGURES) KEYED IN UPSTREAM, DOWNSTREAM, AND LONGITUDINALLY, INTO THE CHANNEL PERIMETER.


(Note: Note 4 was not included in the original source.)
Source: Caltrans, 1997.

*Note*: All aprons need rock cutoff walls (not shown in these figures), keyed in upstream, downstream and longitudinally, into the channel perimeter.
Note: All aprons need rock cutoff walls (not shown in these figures), keyed in upstream, downstream and longitudinally, into the channel perimeter.

References


Description

This measure provides information on temporary devices made of rock that is placed at outlets to temporary channels and pipes to reduce the velocity of water exiting, and to control erosion and scour. This practice protects inlets or outlets from developing plunge pools (small, eroded pools), and protects against scour and the resulting gully erosion at a culvert outlet. Erosion control fabric and hay waddles/coconut rolls can be installed in front of an outlet to provide additional velocity reduction and a softer appearance. (See BMPs SS-1 and SC-5).

Applicability

This measure is intended to describe temporary outlet protection, such as for a sediment basin (BMP SC-3) or dewatering/diversion system (BMPs WD-4, WD-5). See VR-4a for detailed information on permanent outlet protection.

Approach and Standards

Inlet Protection

- Where the bottom is vegetated and the amount of water being conveyed is relatively small, inlet protection may not be necessary.
- If considerable turbulence may be generated around the intake which can cause sediment to be suspended in the discharge water, then the inlet must be protected.
- One technique to protect inlets involves ponding water behind the cofferdam or in an excavated sump. The intake pipe end should be substantially above the bottom of the pond or sump unless a container is used for the sump or the pond bottom is lined with impervious material.
- For gravity systems, a standpipe arrangement is very effective (see figure below). An intake filter can also be used to screen out sediment. However it may not be effective
against fine-grained material such as clay and it is easily clogged by debris, so it is not recommended if the pump must run unattended (e.g., nights or weekends).

Outlet Protection

- For very low flow rates, a sheet of plastic or plywood may be enough to spread the flow and reduce the velocity of the water. However, the most common temporary outlet protect is a rock apron on filter fabric.
- Rock outlet protection is effective at limiting erosion when the rock is sized and placed appropriately. Increase rock size for high velocity flows. Use sound, durable, angular rock.
- Construct rock apron on zero grade.
- Align apron with the receiving stream and keep it straight throughout its length. If a curve is needed to fit the site conditions, place the curve in the upper section of the apron.
- When designing the outlet project, consider flow depth, roughness, gradient, side slopes, discharge rate and velocity. The discharge pipe size governs the rock depth and outlet protection length. Consider hydraulic calculations and velocities to determine the total length of the device.
- For outlets carrying larger or higher flows, consult a registered civil engineer.
- All aprons need rock cutoff walls, keyed in upstream, downstream, and longitudinally into the channel perimeter.
- If discharge is to a tidal area, the discharge pipe may need to be equipped with a flap gate to prevent tidal flows from backing up the outlet.

Limitations

Outlet Protection

- During high flows, loose rock may wash away.
- Outlet protection may have negative impacts on channel habitat. These impacts generally will be less than the impacts from erosion if no protection is provided, however.
- Riprap aprons are best used as a temporary measure during construction.
- High inspection requirements during the rainy season.
Requirements

Maintenance

A fair amount of maintenance is necessary to ensure that temporary outlet protection work properly, especially when used during the rainy season.

Outlet Protection

• Inspect temporary outlets periodically, especially before predicted storms.
• Inspect apron for displacement of the riprap and/or damage to the underlying fabric. Repair and replace as necessary.
• Inspect for scour beneath the riprap and around the outlet, and repair any damage immediately.
• Remove temporary devices as soon as the drainage area has been stabilized or at the end of construction.

Costs

• Moderate capital expenditures required, while operation and maintenance costs are lower. Rock outlet protection is generally less expensive and easier to install than permanent protection.
• Installation costs. Material costs for filter fabric, and rock, including materials necessary for repairs.
• Costs due to staff time for inspection and repairs.

Training

• A registered civil engineer is needed to design outlet protection for flows greater than 1.70 cubic meters per second.

References


**Description**

Devices temporarily constructed around storm drains to pond sediment-laden runoff allow sedimentation to occur, and to filter the water before it enters the storm drain system.

**Applicability**

- When sediments may enter an inlet via surface runoff.
- In areas that have not been permanently stabilized.
- For use during the wet season (October 15 through April 15, typically).
- Locations where the drainage area is 1 acre (0.4 ha) or less.
- Open areas that have sheet flow, or flow not exceeding 0.5 cfs (0.014 cubic meters/second). If flows exceed this rate or if localized flooding must be prevented, block and gravel bag barriers can be used.
- Excavated drop inlet sediment traps can be used with relatively heavy flows and overflow alternatives are required.

This measure is likely to have a significant impact to reduce sedimentation downstream of the storm drain inlet.

**Approach and Standards**

- Do not use filter fabric to cover the inlet grate, as it can clog and cause localized flooding.
- Bring the disturbed area to the grade of the drop inlet and smooth and compact the disturbed area. Stabilize all bare areas around the inlet properly.
- If the inlet is on a slope, the down-slope side of the inlet does not need to be protected as long as the slope is steep enough that runoff will not enter the storm drain from that side.
Filter Fabric Fence
- Can be used for drainage basins less than one acre and less than a 5 percent slope.
- Place wooden stakes, sized 2 inches by 2 inches and at least 3 feet long, around the inlet perimeter at a maximum of 3 feet apart. Drive them at least 8 inches into the ground.
- Excavate a trench about 8 inches wide and 1 foot deep around the outside perimeter of the stakes.
- Using at least one-inch wire staples, staple the filter fabric to the stakes so that 32 inches of fabric extends and can be formed into the trench.
- Backfill the trench with ¾-inch or less washed gravel along the entire perimeter.

Block and Gravel Filter
- Can be used in areas with flows greater than 0.5 cfs.
- Place hardware cloth or wire mesh that has one-half inch openings over the drop storm drain inlet so that the wire extends at least one foot beyond the sides of the inlet structure. Overlap the strips if necessary.
- Place a single row of concrete blocks lengthwise on their sides around the inlet so that the open ends face out not up. The ends of the concrete blocks should abut one another. Blocks can be stacked to adjust the height of the filter.
- Put hardware cloth or wire mesh with one-half inch openings over the outside vertical face (open end) of the concrete blocks to keep stone from being washed through the blocks.
- Pile ¾ to 3 inch washed stone against the mesh to the top of the blocks.

Gravel and Mesh Filter
- Can be used on curb or drop inlets where construction equipment may drive over the inlet.
- Place hardware cloth or wire mesh that has one-half inch openings over the drop storm drain inlet so that the wire extends at least one foot beyond the sides of the inlet structure. Overlap the strips if necessary. Put filter fabric over the wire mesh.
- Put ¾ to 3-inch gravel over the filter fabric/wire mesh to a depth of at least 12 inches over the entire inlet opening.

Sand Bag Barrier
- Can be used to create small sediment traps upstream of the inlets on sloped, paved streets.
- Use sand bags of geotextile fabric, not burlap.
- Fill sand bags with ¾ inch rock or ¼ inch pea gravel.
- Construct on gently sloping, paved streets.
- Locate so there is room upstream of the barrier for the water to pond and sediment to settle.
Place several layers of sand bags, overlapping the bags and packing them together tightly.

Leave a gap of one bag on the top row to act as a spillway. Do not allow flow from a 10-year-average-sized storm to overflow the curb.

Limitations

- Protection may cause localized flooding. Devices should be used only when the ponding will not encroach into heavy traffic areas or onto surfaces and slopes that could erode.
- Use other on-site sediment trapping techniques together with inlet protection during high flow conditions or for drainage areas larger than 1 acre (0.4 ha).
- Frequent maintenance is needed to minimize short-circuiting and to remove sediments and buildup that have collected.

Requirements

Maintenance

- Properly collect and dispose of accumulated sediment.
- Inspect all devices before and after rain events, and at least weekly throughout the rainy season. During extended storms, inspect the devices at least once every 24 hours.
- Remove all devices within 30 days of site stabilization, or when the protection is no longer needed.

Costs


Training

- A full understanding of the techniques and proper inspection and maintenance methods are necessary.

Storm Drain Inlet Protection Strategies:
Source: Caltrans, 1997.

