GUIDELINES
for
COUNTY ROAD MAINTENANCE PRACTICES
that
PROTECT AQUATIC HABITAT AND SALMON FISHERIES

NAPA COUNTY CALIFORNIA

A Tradition of Stewardship
A Commitment to Service

DRAFT DATE JUNE 2014

ACKNOWLEDGEMENTS

These guidelines are derived from Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance, published by the FishNet 4C Program in December 2004. Napa County acknowledges use of the guidelines and thanks the FishNet 4C Program and the agencies and individuals that contributed to the original manual for their willingness to share materials.

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CHAPTER 1: INTRODUCTION

The County of Napa developed this manual to minimize impacts to water quality and fish and wildlife habitat, to guide conformance with the Napa River Sediment Total Maximum Daily Load adopted by the San Francisco Bay Regional Water Quality Control Board, and to meet the requirements of the Phase II NPDES Municipal Stormwater General Permit. These guidelines are designed to be implemented when working on County road-related projects. The chapters aim to assist managers and supervisors to develop and implement trainings for field crews and engineers.

The key focus of this manual is best management practices (BMPs) related to protecting water quality, aquatic habitat, and salmonid fisheries. The practices herein pertain to most routine and emergency road-related maintenance activities undertaken by Napa County Department of Public Works. The guidelines apply to County activities related to County facilities, not to private development.

The primary responsibility of Napa County's Road Department and road crews is to keep the roads open and safe for the public. Providing for all the services the public asks for and ensuring public safety requires sound judgment on the part of road engineers, managers, and crews in the field. It is the intention that these guidelines be implemented in a manner that allows for good judgment and discretion on the part of roads superintendents and field crews.

Chapter 2, Regulations and Permits introduces existing laws and regulations that protect our rivers and streams, the agencies responsible for implementing these laws, and permits needed for each type of activity. This manual does not supersede or replace any other agency's regulations or policies.

Chapter 3, Working in the Watershed, lays the groundwork for understanding the basic science of watershed protection and why this is so important to protecting aquatic habitat.

Chapter 4, Stream Habitat and Salmon Fisheries, outlines the salmonid life cycles and their needs in the aquatic environment. This chapter is of particular importance in training staff on why BMPs are needed and how they protect our rivers and aquatic wildlife.

Chapters 5-10 make up the core of the manual, addressing specific activities that the County routinely undertakes. In these chapters, the manual summarizes areas of environmental concern for each activity and provides mitigations and recommended BMPs to address each concern.

The work of the County Roads Department routinely affects the environment, and in particular, can affect waterways that cross or run close to County roads. This manual provides guidelines to maintain and repair roads while also preserving and restoring crucial aquatic habitats. In particular, the practices in this manual will help protect salmon fisheries and water quality and help meet Total Maximum Daily Load (TMDL) goals for rivers and their drainage basins. The manual will also assist County maintenance departments meet requirements to protect salmonid habitat, as outlined in the Federal ESA 4(d) Rule and California State ESA listings to protect Chinook salmon and steelhead trout in the Central California Coast ESU (Evolutionary Significant Unit).

The core principles to remember during road maintenance are:

- Minimize overall impact on the environment.
- Avoid discharging sediment or other pollutants into waterways such as creeks, wetlands and storm drains.
- Maintain natural drainage patterns and provide for fish passage.
- Retain vegetation (or replace invasive plants with native vegetation).

CHAPTER 2: REGULATIONS & PERMITS

Laws and ordinances are acts of legislation passed by legislative branches of government such as the U.S. Congress, the State Legislature, County Boards of Supervisors and City Councils. Regulations are developed by the executive branch's agencies assigned to administering the implementation of the laws. Although distinct, the terms "laws" and "regulations" are often combined to describe the rules that must be followed to avoid breaking the law.

FEDERAL LAWS AND REGULATIONS

FEDERAL ENDANGERED SPECIES ACT (ESA)

The Federal ESA provides a program for the conservation of endangered and threatened species and designated critical habitat of listed species. Federal agencies are required to ensure that actions or projects are not likely to "jeopardize" the continued existence of listed species and also to ensure that no destruction or adverse modification of critical habitat for the listed species occurs.

- **ESA Section 4 – Determination of Endangered, Threatened, and Species of Concern status and designation of critical habitat.** Section 4 requires development of a recovery plan for declining populations. A species is considered ***endangered*** when it is in danger of extinction throughout all or a significant portion of its range and ***threatened*** when it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. In the Napa River and Suisun Creek watersheds, Steelhead trout are listed under the Federal ESA as *threatened.* Steelhead are not listed under the Federal ESA in the Putah Creek Watershed.[1]

- **ESA Section 4(d)** - Requires NOAA Fisheries (sometimes referred to as National Marine Fisheries Service (NMFS)) to issue regulations deemed "necessary and advisable to provide for the conservation of the species". A 4(d) Rule applies to species listed as *threatened*, and outlines what actions are likely to take a specific listed species. Section 4(d) also allows for fines upon violation and third party lawsuits. On the Central California Coast, which includes the Napa River watershed, steelhead trout have 4(d) Rule regulations. The activities listed in Table 2.1 are enumerated in the 4(d) Rule for Central California Coast steelhead (May 18 2000) as those "most likely to cause harm and thereby violate the 4(d) Rule." NOAA Fisheries ESA enforcement generally focuses on these activities.