*Note: See Appendix B for metric to English conversions*
Section III - VR-5

Velocity Reduction

Storm Drain Inlet Protection

NOTES:

1. Not applicable in areas with high silts and clays with out filter fabric.

2. Periodically remove and replace gravel. Old gravel may be used as backfill material if approved by Engineer.

Source: Caltrans, 1997.
Velocity Reduction

NOTES:
1. Use clean 19 mm gravel or approved equal.
2. Periodically change gravel with new, clean gravel. Old gravel may be used as backfill material if approved by Engineer.

SECTION A-A
TYPICAL BLOCK & GRAVEL FILTER W/O CURB
NOT TO SCALE

Source: Caltrans, 1997.
References


Water Diversion
Description

A structure used to intercept and move surface runoff, especially sheet flow to a specific location, in order to reduce erosion and sedimentation impacts.

Applicability

Earth dikes can be used:

- To move concentrated runoff through or around disturbed areas;
- For diverting runoff to avoid sheet flow over sloped surfaces, and for conveying surface runoff down slopes;
- Below steep slopes where runoff begins to concentrate to divert it to a stabilized channel or drainage pipe;
- With other BMPs such as sediment basins (see SC-3), slope or subsurface drains (see WD-2), or level spreaders (not included herein); or
- To contain construction wastes.

Earth dikes are likely to have a significant effect on reducing the sediment load, and can also reduce impacts from toxic materials, oil and grease, and other construction waste materials.

Approach and Standards

- Compact all dikes with appropriate earth-moving equipment.
- Ensure all dikes have a positive drainage into an outlet that has been stabilized.
- Construct dikes to convey sediments into a sediment trap.
- Stabilize dikes with vegetation or physical devices.
- The dikes can be constructed to allow for construction traffic by building a wide top and flatter side slopes.
- Temporary diversion dikes should have 2:1 side slopes with a minimum height of 1.5-feet, and a minimum top width of 2 feet. Exact dimensions should be based on a
calculation of design flow and safety based on risk evaluation due to erosion, over-topping, flow backups or washout. Runon from off-site sources should be considered.

- Consider soil types and drainage flow patterns when selecting flow velocity.
- Include an emergency overflow section /bypass area for larger-than-design storms.
- Construct the earth dike’s outlet to minimize erosion—convey runoff to a sediment trap or basin when the dike channel or drainage area above the dike are not stabilized (see BMPs VR-4, SC-3, and SC-5).
- Seed and mulch could be used to stabilize slopes less than 5% (see BMP VDM-3). Riprap or sod can be used to stabilize slopes greater than 5%. Stabilization must occur just after construction and before the first rain.
- For riprap stabilization of channels formed along the toe of a dike, use the following specifications:

<table>
<thead>
<tr>
<th>Channel Grade</th>
<th>Riprap Stabilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-1.0%</td>
<td>4-inch Rock</td>
</tr>
<tr>
<td>1.1-2.0%</td>
<td>6-inch Rock</td>
</tr>
<tr>
<td>2.1-4.0%</td>
<td>8-inch Rock</td>
</tr>
<tr>
<td>4.1-5.0%</td>
<td>8- to 12-inch Rock</td>
</tr>
</tbody>
</table>

- Use filter cloth to cover extended-term dikes.
- Keep construction activity on the dike to a minimum.

**Limitations**

- Because earth dikes are temporary structures, they should be used only in areas that drain 10-acres or less, or along slopes that are less than or equal to 10 percent.
- Earth dikes can be obstructions to construction equipment and may create additional disturbed areas.
- Water that has been diverted may cause downstream flooding.
- Easily-erodible soils should not be used to construct earth dikes.
- Temporary diversion structures should be placed and sized correctly so as not to impact nearby properties.
- Earth dikes need to conform to floodplain management regulations.
- High velocity runoff may require lined ditches. Linings include vegetation, riprap, engineering fabric, or concrete.
- Earth dikes are temporary structures that require proper removal at the completion of construction or once the surrounding drainage area is stabilized.
- Stabilize the disturbed area, once the dike is removed.

**Requirements**
Maintenance

- Earth dikes should be inspected—and repaired if necessary—after each rainfall, and periodically during dry weather months. Inspections should include the channel lining, embankments and channel bed for erosion and any debris or sediment. Sediment and debris should be removed, and the lining should be repaired, as needed.
- Stabilize earth dikes immediately with vegetation or physical devices. Once stabilized, little maintenance is required.

Costs

- Staff time for construction, stabilization, inspection, maintenance, and removal.
- Capital costs can be low to moderate, depending on site location and access. Soil material for construction may be available at the site, and the earth dikes can be built during initial grading operations with existing equipment.
- Operation and maintenance costs and training costs are low.
- Cost to stabilize disturbed areas once the dike is removed.

Training

- Training needs are minimal. Staff should be trained on methods to create stability, and remove temporary dikes; and considerations for designing dikes. Employees should have training in channel stabilization.
Section III - WD-1
Earth Dike

Operational Permits Committee III-WD-1.4
EOA, Inc.
June 15, 2000

Flood Control Maintenance BMP Manual

Water Diversion

III-WD-1

III-WD-1.4 EOA, Inc.
June 15, 2000

Water Diversion Earth Dike

Operational Permits Committee

June 15, 2000


<table>
<thead>
<tr>
<th>Requirements Based on Upstream Drainage Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-Dike Height</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>18”</td>
</tr>
<tr>
<td>B-Dike Width</td>
</tr>
<tr>
<td>C-Flow Width</td>
</tr>
<tr>
<td>D-Flow Depth</td>
</tr>
</tbody>
</table>


References


Description

A lined channel or temporary pipe that is used to drain runoff from the top of a slope to a stable point at the bottom of a slope. The slope drain is used to prevent erosion of the slope. Slope drains may include rigid pipe drops; flexible pipe down drains; sectional pipe down drains; and concrete-lined terrace drains.

Rigid Pipes

Rigid pipe slope drains are typically made of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured to the slope. The pipe should be covered by at least twelve inches of soil. Installers may use concrete thrust blocks as determined necessary by calculated thrust forces. Pipes should be properly installed with collars secured with metal strappings.

Flexible Pipe

A flexible pipe is created of heavy duty material, securely attached to the slope. Metal strappings or water tight collars are used to attach the conduit to the inlet and outlet. Connections are watertight.

Sectional Down Drains

This type of pipe is a pre-fabricated, sectional conduit consisting of a third- or half-round material, that performs like a chute. As with the other pipes, it needs to be placed on undisturbed or compacted soils and properly secured to the slope.

Concrete-lined Terrace Drain
This permanent drain is a concrete channel that needs to be designed according to local drainage design criteria.

**Applicability**

Slope drains can be used:
- When concentrated surface runoff needs to be diverted down a slope to prevent erosion.
- With diversion dikes or swales located at the top of a slope (see BMPs WD-1 and WD-3).
- As an emergency spillway for a sediment or detention basin (see BMP SC-3).
- For drainage for the top of cut and fill slopes in areas where water will accumulate.

This measure is likely to significantly reduce erosion.

**Approach and Standards**

- Design conveyance pipe using a 10-year, 24-hour model storm, and local flood control requirements.
- Make sure inlet structures are entrenched properly and compacted to avoid major gully erosion.
- Surround the inlet with dikes to prevent gully erosion, and securely anchor the pipe to the slope.
- Stabilize the outlet using a velocity dissipater (see BMP VR-4), or direct to a stable sediment trap or basin (see BMPs SC-3, or SC-5). Consider using a riprap apron for stabilization in cases where the sediment trap/basin is not used.
- Especially for larger pipes, install a debris rack at the inlets to prevent clogging the pipe, and the resulting gully erosion. If children can enter the outlet pipe, include a debris rack there too for safety.
- If the drainage area is greater than 5 acres, a permanent improvement (e.g., paved chute, rock-lined channel) or other effective option should be installed. For smaller drainage areas, do not use a pipe smaller than the following:
For the pipe slope drain entrance, consider using a standard flare end section with a minimum 6-inch toe plate to prevent undercutting of the pipe inlet. If the entrance slope is typically more than 3 percent, consider securing the flared inlet section to the slope drain and using watertight connecting bands (see BMP VR-4).

- Consider rigorously compacting the soil around and under the pipe and pipe entrance.
- Make sure the slope drain sections are securely fastened to one another, that they have watertight gasket fittings, and are securely anchored to the soil.
- Consider using interceptor dikes—that are at least 12 inches higher at all points than the top of the inlet pipe—to divert runoff to the slope drain.
- Install slope drains so they are perpendicular to the contours of the slope.

**Limitations**

- Gully erosion can easily occur with slope drains that are not properly installed and maintained.
- Drainage areas per pipe slope drain should not exceed 5 acres unless effective options are incorporated that will maintain the integrity and effectiveness of the slope drain.
- Pipes can become clogged or overwhelmed during large storms, causing extensive slope erosion when water flows around the pipe.
- Failure of the structure can result in flooding and significant erosion.
- The sectional down drain must be sized correctly to ensure runoff does not spill over the drain sides and cause structural failure.