[1] Beyond Steelhead and Chinook, which are the focus species of this manual, threatened and endangered species lists can be found on several websites including those of the U.S. Fish and Wildlife Service and the California Department of Fish and Wildlife. Several County Departments also have access to the California Natural Diversity Database (CNDDB) which is a program within the California Department of Fish and Wildlife that maintains a computerized inventory of information on the location and condition of California's rare, threatened, endangered, and sensitive plants, animals, and natural communities.

- **ESA Section 7 – Interagency Cooperation Agreements.** Section 7 requires all federal agencies, in consultation with NOAA Fisheries and U.S. Fish and Wildlife Service, to ensure that protections for the species are built into projects and it requires that a Biological Assessment (BA) be prepared if one or more listed species may be present in the project action area. This section applies to federally-funded and federally-permitted projects including Army Corps of Engineers' projects such as flood control or water supply structures. These types of projects have a "federal nexus," and thus warrant a Section 7 Consultation and Agreement.

- **ESA Section 9 –** Section 9 provides guidance regarding activities determined to result in "take" of a species and applies uniform regulations when a species is listed as endangered. Section 9 defines "**take**" of a species as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" with respect to federally listed species under ESA. "**Harass**" includes annoying a protected species to such an extent as to significantly disrupt behavior patterns such as breeding, feeding, or sheltering. "**Harm**" is defined as an act that kills or injures a protected species and can arise from significant modification or degradation of habitat, which impairs essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering.

- **ESA Section 10 – Exceptions –** Exceptions apply to those projects with no federal involvement. Section 10 also provides guidance on the issuance of "incidental take" permits, which requires development of a satisfactory Habitat Conservation Plan (HCP) for the species and it also covers "direct take" associated with authorized monitoring and research activities.

Table 2-1. Activities Determined to Cause Take or Harm to Listed Species under Section 4(d) of the Federal Endangered Species Act

A	Constructing or maintaining structures like culverts, berms, or dams that eliminate or impede a species' ability to migrate or gain access to habitat
B	Discharging pollutants such as oil, toxic chemicals, radioactivity, carcinogens, mutagens, teratogens, or organic nutrient-laden water (including sewage) into a listed species' habitat
C	Removing, poisoning or contaminating plants, fish, wildlife, or other biota that the listed species requires for feeding, sheltering or other essential behavioral patterns
D	Removing or altering rocks, soil, gravel, vegetation or other physical structures that are essential to the integrity and function of a listed species' habitat
E	Removing water or otherwise altering streamflow in a manner that significantly impairs spawning, migration, feeding or other essential behavioral patterns
F	Releasing non-indigenous or artificially propagated species into a listed species' habitat or into areas where they might gain access to that habitat
G	Constructing or operating dams or water diversion structures with inadequate fish screens or passage facilities
H	Constructing, maintaining or using inadequate bridges, roads or trails on stream banks or unstable hill slopes adjacent to or above a species' habitat
I	Conducting timber harvest, grazing, mining, earth-moving, or other operations that substantially increase the amount of sediment going into stream
J	Conducting land-use activities that may disturb soil and increase sediment delivery to streams, such as logging, grazing, farming, and road construction- in riparian areas and areas susceptible to mass wasting and surface erosion
K	Illegal fishing. Harvest that violates fishing regulations is a top enforcement concern.
L	Various streambed disturbances may trample eggs or trap adult fish preparing to spawn. The disturbance could be mechanical disruption caused by construction push-up dams. Removing gravel, mining or other work in a stream channel. It may also take the form of egg trampling or smothering by livestock in the streambed or by vehicles or equipment being driven across or down the streambed, or any similar disruption.
M	Illegal interstate and foreign commerce dealing in imports or exports of listed or steelhead. Altering lands or waters in a manner that promotes unusual concentrations of predators.
N	Shoreline and riparian disturbances (whether in river, estuary, marine or floodplain environment) may retard or prevent the development of certain habitat characteristics upon which the fish depend (e.g. removing riparian reduces vital shade and cover)
O	Filling or isolating side channels, ponds, and intermittent waters (e.g. installing tidal gates and impassable culverts) can destroy habitats that fish depend upon for refuge during high flows

Source: NMFS. (June 2000). <u>A Citizen's Guide to the 4(d) Rule for Salmon and Steelhead on the West Coast.</u>

CLEAN WATER ACT (CWA)

The Clean Water Act is the nation's primary water quality protection law authorizing the Environmental Protection Agency (EPA) to restrict pollution discharges. Certain sections require permits, based on regulations promulgated by the EPA in conjunction with the State Water Resources Control Board (SWRCB). In many instances, regulatory authority over clean water has been given to the states and is implemented by the State Water Resources Control Board (SWRCB) and the nine California Regional Water Quality Control Boards (RWQCB). In Napa County, the Napa River and Suisun Creek watersheds are in the jurisdiction of the San Francisco Bay RWQCB and the Putah Creek watershed is under jurisdiction of the Central Valley RWQCB.