**Requirements**

**Maintenance**

- Installation and maintenance needs are relatively small, especially for flexible pipe.
- Perform inspection before and after rain storms, and every two weeks until the drainage areas have been stabilized. Then inspect routinely.
• When conducting inspections, examine for erosion and downstream scour near the outlet. Repair, install additional energy dissipation measures, and/or reduce discharge flows if needed.

• Also, inspect the slope drain for debris and sediment. Remove build-ups of either from entrances and outlets as required. If necessary, flush the drains, being sure to capture and settle the sediment in the drain water.

• Inspect to ensure that water is not ponding in inappropriate areas. Correct if needed.

Costs

The costs of diversion devices are usually included in the earthwork cost, under the grading budget. This measure has moderate capital and maintenance costs and minimum operational costs.

Training

• Training is required for proper design and installation since improper design and installation can lead to severe erosion. Training on appropriate monitoring and maintenance is also important.
ALTERNATE: SEDIMENT TRAP (SEE ESC 56)

LENGTH AS NECESSARY TO GO THRU DIKE

H = D+12"

WATERTIGHT CONNECTING BAND

4' MIN LESS THAN 1X SLOPE

SEDIMENT TRAP

6" MIN CUTOFF WALL

PIPE ELBOW

PIECE SLOPE 3X OR STEEPER

SEED TRAP

RIPRAP SHOULD CONSIST OF 6" DIA STONE PLACED AS SHOWN. DEPTH OF APRON SHOULD EQUAL THE PIPE DIA AND RIPRAP SHALL BE A MINIMUM OF 12" IN THICKNESS.

ALTERNATIVE SEDIMENT TRAP: RIPRAP PLAN

PIPE SLOPE DRAIN (FLEXIBLE)


Slope Drain Illustration Alternative: Caltrans
References


Runoff Diversion

Temporary Drains and Swales

Description

Temporary swales and drains can be used to divert runoff around disturbed areas and to direct runoff into sediment basins or traps.

Applicability

- Temporary drains and swales can be used to divert runoff around disturbed or unstable areas to prevent slope failures or other damage including erosion.
- They can also be used to promote infiltration and to move runoff that contains sediments into sediment basins or traps.
- Can be used with an earth dike and slope drain (see BMPs WD-1 and WD-2, respectively) to divert water from the top of a slope to the bottom.
- Swales are more stable, and thus more effective, than dikes.

This measure is likely to significantly reduce erosion and can be used to help contain sediments.

Approach and Standards

- Install during initial grading, and remove after permanent controls are in place or slopes are stabilized.
- Use local drainage design criteria to properly design the temporary swale.
- Have a professional engineer design permanent drainage channels.
- Create drains and swales to conform to the drainage patterns and capacities present before development, and make sure the drain or swale has a positive grade all the way to a stabilized outlet.
- Include velocity dissipation or erosion protection measures if the flow out of the swales or drains has a velocity that can cause erosion (see BMP VR-4).
- Construct the swales or drains so as not to impact adjacent properties.
• Use standard engineering design criteria for a small open channel or closed conveyance system.
• Design so that five or less acres drain to the temporary drain or swale.
• Place the drain or swale above, rather than on, a cut and fill slope.
• The width of the swale bottom should be at least 2 feet; the depth should be at least 1.5 feet; and the side slopes should be 2:1 (vertical to horizontal) or flatter.
• The drain or swale should have a grade between 1 and 15 percent.
• Construct the swale to withstand (not be overtopped by) a 10-year, 24-hour storm.
• Remove all obstructions from the swale during construction.
• Ensure the fill material along the swale path is compacted.
• Immediately stabilize all swales. For swales with a slope less than 5 percent, use seed and mulch (see BMPs VDM-1 through VDM-3). Use rip-rap or sod to stabilize swales with slopes between 5 and 15 percent.
• Provide stabilized crossings if construction or maintenance vehicles must cross the swale.

Limitations

• Temporary swales and drains need to conform to other floodplain management requirements.
• Diverting the runoff increases the volume and velocity of runoff, so the outlet must be stabilized.
• If the drain or swale contains sediments, divert it to a sediment basin or trap (see BMPs SC-3 and SC-5) before being discharged.
• Temporary drains and swales cannot be used directly on a cut and fill slope.

Requirements

Maintenance

• Conduct inspections regularly and after every major rain event. Inspect for accumulation of sediments, piping, unstable banks, and scour holes. Pay attention to outlets and areas where concentrated flow enters or exits the swale.
• As necessary, remove debris and make repairs. Repairs should be made prior to the next storm.
• At the end of its useful life, remove any temporary drains or swales and stabilize the impacted area.

Costs
The most cost-effective diversion is a combination of a swale with a dike on the downhill side of the slope. The costs of diversion devices are usually included in the earthwork cost, under the grading budget.

**Training**

- A professional engineer may be necessary for the design of the temporary drain or swale.
- Training needs for installation, maintenance, and repair are minimal.

![Typical Drainage Swale](image)

NOTES:
1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade, in conformance with Section 19-5 of the Caltrans Standard Specifications.

Source: Caltrans, 1997.

**References**


Description

Practices and methods to remove water from a work area. Dewatering practices should be considered as a last resort control measure, to remove water from a work site after erosion and sediment control measures have been taken.

Applicability

- This applies to flood control channel activities where working under “dry” conditions is necessary or where erosion and sediment control measures have already been applied and water is interfering with work activities. (“Dry” is a relative state essentially meaning that the work is isolated from flowing water).
- Used as a water quality measure to prevent downstream turbidity.

Approach and Standards

- Site should be dewatered if water is present before repairs are begun.
- Bypass water around work sites so work can be done in dry conditions.
- When remaining nuisance water use coffer dams, sumps, water dams, or sheet pilings to keep water out of the work site. Dewater work site so dredging does not cause downstream sedimentation.
- In some dredging instances, dewatering the work site is not necessary. A berm, consisting of accumulated sediment, can be in place as a barrier between the work site and flowing water.
- Properly use gravity systems, or if necessary, pump/generator sets properly to regulate flows to prevent pump damage or wash-out conditions.
- Discharge nuisance water over some form of energy dissipater to keep erosion of the downstream channel to a minimum (see BMPs VR-1 through VR-5).
- Protect diverted water or stored water from getting polluted from construction-related activities.
Limitations

The controls discussed in this BMP address sediment only. If the presence of polluted water is identified, additional dewatering pollutant treatment controls, such as filtering, should be implemented. Contact the local municipal stormwater program or the Regional Water Quality Control Board for direction.

Requirements

Maintenance

- Inspect dewatering devices and containment systems regularly and repair or replace if the sediment build-up prevents the structure from functioning as designed.
- When floating suction hoses are used, personnel should be assigned to periodically monitor dewatering operations and effluent to ensure that sediment is not discharged into a storm drain or the channel.
- Accumulated sediment removed from a dewatering device must be spread on site and stabilized or disposed of at a disposal site.
- Service pump/generator sets before use. Keep daily records of service and maintenance of your pump-generator systems.

Costs

- Materials and maintenance costs for coffer dams, sumps, temporary dams, sheet pilings, hay bales, and/or pump and generator sets.
- Additional costs may be associated with this BMP if dewatering pollutant treatment controls other than sedimentation controls need to be implemented.
- Costs for twenty-four hour security may be needed to prevent vandalism to the pumps, generator, piping, and other materials.
- Staff costs may be necessary to keep the generators fueled if it is necessary to keep the pumps running all night to keep up with flows.

Training
**Water Diversion**

- Train maintenance staff on dewatering techniques, and the inspection of dewatering devices.
- Staff should be trained on pollution prevention measures for maintaining bypass water free of contaminants generated during construction. Train staff to recognize polluted water.

---

**NOTES:**

1. Weld shall be designed for the capacity of the tank.
2. For bottom drum, remove top cover only. Remove top & bottom covers for top & middle drums.

---

**Source:** Caltrans, 1997.
Flood Control Maintenance BMP Manual

Section III - WD-4

Dewatering

Water Diversion

Nuisance Water

Note: See Appendix B for Metric to English conversions.

Source: Caltrans, 1997.
**Section III - WD-4**

**Dewatering**

**Water Diversion**

**Nuisance Water**

---

**Source:** Caltrans, 1997.

---

**Typical Portable Sediment Tank**

*Not to Scale*
References


Description

Practices and methods to prevent flowing or tidal waters in a watercourse or channel from entering a work area. The purposes are twofold: to prevent flowing or tidal water from interfering with the work (e.g., excavation, concrete work, etc.) and to prevent contaminants such as suspended sediment, cement, and other work materials from being discharged downstream. This BMP does not cover discharges from the protected work area. See BMPs for Sediment Control (SC), and Water Diversion (WD) for more information.

Applicability

These methods are applicable during the dry season when work must be conducted in watercourses or channels where there is a residual base flow but little likelihood of storm flow.

Approach and Standards

- Dewatering system should be in place and functioning before in-channel work is started.
- Intakes and outlets should be designed and maintained so as not to add contaminants to the stream flow.
- If water is discharged from the disturbed and isolated work area, then filtration devices or settling basins must be provided as necessary to insure that its turbidity (suspended sediment content) does not significantly exceed that of the channel flow to which it is discharged.
- Depending on the rate of discharge, filtration/settling may involve sophisticated systems such as shown in WD-4, SC-3, or SC-5 or simple filter fabric or hay bale barriers as shown in SC-4 and SC-6. Such filtration/settling systems are not designed...
Water Diversion

for any purpose other than turbidity reduction. Other measures may be necessary to prevent and control discharges of other pollutants. Some of these are discussed in other sections of this manual.

- Following construction work, it is important to remove all system components and to restore disturbed areas at the intake, cofferdam, and discharge sites to preconstruction grades.

- Once the project work is complete and as system components are being removed, release water slowly back into the work area. Water released at higher velocities can cause erosion and increased turbidity.

Limitations

- These are considered temporary systems and are not generally designed to accommodate winter storm flows. They should not be relied upon when there is substantial risk of storm flow in the channel.

- These systems will have the effect of blocking fish passage. If the stream or channel supports a steelhead or salmon fishery these diversions should not be used between November 1st and May 31st. For other fisheries, consult the California Department of Fish and Game. See also, BMP NR-3.

Requirements

Maintenance

- **Maintenance of these systems is critical.** In general, diversion systems must be operational 24 hours per day during the period when construction in the channel is in progress. Failure could result in flooding of the work area and the overwhelming of work area discharge filtration or settling systems by the full stream flow. All system components should be inspected at least twice per day.

- If pumps are used, they must be serviced (fuel, oil, running condition) regularly and a standby pump of equivalent capacity should be available on site. If pumps are electric (e.g., submersible pumps) and a generator is used to supply power, it also must be serviced. Appropriate BMP’s should be used (see CU-4 and EV-1).

- Both intake and discharge components are capable of generating suspended sediment and should be inspected and repaired or modified if there is any sign of increased turbidity in the discharge.
Costs

- Moderate costs for purchasing and servicing equipment and materials.
- Costs for staff time to inspect and maintain to ensure system is operational 24 hours per day.

Training

- Staff should be trained in correct implementation and monitoring of the system.
- Need trained personnel to maintain and service equipment as necessary.
- Staff should be aware of which waterbodies contain sensitive fish populations and other habitat considerations.
GENERALIZED SCHEMATICS

TRANSVERSE COFFERDAM

For situations where equipment must be operated from the channel bottom or the work extends across the bottom. Flow from upstream must be captured and conveyed to a point downstream of the work.
LONGITUDINAL COFFERDAM

For situations where equipment will be operated from the top of bank and the work does not extend completely across the channel bottom. The channel bottom outside the cofferdam remains undisturbed.
All materials used in these systems - cofferdams, intake and discharge protection, and mechanical components - should be completely removed after construction and the areas restored to grade.

**A. Intake:** Where the bottom is vegetated and the amount of water being conveyed is relatively small, inlet protection may not be necessary. However, considerable turbulence may be generated around the intake which can cause sediment to be suspended in the discharge water and this should be avoided. A variety of techniques can be used for this purpose, including ponding of water behind the cofferdam or in an excavated sump. The intake pipe end should be substantially above the bottom of the pond or sump unless a container is used for the sump or unless the pond bottom is lined with impervious material. For gravity systems, a standpipe arrangement is very effective. An intake filter can also be used to screen out sediment, but it may not be effective against fine-grained material such as clay and it is easily clogged by debris. Therefore, an intake filter is not recommended if the pump must run unattended (e.g., nights or weekends).

**B-1 Cofferdam:** The cofferdam is an impervious structure designed to prevent surface flows from passing into the work area. It can be constructed of fill materials such as bottom sediments (usually reserved for sediment removal operations where the material is being moved around anyway), of sandbags filled with soil, sand, or gravel, or of structural materials such as driven sheet piles, timber and plywood, water dams (large water filled tubes), K-rails, or, for small scale applications, even hay bales. Many of these structures will require sealing with plastic sheeting to become impervious.

**B-2 Cofferdam:** When the construction site is in a tidal channel or otherwise subject to backflow from downstream, it will be necessary to construct a cofferdam downstream of the site to exclude these flows. Construction is similar to the upstream cofferdam (B-1, above) except that it must be high enough and strong enough to withstand the highest tide expected during the construction period. The longitudinal cofferdam will perform both B-1 and B-2 functions. (Note that tidal action will also impose design challenges for any discharges from the work area.)

**C-1 Gravity Pipeline:** A gravity flow system is preferable from the standpoint of reliability because it does not depend on a pump. Water flows continuously from the
intake. The disadvantage is that the pipeline must slope continuously down grade and therefore may have to pass through or near the work area. In some circumstances, the flow can be contained by a ditch or berm rather than a pipeline. Such systems must not be erosive. In all likelihood they will have to be lined with fabric, plastic, or other protective materials. If a ditch is excavated into native bottom material (as opposed to deposited sediment) it should be backfilled and compacted after completion of the work. Otherwise, it could lead to downcutting on site and/or headcutting upstream.

C-2 Pump Pipeline: A pumped system is necessary where there is no available discharge point continuously down grade of the intake, for example, where the work area spans the channel bottom and the pipeline cannot be routed through it. The pump, itself, can be located at the intake (e.g., submersible pump) or elsewhere depending on the situation. It should be automatically actuated by water levels at the intake and of sufficient size to accommodate the maximum expected flows. The disadvantage is that the system is dependent on pump reliability. Any malfunction or vandalism can result in flooding of the construction site and carry pollutants downstream, especially if it occurs outside of working hours (see Maintenance). It is sometimes preferable to divert the flows to a point outside the channel such as a storm drain. If this is contemplated, however, it should be recognized that downstream aquatic plants and animals would be adversely affected by the loss of flow and this should be carefully considered and addressed before implementing such a system.

D. Discharge: The discharge point is another location where unnecessary turbidity can be generated. It may not be necessary to provide energy dissipation or other protection if the discharge is to an existing hardened structure (such as a culvert or a riprap or concrete apron), to deep water, or even to a vegetated area if the discharge rates are low enough. However, if the discharge may cause erosion or scour it should be protected. For low flow rates this may be as simple as a sheet of plastic or plywood to spread the flow. For higher flows, a riprap apron (see WD-2 and VR-4) or other, more resistant means may be necessary. Note that if the discharge is to a tidal area it may be necessary to equip the discharge pipe with a flap gate to prevent tidal flows from backing up to the intake.

References

Section IV
Evaluating the Performance of Best Management Practices
EVALUATION OF BMP PERFORMANCE

The goal of this manual is to remain a useful document over a long period of time, through the incorporation of periodic updates as additional information and improved techniques are found. The art of minimal-impact flood control maintenance still has substantial room for improvement. As such, a survey is attached that can be used to provide updated or new information on specific BMPs. Information from these surveys will be used to periodically update the manual. Alternately, a blank BMP form is included if you wish to submit your own BMP.

The BASMAA Operational Permits Committee requests that updated information be provided as new techniques or as problems with described techniques arise for those BMPs which flood control personnel determine can be improved.

Copies of the survey form should be completed when appropriate and sent to the following address:

BASMAA OPC—Flood Control BMP Manual
Attn: Executive Director, BASMAA
1515 Clay Street, Suite 1400
Oakland, CA 94612
Phone: (510) 622-2326
Fax: (510) 622-2460

Thank you for your assistance.
### BMP Survey

**Reference Code (e.g. VR-1):** _____________  **BMP Name:** ___________________

(Answers to the following questions can be completed on the back of this page).