- **Section 401 –** Requires that anyone discharging dredge or fill material into a surface water of the U.S. must not violate the State's water quality standards. The State's authority or duty to issue 401 Water Quality Certifications, is dependent on a valid Section 404 application with the Army Corps of Engineers. The State may only enforce 401 for a valid Section 404 project. "Water Quality Certification" is carried out and enforced by the RWQCB.
- **Section 402 and NPDES Phase-II -** Prohibits the discharge of all pollution unless permitted. Permits generally require a Notice of Intent (NOI) to be filed with the SWRCB and permit conditions are issued by the RWQCB. The permit program entitled National Pollution Discharge Elimination System Phase II (NPDES Phase II) for small municipalities, including all municipalities in Napa County, provides conditions for discharges of storm water from: (a) construction activity >1 acre of soil disturbance; (b) certain industrial activities including mining and vehicle maintenance (such as County Road Maintenance Yards); and c) municipal facilities, including roads. The Phase II Stormwater permit requirements address water quality issues in areas of the watershed that are served by a municipal storm sewer system. Phase II compliance includes implementation of BMPs such as published in these guidelines. Each municipality in Napa County participates in the Napa County-wide Stormwater Pollution Prevention Program (NCSPPP) for activities that are most cost-effectively achieved as a group and each municipality also implements several stormwater management practices individually.
- **Section 404** - Regulates the discharge of dredged or fill material into "waters of the United States", including tidal and non-tidal wetlands (tied to Sect. 401 State process above). Permitting under Section 404 is carried out by US Army Corps of Engineers (COE).
  - **"Waters of the U.S."** - In nontidal waters, jurisdiction extends:
    - a) to the ordinary high water mark in the absence of adjacent wetlands.
    - b) beyond the ordinary high water mark to the limit of the adjacent wetlands, when present.
    - c) to the limit of the wetland when only wetlands exist.
  - **"Ordinary High Water Mark"** is defined as "That line on the shore established by the fluctuations of water and indicated by physical characteristics such as [a] clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area." [33 CFR 328.3(e)]

FISH AND WILDLIFE COORDINATION ACT
The Fish and Wildlife Coordination Act requires all federal agencies to consult with USFWS, NOAA Fisheries and California Department of Fish and Wildlife (CDFW) for activities that "affect, control, or modify waters of any stream or other bodies of water." These agencies review applications for Clean Water Act Section 404 permits and provide comments to the COE about the environmental impacts of the proposed project.

The Act also gives USFWS & NOAA Fisheries an expanded responsibility for review of federal projects (including those with federal permits or funding) that includes concerns about general plant and wildlife species that may not be addressed by the Endangered Species Act, particularly including a project's secondary effects.

COASTAL ZONE MANAGEMENT ACT (CZMA)
The CZMA is implemented through the State by the Coastal Commission. It requires that Clean Water Act Section 404 general permits comply with CZMA. Only a small portion of southern Napa County may be in the Coastal Zone.

NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)
NEPA requires federal agency decision-makers to document and consider the environmental implications of their actions, including the issuance of permits, funding, and rights-of-entry.

RIVERS AND HARBORS ACT OF 1899 - Section 10
- Prohibits the unauthorized obstruction or alteration of any navigable waters of the U.S. without a permit from the Corps of Engineers (COE).
- Jurisdiction is limited to those activities affecting the "navigable waters of the U.S." See Figures 2-1 and 2-2.
- Original regulatory authority has been superseded by Section 404 of the Clean Water Act to a great extent.

NATIONAL HISTORIC PRESERVATION ACT OF 1966 – Section 106
- Requires federal agencies to review projects for impacts to historic and archeological resources. Such resources may include bridges.
- Requires projects with federal involvement to determine the significance of cultural resources with the Area of Potential Effect.
- Requires consultation and concurrence with the State Office of Historic Preservation (SHPO).

STATE LAWS & REGULATIONS

CALIFORNIA FISH AND WILDLIFE CODE
Sections 1600-1607 - "Lake and Streambed Alteration Agreement Process"
- Public agencies must comply under Section 1602 of DFW code.

- Requires notification to CDFW for any project that will impact a river, stream or lake. Measures to prevent substantial adverse effects on fish or wildlife are developed with applicant in an Agreement.
- Agreement is technically not a "permit" but a "mutual agreement" between CDFW and project proponent.
- Projects must also (since 5/1/99) be reviewed under the California Environmental Quality Act (CEQA).
- No pre-notification is required for emergency projects carried out by a public agency to maintain, repair or restore an existing highway, within the existing right-of-way, within one year of damage. Notification is required within 14 days of beginning work.
- Jurisdictional limit is usually marked by CDFW – in practice - to be at the top of the stream or lake bank or at the outer edge of the riparian vegetation, whichever is wider. However, the broad definition in CDFW Code Section 1602 gives CDFW great flexibility in deciding what constitutes a stream – sometimes to the 100-year flood plain.