1. If this is a proposed new BMP, please provide a short **Description** here.

   

2. Provide suggested changes to the **Applicability** section here.

   

3. Provide suggested changes to the **Approach and Standards** section here.

   

4. Provide suggested changes to the **Limitations** section here.

   

5. Provide suggested changes to the **Requirements—Maintenance** section here.

   

6. Provide suggested changes to the **Requirements—Costs** section here.

   

7. Provide suggested changes to the **Requirements—Training** section here.
EVALUATING BMPs

8. Any other suggested changes, with justification.

9. Do you have suggestions for new BMPs not currently in the manual (you can also fill out the blank BMP form, attached)

10. Describe any problems that you have experienced which are not adequately addressed by existing BMPs.

11. Should any of the BMPs be deleted because they are not practical, not effective, or for some other reason(s). Please state why.

12. Please provide your name and contact information in case we have any questions.

   Name: ______________________  Agency: ______________________
   Phone: ______________________  E-mail: ______________________

   Thank you!
Description
(Text Here)

Applicability
(Text Here)

Approach and Standards
(Text Here)

Limitations
(Text Here)

Requirements
(Text Here)

Maintenance
(Text Here)

Costs
(Text Here)

Training
(Text Here)

References
(Attach any figures, plans, specs.)
Section V
References and Additional Resources
REFERENCES


Rugg, Mike, California Department of Fish and Game, personal communication, BASMAAA OPC meeting, September 14, 1999.

Rugg, Mike, California Department of Fish and Game, personal communication March 13, 2000.
REFERENCES AND ADDITIONAL RESOURCES


ADDITIONAL RESOURCES

Leidy, Robert, Database on coho, steelhead, and Chinook salmon. (www.sfei.com)


Appendix A

Field Guide for Flood Control Facility Maintenance Best Management Practices
Field Guide
for Flood Control Facility Maintenance
Best Management Practices

A Field Guide for Minimizing Environmental Impacts from
Stream and Channel Maintenance Activities

June 2000

Operational Permits Committee

Photo courtesy of SCVWD

EOA, Inc.
INTRODUCTION

The purpose of this Flood Control Facility Maintenance Best Management Practices (BMP) field guide and associated manual is to provide guidance for maintenance field staff, engineers, and planners in selecting and implementing BMPs and devices that avoid or minimize impacts to natural resources while allowing for stream maintenance activities to proceed with minimal regulatory requirements. This field guide includes memory-jogging descriptions and approaches of the BMPs. For full descriptions, please refer to the desktop manual.

This field guide and the manual were prepared for the San Francisco Bay Area Stormwater Management Agencies Association’s (BASMAA) Operational Permits Committee.

Project Manager:
Patrick E. Baker, CEP
Alameda County Public Works Agency

This document was prepared by:
Eisenberg, Olivieri, & Associates
1410 Jackson Street
Oakland, CA  94612

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation Management</td>
<td>FG-3</td>
</tr>
<tr>
<td>Debris Removal</td>
<td>FG-9</td>
</tr>
<tr>
<td>Erosion Repair/Prevention</td>
<td>FG-10</td>
</tr>
<tr>
<td>Sediment Control</td>
<td>FG-23</td>
</tr>
<tr>
<td>Structural Repair</td>
<td>FG-30</td>
</tr>
</tbody>
</table>

BASMAA Operational Permits Committee

FG-2

EOA, Inc.
VEGETATION MANAGEMENT

(See also Structure Repair (EV-1, EV-2))

Vegetation Preservation (VDM-1). Methods to minimize soil erosion by preserving existing vegetation.

Applicability

- Inactive areas
- Stream banks or steep slopes
- Flood plains
- Where erosion control would be difficult
- Where required or beneficial

Approach Highlights

- Decide which vegetation will be preserved.
- Protect that vegetation from mechanical and other injury during maintenance project by physically defining a setback area.
- Repair any damage done.
Vegetation Removal (VDM-2). Removal techniques to preserve channels’ flood control functions, create stable channel environments, and/or provide safe access.

Applicability

Areas where:

- ♦ Work could damage existing vegetation or equipment.
- ♦ Flow is obstructed or diverted against a bank.
- ♦ Necessary for public safety.

Approach Highlights

- Use equipment that will minimize impacts. Protect stream shading.
- Consult with vegetation specialist when necessary.
- Minimize use of herbicides. Use herbicides that are approved for water use.
- In natural streams, avoid removing stumps. Do not top live willows.
- Remove non-native vegetation that inhibits native vegetation.
- Reuse vegetation as appropriate.
**Revegetation (VDM-3).** Methods to revegetate sites after site disturbance to reduce bank erosion potential.

**Applicability**
- Inactive areas
- Stream banks or steep slopes
- Sensitive areas
- Upstream of critical habitats
- Where required or beneficial

**Approach Highlights**
- Revegetate as soon as possible after construction.
- Use native plants and grasses.
- Use cuttings and seeds from existing native vegetation taken before disturbance.
- Revegetate at ratio of 1:1. Regularly monitor revegetated areas.
- Supplement with water until established, if necessary.
- Use mulch or erosion control blankets as appropriate.
**Qualified Pesticide Applicator (CU-1).** Persons performing pest control should be certified by the State of California. Persons applying Class I pesticides must obtain a qualified applicator certificate (QAC). Those persons who purchase Type I or Type II pesticides or who oversee the application of such pesticides, must obtain a qualified applicator license (QAL).

**Applicability**

- All sites where pest control activities are necessary.

**Approach Highlights**

- Ensure personnel have obtained appropriate training.
- Use integrated pest management to control pests. Use pesticides with low environmental persistence, and prescribe at the lowest possible effective levels.
- Triple rinse empty pesticide containers and use the rinse water as product. Properly dispose of containers per label instructions.
- Handle and store materials safely. (See CU-3, and CU-4 in Structure Repair for more information on proper material handling and spill prevention and control.)
**Pesticide Application and Aquatic Conditions (CU-6).** *Land application techniques for ensuring safe pesticide dosage for local conditions and for preventing excess runoff.*

**Applicability**

- All sites where pest control activities are necessary.

**Approach Highlights**

- Perform work when tides are favorable to prevent off target movement.
- Make aquatic applications from the downstream to the upstream end of the project.
- Apply only herbicides, algaecides and surfactants that are registered for use in channel bottoms, regardless of whether water is present at the time.
- Use only USEPA-approved herbicides in areas where spray could contact aquatic life.
- Do not apply herbicides when rain may cause the herbicide to runoff the target.
- For any new structures or for any repairs to or replacements of existing structures coated with creosote, properly wrap the structure with plastic to prevent leaching. Only factory pressure treatments are acceptable as an alternative to creosote.
Pesticide Application and Landscape Conditions (CU-7). Land application techniques for ensuring safe pesticide dosage for local conditions and for preventing excess runoff.

Applicability

- All sites for which pesticides are applied.

Approach Highlights

- Use integrated pest management practices whenever possible.
- Use new pesticides on small scale test plots first to determine local efficacy and minimum safe dosage needed to control weeds.
- Follow the product label instructions for proper application and disposal.
- Only use pest control equipment that is in good repair, safe to operate, and suitable for the proper application of pesticides.
- Avoid spray drift. Cease spray operations before winds reach 10 mph.
- See also BMPs CU-2 and CU-5 in the BMP Manual for more information on equipment maintenance and wind conditions.
DEBRIS REMOVAL

(SEE ALSO VEGETATION MANAGEMENT (VDM-2, VDM-3), EROSION REPAIR AND PREVENTION (NR-3), AND STRUCTURE REPAIR (CU-8, EV-1, AND EV-2))

Debris Removal (VDM-4). Methods for removing debris from channels to minimize pollution, protect habitat/wildlife, provide for public safety, and minimize erosion.

Applicability

- For activities that generate by-products, residuals, or wastes.

Approach Highlights

- Use equipment and methods that minimize impacts.
- Divert runoff to control measures to remove wastes as necessary.
- Consider leaving stumps in place.
- Salvage and recycle useful debris as practical.
- Perform general housekeeping of site.
EROSION REPAIR/PREVENTION

(SEE ALSO VEGETATION MANAGEMENT (VDM-1, VDM-2); DEBRIS REMOVAL (VDM-4); AND STRUCTURE REPAIR (EV-1, EV-2))

Channel Protection and Restoration (NR-1). Practices to protect or provide habitat for fish and wildlife dependent on the riparian area.

Applicability

☀ Channels and stream work

Approach Highlights

➢ Schedule work to avoid nesting and wildlife breeding seasons.
➢ Regrade channel bottoms at end of work to as close to original conditions as possible.
➢ Release flow after work at a reduced velocity to minimize erosion.
➢ Keep disturbance to the minimum necessary to accomplish repairs.
➢ Natural channels: allow stable undercut banks and leave wood in place for habitat.
**Biotechnical Bank Stabilization (NR-2).** Soft bank repair techniques incorporating biological materials such as seeds, plants, root wads and inert materials such as brush mats, wattles, branch packing or layering. These techniques help protect and provide suitable habitat for fish, amphibians, and wildlife dependent on the riparian area.

**Applicability**

- Channels and streams requiring bank repairs

**Approach Highlights**

- With help of qualified person, create and implement a soft bank repair plan.
- Retain natural banks where feasible.
- Willow cuttings can be used effectively. Do not top live willows.
- Regularly monitor and maintain vegetation until established.
**Scheduling (NR-3).** Plan channel maintenance projects to minimize potential for erosion and to protect special status species.

**Applicability**

 marca • All flood control maintenance activities

**Approach Highlights**

- Avoid disturbance during nesting and breeding seasons. Perform wildlife surveys.
- Avoid soil disturbance from October 15 through April 15.
- Monitor weather forecasts and prepare site with erosion and sediment controls when necessary. Be prepared for rain year-round and keep controls readily available.
- Incorporate staged seeding and revegetation of channel banks as work progresses.
**Brush or Rock Filter (VR-1).** Rock filter berms are created on level contours to cause ponding of sheet flow and to promote sedimentation. A brush barrier is created of brush wrapped in filter cloth and attached to the toe of the slope.

**Applicability**

- As check dams
- Below the toe of slopes
- Along streams/channels
- Below small cleared areas/spoils areas
- At culvert/pipe outlet sediment traps

**Approach Highlights**

- Rock Filters: use rock sized 3/4 to 3 in. in diameter. Use larger rocks in woven wire sheath staked to the ground in areas with greater volume or velocity of water.
- Place filter on level ground, in areas of sheet or rill flow.
- Allow enough area behind berm for runoff to pond, allowing settling of sediment.
- Brush collected during site clearing can be used to create a brush filter.
Check Dams (VR-2). Small dam placed across swales/drainage ditch channels to slow stormwater flows. Check dams can reduce erosion and help sediment settle out.

Applicability

- Across small, steep swales or drainage ditches with velocities >2 fps
- During establishment of grass linings
- When not enough time to establish erosion control linings

Approach Highlights

- Create to allow small pools that reach the toe of the upstream check dam to form between each one. Construct to withstand and allow for safe overflow of storms.
- Use rocks, logs, pea-gravel secured in sandbags, or properly-anchored brush filters. Do not use straw bales or silt fences.
- Use rock sized 8-12 inches or as suitable, and do not dump rock into channel. Use logs 4-6 inches in diameter and embed them at least 18 inches into soil.
- Construct and secure dam completely across channel to prevent washout.
Slope Roughening or Terracing (VR-3). Techniques to create unevenness on bare soil to reduce runoff velocity, trap sediment, or increase water infiltration. Techniques include furrows, stairsteps or terraces, and tracking up and down a slope.

Applicability

- Disturbed slopes where vegetation is planned
- To help seeding, planting, mulching
- Graded areas with smooth or hard surfaces
- Long slopes
- Graded areas with smooth or hard surfaces
- Long slopes

Approach Highlights

- Tracking: Move bulldozer up and down slope (not across) to track horizontal grooves.
- Terracing: Terrace long, smooth slopes to control runoff. Make cuts ≤ 30 feet in height from trough base to top of bench. Any fill to make downslope terraces should be ≤ 25 feet in height. Length from bottom of cut trough to top of fill bench: ≤ 6.5 ft.
- Serrate shorter slopes between 6-15 in. apart and 1-3 in. deep.
- Waddles/Rolls: Install hay waddles/coconut rolls into slopes to reduce flow velocity.
Outlet Protection (VR-4). A device made of rock, grouted riprap, or concrete rubble that is placed at outlets to channels and pipes to reduce water velocity, and to retain the embankment near the pipe inlets and outlets to control erosion and scour.

Applicability

- Outlets of pipes, drains, conduits or channels
- Areas where lined conveyances discharge to unlined conveyances
- Inlets of slope drains and culverts (can use the flared culvert end section)

Approach Highlights

- For rock outlet protection, increase size for high velocity flows; use durable, angular rock. Construct rock apron on zero grade and align straight with receiving stream. Provide cutoff walls. For larger or higher flows, consult a registered civil engineer.
- Construct flared culvert end sections on zero grade; ensure water tight pipe connections.
- For temporary outlets with low flows, plastic or plywood can dissipate energy.
**Storm Drain Inlet Protection (VR-5).** Devices temporarily constructed around storm drains to pond and filter sediment-laden runoff before it enters the storm drain system.

**Applicability**

- When sediments may enter a storm drain inlet

**Approach Highlights**

- Bring disturbed area to grade of drop inlet and smooth and compact it.
- Do not use filter fabric to cover the inlet grate.
- Place several layers of gravel bags, overlapping the bags and packing them tightly.
- Leave a gap of one bag on the top row to act as a spillway. Do not allow flow from a 10-year average sized storm to overflow the curb.
- If the inlet is on a slope, the down-slope side of the inlet does not need to be protected as long as the slope is steep enough that runoff will not enter the drain from that side.
**Erosion Control Blankets/ Mats (SS-1).** Biodegradable or synthetic blankets used to stabilize disturbed soils, especially on slopes.

**Applicability**

- Channels with flows from 2 fps to 4 fps
- Slopes steeper than 1:2
- Channels that will be vegetated and flow velocity is greater than appropriate
- Disturbed areas where mulch needs to be anchored
- Areas with high erosion danger
- Slopes adjacent to sensitive areas
- Disturbed areas where plants are slow to mature

**Approach Highlights**

- Consider cost, effectiveness, acceptability, vegetation enhancement, installation and O&M requirements when choosing materials.
- Prepare sites and place blankets so blankets have complete soil contact.
- Seed the area first. Follow manufacturer’s installation recommendations.
**Dust Control (SS-2).** Measures to minimize the amount of airborne dust particles and to reduce erosion and pollutants between the time of site disturbance and revegetation or paving.

**Applicability**

- Control dust from vehicles at work site
- Windy/wind-prone areas
- Sites with silt and clay soils
- Disturbed areas
- Demolition areas
- Material stockpiles
- Unpaved roads

**Approach Highlights**

- Schedule activities to minimize the amount of time an area is exposed.
- Use vegetation, mulch, spray-on adhesives, chemical measures to stabilize areas.
- Create stabilized site entry and exit points, and unpaved roads and staging areas.
- Use street sweepers on paved roadways. Clean sediments by sweeping, not washing. Cover trucks that haul soils and reduce amount of vehicle trips.
- Application rates for water is generally 0.125 gal/yard² every 20-30 min.
**Temporary Stream Crossing (SS-3).** Stream or drainage crossings that minimize impacts to the stream bottom and reduce erosion. Includes culverts, fords, and bridges.

**Applicability**
- Sites where vehicles will frequently cross a drainage or waterway
- Temporary crossings (< 1 year)
- Sites where alternatives to crossing are infeasible

**Approach Highlights**
- Select a site with minimal erosion probability. Stabilize disturbed areas before and during installation, and after removal of crossing. Install/remove during dry season.
- Have design approved by registered civil or structural engineer. Consider overtopping, flow backups and washout risks. Build near natural elevation of streambed.
- Install sediment traps downstream of crossing during construction. Protect culvert outlet to minimize erosion. Implement erosion and sediment controls.
- Divert road surface flow with a swale/dike. No hazardous material surface treatments.
**Stabilized Unpaved Roads and Entrances (SS-4).** Measures to prevent vehicles from tracking sediments out of a work site onto paved roadways.

**Applicability**

- Entrances or exits from an unpaved area to a paved roadway.

**Approach Highlights**

- Construct site access on level ground, using washed, well-graded gravel or crushed-rock from 1-3 inches in size to prevent tracking of rocks onto the roadway.
- Class II aggregate base (max. 1.5-in rock) can be used if street sweeper is used.
- Properly grade entrance. Place stones 6-in. deep. Track walk aggregate base.
- Minimum length: 50-ft; Minimum width: 30-ft (20-ft for smaller maintenance roads).
- Provide enough turning radii or driveway return at entrance.
- If necessary, adjust gates to allow for increased road height.
**Temporary Drains and Swales (WD-3).** Swales and drains to divert runoff around disturbed areas to prevent erosion or to sediment basins or traps

**Applicability**

- Prevent erosion from disturbed areas
- Divert runoff to sediment basins/traps
- Use with earth dike and slope drain (see BMP Manual (WD-1, WD-2)) to divert water from the top to the bottom of a slope.