Section 5650 – Water Pollution

- Prohibits anyone from depositing, permitting to pass into, or place where it can pass into the waters of this state, most pollutants, including any petroleum, acid, asphalt, bitumen, or residuary product of petroleum; …or any substance or material "deleterious to fish, plant life, or bird life."
- Does not apply to pollution discharged under a permit from RWQCB or SWRCB

PORTER-COLOGNE WATER QUALITY CONTROL ACT

- Regulates any discharge that may affect waters of the state (which include all surface and ground waters).
- Provides the State with authority to regulate consistent with, and in excess of), Federal Clean Water Act (CWA) requirements.
- The CWA distinguishes between point (pipe) and nonpoint (runoff) sources of water pollution in California.
- Administered by the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCB)

CALIFORNIA ENDANGERED SPECIES ACT (CESA)

A comprehensive Recovery Plan for listed fish was completed in 2004 by the California Department of Fish and Wildlife as part of the State Fish and Wildlife Commission's agreement to implement the listing.

- Regulations under CESA prohibit the "take" of plant and animal species designated by the California Fish and Wildlife Commission as either endangered or threatened. CESA seeks to ensure that actions are not likely to destroy or adversely modify "essential habitat" necessary to the continued existence of the species. [Fish & Wildlife Code Sections 2080-2081]
- "Take" includes hunting, pursuing, catching, capturing, killing, or attempting such activity, but does not now include indirect mortality resulting from habitat modification

(due to change by recent legislation).

- Section 2080 states that no further State authorization needed if a Federal ESAs Section 10 Incidental Take Permit has been obtained.
- Section 2081 authorizes incidental take permits by CDFW, under certain conditions. Projects with potential impacts to California Freshwater Shrimp in the Napa River watershed, (*endangered),* require an incidental take permit, 2081. (Sect. 2090, state agency consultation requirement, was repealed effective 1/1/99.)
- When a species is listed in California and also listed under the Federal Endanged Species Act, CDFW must participate in the federal consultation to the greatest extent practicable and adopt the federal Biological Opinion as its Biological Opinion, wherever possible.
- Website: www.DFW.ca.gov/hcpb/ceqacesa/cesa/cesa.html

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

- CEQA requires state, regional, and local public agencies to assess the significant environmental effects of proposed projects and to circulate these assessments to other agencies and the public for comment before making decisions on the proposed projects.
- CEQA exempts most road maintenance actions through the use of a Categorical Exemption (CE or Cat Ex), when no potential for significant environmental impact exists. However, there is often potential for impact – e.g. there is a presumption that ESA species are present and may be affected (in this chapter, see ***Federal Laws and Regulations: ESA***) – and CE's are limited by the following (CEQA Title 14, Categorical Exemptions, 15300.2 – Exceptions):
    - Location (e.g. a particularly sensitive environment)
    - Cumulative Impact (of successive projects in same place)
    - Scenic Highways (damage to scenic resources such as trees and rock outcroppings within officially designated state scenic highway)
    - Hazardous Waste Sites
    - Historical Resources
- Given that such exceptions can be and are broadly interpreted, it is often more efficient to implement appropriate BMPs to ensure that activities result in less than significant impacts.

  Cat Ex examples include:
    - Class 1 (Existing Facilities): Includes maintenance of existing public facilities, such as road grading for purpose of public safety; rehabilitation of damaged facilities to meet current standards of public health and safety; maintenance of stream channels (clearing of debris) to protect fish and wildlife resources;
    - Class 2 : Replacement or Reconstruction of existing facilities involving negligible or no expansion of capacity
    - Class 4 (Minor Alterations to Land): Minor alterations (excluding removal of healthy, mature scenic trees), such as grading on slope <10% not in waterway, wetland, or geologic hazard area; filling of earth into previously excavated land.
    - Other actions (or group of actions) should achieve CEQA compliance through completion of an Initial Study supporting a Negative Declaration ("Neg Dec"), a Mitigated Negative Declaration ("Mit Neg Dec"), or an Environmental Impact Report (EIR).

- Issuance of Local and State permits, such as DFW's 1602 agreement or a County Use Permit, also must comply with CEQA procedural requirements.

CALIFORNIA COASTAL ACT

The California Coastal Act may only be applicable to small portions of southern Napa County around the bay. The California Coast Act sets policy for land use within the coastal zone and assigns decision-making and administration to the Coastal Commission. It is implemented at the local level primarily through County or City Local Coastal Plans (LCP), once LCPs are approved by the Coastal Commission. No coastal development permit is required for repair and maintenance of existing public roads, including resurfacing, ditch cleaning, and slide removal. A permit is required for excavation or disposal of fill outside of the roadway prism. (Section 30610).