**Approach Highlights**

- Install during initial grading, using local drainage design criteria. Conform to drainage patterns and capacities present before development. Grade should be 1-15%.
- Ensure a positive grade throughout, to stabilized outlet. Include outlet protection.
- Design to drain ≤ 5 ac.; Swale bottom width: ≥2 ft.; depth: ≥1.5 ft.; side slopes ≤2:1.
- Construct swale to withstand 10-year, 24-hour storm. Stabilize all swales immediately (grade<5%: seed/mulch; grade>5%: rip-rap or sod). Ensure fill material along path is compacted.
SEDIMENT CONTROL

(SEE ALSO VEGETATION MANAGEMENT (VDM-1, VDM-3), EROSION REPAIR AND PREVENTION (NR-3, VR-1, VR-2, VR-3, VR-5, SS-2, SS-4) AND STRUCTURE REPAIR (EV-1, EV-2))

Dredging (SC-2). Practices to protect water quality from dredging.

Applicability

Channels and streams requiring sediment removal.

Approach Highlights

- Perform wildlife and vegetation surveys prior to dredging. Use a hydraulic/barge-mounted dredge to reduce habitat impacts on channel banks. Dredge small channels with excavator. Desilt: later summer to avoid nesting birds.

- Monitor upstream and downstream water quality for sedimentation. Properly dispose of sediments (see BMP Manual SC-1 for more information on disposal).

- Remove sediment in large channels on one side only in alternate years or in checkerboard pattern to minimize wildlife disturbance.
**Sediment Basins (SC-3).** Structures designed to slow velocity and temporarily retain water to allow settling and prevent sediment-laden runoff from entering channels/drainages.

**Applicability**

- Use with dikes, temporary channels, or pipes
- Use with outlets of disturbed watersheds
- During rainy season maintenance projects
- Where detention basins will be located

**Approach Highlights**

- Locate where low embankment can be built across swale or excavation and allows for safety and easy maintenance.
- Size per Regional Board recommendations; build prior to wet season activities.
- Maximize residence time via length-to-width ratio and baffles.
- Locate outlet structure on firm, smooth foundation, with base secured with concrete. Connect riser pipe with watertight connection to the horizontal pipe that extends
through the embankment to the toe of the fill. Provide anti-seep collars.

- Include an emergency spillway—comprised of an open earthen or vegetated channel on top of undisturbed material (not fill) or constructed of non-erodible riprap—to handle overflows.
- Install a safety fence around the basin to keep children out.
- Per appropriate regulations, properly dispose of any contaminated or hazardous material that is excavated.

**Straw or Sand Bag Barriers (SC-4).** Temporary devices of straw, biodegradable fiber, or sandbags that are placed to direct flow as to intercept sheet flow runoff and settle sediments behind barriers while slowly allowing water through.

**Applicability**

- 🔹 Along site perimeter 🔹 Flood control channels as part of sediment removal work
- 🔹 Straw bales: beneath flat disturbed areas subject to sheet and rill erosion; at grade
breaks and along face of exposed, erodible slopes to shorten slope length; along streambanks for stabilization and revegetation; and in drainage swales to slow flows

🌟 Sand or Gravel Bags: Across channels to protect maintenance trenches or as temporary crossings; parallel to roads, for diverting water to sediment basin, as temporary barriers, upflow of storm drain inlets.

**Approach Highlights**

- **Straw Bales:** Place dikes on ≤2% slopes, preferably; keep upstream drainage to 0.25/ac/100 ft; slope length to ≤100 ft. Allow 6 in.-5 ft of space between hay bale and toe of slope. Properly entrench bales at least 4 in. into the soil. Anchor with stakes.

- **Fiber Rolls:** Fine grade subgrade. Contour a concave key trench 2–4 in. deep. Install rolls per manufacturer’s recommendations in trench and stake both sides every 6 in. Do not overlap rolls.

- **Sand/Gravel Bags:** Use geotextile fabric, not burlap. Fill bags with 3/4 in rock or 1/4 in pea gravel. Place several layers of overlapping, tightly-packed sand bags.
**Sediment Trap (SC-5).** A basin with a controlled release structure to retain large sediment.

**Applicability**

- Wet season projects
- For nuisance groundwater
- Pre-sediment basin
- Areas where sediment-laden runoff may enter watercourse/storm drain system

**Approach Highlights**

- Size traps based on Regional Board recommendations before wet season begins.
- Locate in safe locations where low embankment can be built across a swale/excavation, and that allow for maintenance access and sediment removal.
- Maximize residence time. Design length to width ratio > 3:1 (L:W) or include baffles.
- Protect outlet from erosion by using rocks or vegetation.
- Outlet: Use corrugated metal or reinforced concrete riser pipe with dewatering holes encased in gravel to prevent clogging. Build a crushed stone outlet section of the embankment at the trap’s low point for easier dewatering.
**Silt Fence (SC-6).** Temporary device of permeable fabric placed to intercept sheet flow run-off.

**Applicability**

- Along (not across) streams/channels
- Below toe of exposed/erodible slopes
- Along site perimeter
- Around soil stockpiles

**Approach Highlights**

- Construct fence along level contours, keeping upstream drainage < 0.25 ac./100 ft.
- Keep slope length that drains to fence to ≤ 100 ft; limit single fence length to 500 ft. Overlap by ≥ 12 in. but do not connect fence segments. Turn last 6 ft. of the face upslope in a “J” or “L” shape to allow for ponding.
- Do not locate across areas with concentrated flows (e.g. drainages), or not suitable for temporary ponding/sedimentation.
- To install, bury filter fabric ≥ 6 in. below ground and 6 in. across. Backfill with dirt or gravel. Allow 2-5 ft. at toe of slope for ponding. Add gravel backfill on upslope side to strengthen. Anchor fence with rope attached to stakes and anchored up-slope.
Dewatering (Nuisance Water) (WD-4). Practices to remove water from a work area.

Applicability

- For areas where nuisance water is interfering with work activities in areas isolated from flowing water
- As water quality measure to prevent turbidity downstream

Approach Highlights

- Dewater site before beginning construction or maintenance repair work.
- Use coffer dams, sumps, water dams, or sheet pilings to keep water out of work area.
- Properly use gravity systems or pump/generator sets to regulate flow/prevent damage.
- Discharge nuisance water over an energy dissipater to keep erosion of downstream channel to a minimum.
- Use filtration devices or settling basins to reduce turbidity to natural conditions when discharging water from the disturbed or isolated area.
STRUCTURE REPAIR

(SEE ALSO VEGETATION MANAGEMENT (VDM-1, VDM-2, VDM-3); EROSION REPAIR AND PREVENTION (NR-3, SS-3, SS-4, VR-4); AND SEDIMENT REMOVAL AND CONTROL (SC-2))

Material Handling (CU-3). Methods to ensure chemicals are handled in safe manner.

Applicability

• All sites where chemical handling occurs.

Approach Highlights

➢ Use less toxic products when appropriate.
➢ Mix small batches of chemicals at a time to avoid excess. Follow label for exact rate, mixing and application of herbicides.
➢ Follow manufacturer's instructions.
➢ Do not mix or load chemicals where spill would be likely to enter storm drain inlet or channel.
**Spill Prevention and Control (CU-4).** Practices to prevent or reduce the discharge of chemicals to flood control channels and the storm drain system.

**Applicability**

- All sites where chemicals are stored or used.

**Approach Highlights**

- Place storage area for chemicals away from channel and storm drain system. Use double-walled containment; place items on pallet as possible. Keep well labeled.
- From October 15 to April 15, all chemicals need to have an impermeable cover.
- Be present when pesticides are delivered and store in separate storage unit. Keep on-site storage to a minimum. Have proper storage instructions posted.
- Have spill clean up materials readily available near storage areas, and immediately clean up spills: sweep dry spills, use absorbent material for wet spills on impervious surfaces; dig up wet spills on exposed soil. Properly dispose of materials. Contact regulatory agencies when appropriate.
Concrete Use and Disposal (CU-8). Use, washout, and disposal practices for concrete activities to prevent leaching discharge to channels, waterways, and storm drain systems.