SURFACE MINING AND RECLAMATION ACT (SMARA)

- Requires local government to adopt and implement ordinances regulating upland surface mines and instream gravel mining and requires Reclamation Plans for mining sites obtaining a local use permit.
- Reclamation plans are overseen in an advisory capacity by the California Deptartment of Conservation, Office of Mine Reclamation.
- Caltrans reviews reclamation plans for mines in the 100-year floodplain, or within 1 mile upstream or downstream of a Caltrans bridge.

PERMITS

Permits are needed from different agencies for many types of project and purposes. To help you find out what permit is required, from which agency, and for what type of projects, three tables are provided below. You can look up the permit by agency name, by permit name, or by project type. Once you have a permit, you need to know what is important about its contents. A checklist of important categories to look for in each permit is provided. Compliance with the rules is essential – penalties and fines for the County and individuals can be stiff. A significant change in the project must be run by all permitting agencies.

Table 2-3. Types of Permits - By Agency

FEDERAL AGENCY	PERMIT	WHAT TYPES OF PROJECTS
U.S. Army Corps of Engineers (COE)	CWA Section 404 Permit	Projects that will deposit dredged or fill material into "waters of the U.S.," including wetlands
	Individual Permit	All activities not covered by a General Permit (see below)
	General –Nationwide Permit (NWP) NWPs related to road maintenance	Categories of activities with minimal impacts on aquatic resources: #3 – Maintenance #7 – Outfall Structures and Maintenance #12 – Utility Line Activities #13 – Bank Stabilization #14 – Linear Transportation Crossings #23 – Approved Categorical Exclusions #27 – Stream & wetland restoration #33 – Temporary Construction, Access, and Dewatering #41 – Reshaping existing drainage ditches #43 - Storm Water Management Facilities
	Regional General Permit (RGP) 1 – San Francisco District	Only for fish passage/ sediment reduction projects at water crossings in the San Francisco District of COE.
NOAA Fisheries	ESA Section 4(d) rules ESA Sect. 7 Consultation to COE 404 permit, or other federal agency ESA Section 10	When project involves work in a stream with listed salmon or steelhead species. This must be considered when working in the Napa River watershed because of the presence of threatened Steelhead.
Fish and Wildlife Service (USFWS)	ESA Sect. 7 Consultation to COE 404 permit or other federal agency ESA Section 10	When project could jeopardize an endangered or threatened species (non-anadromous) or result in adverse impact to its critical habitat (e.g., California Freshwater Shrimp in the Napa River watershed)

STATE AGENCY	PERMIT	WHAT TYPES OF PROJECTS
CA Dept. of Fish & Wildlife (CDFW)	Fish & Wildlife Code Sect. 1602 Streambed Alteration Agreement	Instream projects/culverts/stream crossings /fish screens/water & stream diversions/bank stabilization/bridges/riparian plant removal
	CESA Section 2081 Incidental Take Permit	For projects likely to cause the death of a species listed as threatened or endangered under CESA (e.g., California Freshwater Shrimp in the Napa River watershed)
State Water Resources Control Board (SWRCB)/ Regional Water Quality Control Board (RWQCB) – San Francisco Bay Region (Region II) or Central Valley Region (Region V)	CWA Section 401 – Water Quality Certification	Same as 404 (Corps) – 401 needed whenever 404 required. If no 404 required (isolated wetlands), may need waste discharge requirements (WDR) or waiver under Porter- Cologne Act. File Notice of Intent (NOI) with RWQCB.
	CWA Section 402 – NPDES Storm Water Permit	Construction projects that cover > 1 acre of soil disturbance including but not limited to actvivities in areas of industrial and municipal operations and maintenance programs. NPDES storm water permits (industrial, construction and municipal) require consideration of runoff treatment systems to minimize impacts of runoff discharges.
	Waste Discharge Requirements (WDRs or WDR waivers)	Any project involving activity within waters of the state (including wetlands). ***Note:*** The definition of "waters of the state" is broader than "waters of the U.S." Therefore, projects not subject to a CWA Section 404 permit (headwaters, isolated water bodies, etc.) may still require permits from this agency.
State Lands Commission (SLC)	Land use lease	Installation of structures or disposal of dredged material on beds of navigable streams, bays and estuaries.
Lead Agency	CEQA compliance (not a permit)	State permit-issuing agencies must comply with CEQA process during permit process

LOCAL AGENCY	PERMIT	WHAT TYPES OF PROJECTS
Planning, Building and Environmental Services Dept.	Use Permit Exception to the Conservation Regulations; Grading and/or Building	Rock quarries / gravel extraction Stream bank projects Vegetation management
Public Works Dept.	Encroachment permit	Soil disturbance > X cu. yds. (depending on county grading ordinance)
Lead Agency	CEQA compliance (not a permit)	Permit-issuing agency must comply with CEQA process during permit process

Table 2-4. Types of Permits – By Permit Name

PERMIT – INFORMAL NAME	PERMIT – FORMAL NAME	AGENCY	PURPOSE
401	CWA Section 401 - Water Quality Certification or Waiver	SWRCB	Same as 404 but for up to 5 years and multiple projects.
402	SWP/CWA Section 402 – Storm Water Permit	Regional Water Quality Control Bd. (RWQCB) – San Francisco Bay Region II / Cental Valley (Region V)	Storm water runoff – minimize impacts
404	CWA Section 404	US Army Corps of Engineers (COE)	Protection of wetlands and waters of the U.S. from discharge of dredged or fill material
Individual permit			Regulate specific activities on an individual basis
NWP	General Nationwide Permit		Regulate specific categories of activities, usually with minimal impacts on aquatic resources, on a national basis
RGP	Regional General Permit		Regulate specific categories of activities, usually with minimal impacts on aquatic resources, on a regional basis
Section 4(d) ESA Rule		NOAA Fisheries	Protect federally-listed anadromous fish species (salmon & steelhead & habitat)
Section 7 Consultation			
Take for monitoring & research	Section 10 HCP	US Fish and Wildlife Service (USFS)	Protect other federally- listed species & their habitat
1602	Fish & Game Code Sect.	Calif. Dept. of Fish & Wildlife	Ensure no net loss of stream habitat values or acreage

	1602 Streambed Alteration Agreement	(DFW)	
2081	Fish & Game Code Sect. CESA Incidental Take Permit		Protect State-listed animal and plant species & habitat
CEQA Compliance (not a permit)		Lead agency	Assess the significant environmental effects of proposed projects.
Use permit, Conditional Use permit; Building permit; Grading permit		County or City Planning Dept.	Ensure compliance with General Plan & ordinances
Grading permit		County Planning or City Public Works Dept.	Minimize or avoid erosion and sedimentation

Table 2-5. Permits by General Permit Type for Routine Road Maintenance

General Road Maintenance Project Category	General Environmental Concerns about Activity	Permits or Approval that <u>may</u> be required
Streambank erosion control	• Sediment discharge to stream • Riparian plant impact	• 404 CWA permit – NWP • #13 or RGP #1 • 401 CWA permit • NOAA Fisheries consultation • 1602 CDFG agreement
Ditch maintenance	• Sediment discharge to stream from ditches • Aquatic habitat removal	• 404 CWA permit <u>if</u> "water of the US" • NWP #41 for reshaping • 401 CWA if 404 needed • 1602 CDFW agreement • ESA consultation
Culvert maintenance & replacement	• Sediment or debris discharge into stream • Fish stranding or blockage to migration	• 1602 CDFW agreement • 404 CWA – NWP #14 or RGP #1 • 401 CWA permit • ESA consultation with NOAA Fisheries.
Vegetation management	• Loss of riparian plants • Create erosion risk	• County Tree Policies • 1602 CDFW if working within riparian zone • County Pesticide Rules • Special use permit if located on Federal land • May require a Habitat Conservation Plan

Spoil disposal	• Sediment and debris discharge to stream • Harms slope stability of site • Filling wetlands	• County conditional use permit/coastal permit • County grading permit • Special use permit if on federal land • 404 CWA if wetlands or floodplain involved • 401 CWA if 404 needed • Possible ESA Consultation
Maintenance yard management	• Stormwater runoff of stored materials to streams • Spills of hazardous materials • Contamination of groundwater & soils	• 402 CWA Stormwater Municipal General Permit & General Industrial Permit • County Pesticide Rules • Compliance with County Spill Plan • CWA Waste Discharge Permit for petroleum discharge to septic system or for oil/water separators
Bridge maintenance	• Discharge of bridge materials into stream • Damage to riparian area • Harm to bats & swallows	• CWA Waste discharge permit for lead-based paint discharge • CDFW & USFWS notification • 404 CWA permit for instream work • 401 CWA permit for instream work • 1602 CDFW agreement for instream work
Emergency maintenance (Includes: storm damage patrol; debris removal; emergency road opening or closing; repairs to roads, slopes, and drainage facilities.)	• Discharge of sediment and debris into stream system • Stream habitat damage due to heavy equipment instream or in riparian zone	• 1602 CDFW post-project notification • 404 CWA pre-project notification • 401 CWA post-project notification • Hazardous spill notification process to checklist agencies

CATEGORIES OF PERMIT CONDITIONS

The following checklist includes most of the categories of requirements, conditions, mitigations, and limits often placed on a permit. Permit conditions and project mitigations protect against both direct impacts and potential impacts to the species or habitat.