Applicability

任何形式混凝土可能接触水。

Approach Highlights

- Avoid mixing extra concrete on site, to degree possible. Store materials under cover, away from sensitive areas (channel/storm drains).
- Do not wash concrete fines into street or sensitive areas. Return fines to aggregate base stockpile, or dispose of properly. Have positive shutoff on washout hose.
- Designate concrete disposal areas, including for vehicle washout, at least 50 ft. from storm drain inlets, drainage facilities or channels. Construct a pit or berm to contain the washout area. Dispose of hardened concrete regularly.
- Ensure concrete dust from sawcutting or sanding does not enter waterway. Isolate concrete that is used in channels for generally 2.5 weeks to one month for curing.
**Equipment and Vehicle Maintenance (EV-1).** *Methods to reduce pollutant discharge from vehicle and equipment maintenance.*

**Applicability**
- All equipment/vehicle maintenance activities associated with flood control maintenance

**Approach Highlights**
- Keep vehicles/equipment clean. Do not allow excessive grease buildup.
- Maintain and conduct fueling off site, or in designated protected areas. Locate designated areas away from drainage courses. Designate service area with barriers (berms).
- Use 110% secondary containment of equipment fluids > 55 gal. Use secondary containment to catch spills or leaks when changing fluids. Store and dispose of properly.
- Cover maintenance areas from Oct. 15 to April 15. Store materials under cover.
- Have spill cleanup materials readily available. Regularly inspect vehicles/equipment for leaks. Place cracked batteries in secondary container and remove from site.
Equipment and Vehicle Cleaning (EV-2). Practices to reduce pollutant discharge from vehicle and equipment cleaning.

Applicability

- All equipment that is used for flood control facilities and requires cleaning.

Approach Highlights

- Wash vehicles and equipment off-site whenever possible.
- If cleaning must be done on site, drain to sanitary sewer if possible. Otherwise, locate outside cleaning area away from storm drain inlets, drainage facilities, or channels; berm area to contain wash waters; configure wash area with sump to allow collection and disposal of wash water; discharge water as dust control or to pervious surface away from channel, or storm drain.
- Use as little water as possible. Avoid or minimize use of soap; use phosphate-free, biodegradable soap when necessary.
- Do not permit steam cleaning without filtering devices, solvents, or degreasers on-site.
In Channel Flow Diversion Systems (WD-5). Methods to prevent flowing waters in a channel or watercourse from entering the work area.

Applicability

- During dry season when work must be conducted in channel with a residual base flow but little likelihood of storm flow

Approach Highlights

- Put dewatering systems in place before starting in-channel work.
- Design and maintain intakes/outakes so no contaminants are added to stream flow.
- Use filtration devices or settling basins to reduce turbidity to natural conditions when discharging water from the disturbed or isolated area. These could be as simple as filter fabric or hay bale barriers (SC-4, SC-6) or more complex systems (WD-4, SC-3, SC-5).
- Other measures may be needed to prevent and control other pollutants
- Following construction work, removal all system components and restore disturbed areas to pre-construction grades. Reduce water slowly back into work area.
### INDEX BY BMP MEASURE

<table>
<thead>
<tr>
<th>BMP Measure</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotechnical Bank Stabilization (NR-2)</td>
<td>FG-11</td>
</tr>
<tr>
<td>Brush or Rock Filter (VR-1)</td>
<td>FG-13</td>
</tr>
<tr>
<td>Channel Protection and Restoration (NR-1)</td>
<td>FG-10</td>
</tr>
<tr>
<td>Check Dams (VR-2)</td>
<td>FG-14</td>
</tr>
<tr>
<td>Concrete Use and Disposal (CU-8)</td>
<td>FG-32</td>
</tr>
<tr>
<td>Debris Removal (VDM-4)</td>
<td>FG-9</td>
</tr>
<tr>
<td>Dewatering (Nuisance Water) (WD-4)</td>
<td>FG-29</td>
</tr>
<tr>
<td>Dredging (SC-2)</td>
<td>FG-23</td>
</tr>
<tr>
<td>Dust Control (SS-2)</td>
<td>FG-19</td>
</tr>
<tr>
<td>Equipment and Vehicle Maintenance (EV-2)</td>
<td>FG-33</td>
</tr>
<tr>
<td>Equipment and Vehicle Cleaning (EV-2)</td>
<td>FG-34</td>
</tr>
<tr>
<td>Erosion Control Blankets/Mats (SS-1)</td>
<td>FG-18</td>
</tr>
<tr>
<td>In Channel Flow Diversion Systems (WD-5)</td>
<td>FG-35</td>
</tr>
<tr>
<td>Material Handling (CU-3)</td>
<td>FG-30</td>
</tr>
<tr>
<td>Outlet Protection (VR-4)</td>
<td>FG-16</td>
</tr>
<tr>
<td>Pesticide Application and Aquatic Conditions (CU-6)</td>
<td>FG-7</td>
</tr>
<tr>
<td>Pesticide Application and Landscape Conditions (CU-7)</td>
<td>FG-8</td>
</tr>
<tr>
<td>Qualified Pesticide Applicator (CU-1)</td>
<td>FG-6</td>
</tr>
<tr>
<td>Revegetation (VDM-3)</td>
<td>FG-5</td>
</tr>
<tr>
<td>Scheduling (NR-3)</td>
<td>FG-12</td>
</tr>
<tr>
<td>Sediment Basins (SC-3)</td>
<td>FG-24</td>
</tr>
<tr>
<td>Sediment Trap (SC-5)</td>
<td>FG-26</td>
</tr>
<tr>
<td>Silt Fence (SC-6)</td>
<td>FG-28</td>
</tr>
<tr>
<td>Slope Roughening or Terracing (VR-3)</td>
<td>FG-15</td>
</tr>
<tr>
<td>Spill Prevention and Control (CU-4)</td>
<td>FG-31</td>
</tr>
<tr>
<td>Stabilized Unpaved Roads and Entrances (SS-4)</td>
<td>FG-21</td>
</tr>
<tr>
<td>Straw or Sand Bag Barriers (SC-4)</td>
<td>FG-25</td>
</tr>
<tr>
<td>Storm Drain Inlet Protection (VR-5)</td>
<td>FG-17</td>
</tr>
<tr>
<td>Temporary Drains and Swales (WD-3)</td>
<td>FG-22</td>
</tr>
<tr>
<td>Temporary Stream Crossing (SS-3)</td>
<td>FG-20</td>
</tr>
<tr>
<td>Vegetation Preservation (VDM-1)</td>
<td>FG-3</td>
</tr>
<tr>
<td>Vegetation Removal (VDM-2)</td>
<td>FG-4</td>
</tr>
</tbody>
</table>
Appendix B

Conversions: Metric to English Units
Appendix B: Metric to English Conversions

<table>
<thead>
<tr>
<th>Metric Unit</th>
<th>English Unit</th>
<th>Multiply By:</th>
</tr>
</thead>
<tbody>
<tr>
<td>m</td>
<td>feet</td>
<td>3.28</td>
</tr>
<tr>
<td>mm</td>
<td>inches</td>
<td>0.04</td>
</tr>
<tr>
<td>hectare</td>
<td>acre</td>
<td>2.47</td>
</tr>
<tr>
<td>kg</td>
<td>lb</td>
<td>2.20</td>
</tr>
</tbody>
</table>

Conversions

<table>
<thead>
<tr>
<th>Metric Unit</th>
<th>English Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>meters</td>
<td>feet</td>
</tr>
<tr>
<td>1</td>
<td>3.28</td>
</tr>
<tr>
<td>1.2</td>
<td>3.94</td>
</tr>
<tr>
<td>1.5</td>
<td>4.92</td>
</tr>
<tr>
<td>15</td>
<td>49.21</td>
</tr>
<tr>
<td>600</td>
<td>1968.5</td>
</tr>
<tr>
<td>mm</td>
<td>inches</td>
</tr>
<tr>
<td>1</td>
<td>0.04</td>
</tr>
<tr>
<td>12.7</td>
<td>0.5</td>
</tr>
<tr>
<td>19</td>
<td>0.75</td>
</tr>
<tr>
<td>25</td>
<td>0.98</td>
</tr>
<tr>
<td>40</td>
<td>1.57</td>
</tr>
<tr>
<td>50</td>
<td>1.97</td>
</tr>
<tr>
<td>63</td>
<td>2.84</td>
</tr>
<tr>
<td>80</td>
<td>3.15</td>
</tr>
<tr>
<td>100</td>
<td>3.94</td>
</tr>
<tr>
<td>150</td>
<td>5.91</td>
</tr>
<tr>
<td>200</td>
<td>7.87</td>
</tr>
<tr>
<td>230</td>
<td>9.06</td>
</tr>
<tr>
<td>300</td>
<td>11.81</td>
</tr>
<tr>
<td>400</td>
<td>15.75</td>
</tr>
<tr>
<td>450</td>
<td>17.72</td>
</tr>
<tr>
<td>600</td>
<td>23.62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>m³/hectare</th>
<th>ft³/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>1857.8</td>
</tr>
<tr>
<td>65</td>
<td>928.9</td>
</tr>
<tr>
<td>kg</td>
<td>lb</td>
</tr>
<tr>
<td>40</td>
<td>88.2</td>
</tr>
</tbody>
</table>
Appendix C

Photographic Monitoring Techniques