- **Project Description and Purpose** – Scope of proposed action
- **Timing of Project Actions** – Limits to season, month, time of day,
- **Limited Operating Periods** (LOPs) which can restrict action during special periods for

sensitive animals (e.g., spawning, nesting)

- ➢ **Project Location –** Map or description of project site
- ➢ **Mitigations** included in the original Project Description – These are the practices proposed by the applicant (County) to minimize or avoid environmental impacts
- ➢ **Revised or Additional Mitigations –** Other practices required by the permitting agency to minimize or avoid environmental impacts
- ➢ **Monitoring Requirements –** Records that must be kept and data that must be collected during and after the project
- ➢ **Endangered or Threatened Species –** List of those known or possible at the site
- ➢ **Site Inspections –** Who and when an agency representative may need to be on-site during the project and his/her right to be there
- ➢ **Emergency Actions –** Clarifies which emergency actions can begin without prior notification or permit; agency must still be notified after action has begun.
- ➢ **Duration of Permit –** Beginning and Ending Date of permit's active status
- ➢ **Penalties for Violation** of Permit Conditions – Potential fines and jail sentence
- ➢ **Biological Assessment (BA) –** As required by Federal Endangered Species Act
- ➢ **Alternatives Analysis** - Alternative actions to the original proposal

ARE THESE PERMITS ALWAYS REQUIRED?
The need for permits and CEQA compliance can depend on the size and location of a project and the methods being used for the project. Site-specific conditions are important to consider. See *"Permits"* at the end of each maintenance activity in Chapters 5-9 for more information.

***BEFORE* performing a Routine Maintenance Project, be sure of the following:**

- ✓ All necessary permits/agreements/consultations are completed and are on site at the project.
- ✓ The final permit paperwork is available in the Project file.
- ✓ Review with all road crew involved, the specific conditions listed on the permits (see Permit
  Conditions above) *and make sure they understand the requirements.*
- ✓ Post Final permits on site, if required. DFW 1602 Agreements must be available on site.
- ✓ Notify permit-issuing agencies prior to beginning the project.

CONSEQUENCES OF NOT COMPLYING WITH PERMIT REQUIREMENTS
If work is not in compliance with permits or necessary permits are not obtained, the penalties to the County (with liability including the responsible individual) can be quite strong. Penalties are subject to change over time.

1. **Regional Water Quality Control Board (RWQCB)** enforcement of violations to the Clean Water Act, the Porter-Cologne Act, and the Basin Plan can involve the following actions:
   a) Administrative Civil Liabilities, with fines at $10 per gallon of spill ($2,000 /cu. yd., or $20,000 per 10 yd. dump truck) of liquid or sediment. (One cubic yard of soil is equivalent to 202 gallons.) *Penalties subject to change.*
   b) Cleanup and Abatement Order – with fines for non-compliance

c) Time Schedule Order – with fines for non-compliance with deadlines
d) Cease and Desist Order – subject to fines
e) Fines < $50,000 can be issued by the Executive Officer or Board; larger fines can be decided by the Board. *(Subject to change)*

2. **California Dept. of Fish and Wildlife (CDFW)** can issue fines and penalties for violations of the **Fish & Wildlife Code** (see Section 12000-):
   a) Most violations are misdemeanors.
   b) Punishment is a fine <$1,000, imprisonment in the County jail for not more than six months, or both fine and imprisonment.
   c) Violation of pollution prohibitions under F& W Code Section 5650 punishable by civil penalty of not more than $25,000 for each violation; imprisonment in the County jail for not more than one year, or both fine and imprisonment. Person is also liable for all actual damages and for reasonable costs incurred in cleaning up the deleterious material.
   d) Punishment for a second or subsequent violation of Section 1602 on the same project or streambed alteration agreement, or any violation of the State Endangered Species Act (CESA), is a fine of <$5,000 or imprisonment in the County jail for a period not to exceed one year, or both.

3. **Federal Endangered Species Act (ESA)** violations are assessed by the NOAA Fisheries Director (SW Region) or the USFWS Director (Western Region) and may involve the following penalties:
   a) Civil penalty of up to $25,000 per violation against any person who knowingly violates any provision of the ESA or any regulation issued to implement the taking and no damage/destruction provisions of Section 9.
   b) Criminal penalties of up to $50,000 (total) and/or one year's imprisonment for knowing violations of the act or regulations.
   c) Penalties are most often assessed against private individuals and entities for section 9 violations.
   d) Citizens may bring suit to enforce the act when compliance is not followed.

4. **Clean Water Act Section 404 (EPA and COE)** violations are similar to the RWQCB actions above. Both the Corps (COE) and EPA have independent enforcement authority.
   a) Administrative penalties for EPA involve:
      i. Class I violations – for less serious unpermitted activities, carry a maximum of $10,000 per violation, with a total maximum of $25,000;
      ii. Class II violations – for more serious unpermitted activities, carry a maximum of $10,000 per day for each day during which the violation continues, with a total maximum of $125,000.
   b) COE enforcement has a maximum of $25,000 per day for both classes.
   c) Negligent violations carry misdemeanor sanctions, including penalties of $2,500 to $25,000 per day and imprisonment of up to one year.
   d) Known violations carry felony sanctions, including penalties of $5,000 to $50,000 per day and imprisonment of up to three years.

TIME REQUIED TO OBTAIN A PERMIT

Since the time for obtaining necessary permits can be lengthy, it is very important to begin the permit process as soon as possible. Pre-consultation prior to permit application is highly encouraged. Table 2-6 lists the estimated time required for most permits. Some permit time schedules are established by statute (*), while other time periods are set at the discretion of the agency. Timing can be delayed by complex projects, incomplete applications, insufficient staffing for permit reviews, and “surprise” issues during inspection of the proposed project site. Note that the clock begins when the agency formally deems the application to be “complete.”

Table 2-6. Estimated Time Required for Permits by Permit Name

PERMIT / Other Requirement	AGENCY	TIME REQUIRED Minimum / Maximum
401 CWA – Water Quality Certification or Waiver (from discharge requirements)	RWQCB	30 days to determine if application is “complete”; 60 days from complete application
402 CWA – General Storm Water Permit	RWQCB/SWRCB	Valid on receipt of complete Notice of Intent (NOI) (30 days)
404 CWA – Individual	COE – US Army Corps of Engineers	60-90 days / 2 years +
404 CWA – Federal/ Nationwide		30 days to determine application complete; 45 days from complete application
404 CWA–General/Reg.(RGP)		Same as Nationwide
Section 4(d) rule take limitation	NOAA Fisheries or US Fish & Wildlife Service (USFWS)	No time limit
Section 7 ESA Informal Consultation		30 days to get species list + 180 days max. for Biological Assessment (BA) + 30 days to accept BA*
Section 7 ESA Formal Consultation		135 days max. for Biological Opinion, after complete BA received.*
Section 10 ESA Habitat Cons. Plan Incidental Take Permit		No time limit
1602 – DFW Streambed Alteration Agreement 2081 – CESA- Incidental Take Permit	CDFW	45 days* / 65 days* 120 days *
Use Permit	County / City	45-90 days
Grading Permit	County / City	varies

** Time limit set by statute*

MOST COMMON PLAYERS IN THE PERMIT PROCESS

The following County, State and Federal agencies are the most common players setting the conditions for projects that could potentially affect water quality, stream habitat, or salmon and steelhead fisheries. Getting to know the abbreviations or acronyms for the agencies and types of permits is helpful in permit discussions (See *Appendix B - Glossary*).

County / City Planning, Public Works, and Environmental Health Departments

- Responsible for permits to be issued under ordinances, such as Grading and Riparian Protection Ordinances, Tree Protection, Surface Mining and Reclamation, and encroachment.

California Dept. of Fish and Wildlife (CDFW) www.wildlife.ca.gov/Home.aspx

- Responsible State agency for the public trust resources of fish and wildlife in California
- Regulates activities potentially resulting in alteration of streambeds and banks or diversion of a stream's natural flow, as per the Fish and Wildlife Code Section 1600
- Protects species listed under the California Endangered Species Act (CESA).
- Commenting agency (not permit-issuing) for Federal and State permits under the Clean Water Act, Coastal Act and for other regulations or ordinances that trigger CEQA

Regional Water Quality Control Board (San Francisco Bay and Central Valley Regions)

- Responsible agency for implementation of the State Porter-Cologne Water Quality Control Act and the Federal Clean Water Act.
- Regulates activities that may potentially discharge pollutants into waterways or storm water drainage systems.
- Administers permit program entitled National Pollution Discharge Elimination System (Phase I & II) for discharges of storm water from: (a) construction activity >1 acre of soil disturbance; (b) certain industrial activities including mining and vehicle maintenance (such as County Road Maintenance Yards); and c) municipal facilities, including roads.
- Issues certifications under the Clean Water Act, such as the Sect. 401 certification required for a U.S. Army Corps of Engineers permit under Sect. 404
- Issues Waste Discharge Requirements (WDRs) under the State Porter-Cologne Act; (WDRs are the main state permitting tool as authorized by the California Water Code). Such permits may be issued for any discharge of waste that could affect waters of the state, including wetlands.
- Regulates potential discharge of pollutants into all surface and ground waters, including "creeks," a term that includes drainage ditches and similar waterways with beneficial uses

California Coastal Commission (coastal counties only) **www.coastal.ca.gov**

- Responsible for administering the California Coastal Act and the federally approved California Coastal Management Program of the Coastal Zone Management Act (CZMA)
- Regulatory jurisdiction within the coastal zone varies in dimensions along the coast, with a maximum extension of up to five miles inland from the mean high tide line. Permit jurisdiction for proposed projects within the immediate ocean or bay shoreline (tidelands, submerged lands, and public trust lands)

- Counties and cities implement Coastal Act policies through their adopted Local Coastal Plans (LCPs) certified by the Coastal Commission. Coastal Zone permits are usually issued by local planning agency, such as a County or City.
- Coordinates with local and state commenting agencies

U.S. Army Corps of Engineers (US COE) http://www.spn.usace.army.mil

- Major agency responsible for regulation of Sect. 404 under the federal Clean Water Act, which includes "waters of the U.S." and almost all wetlands. Jurisdiction essentially includes all bodies of surface water in California.
- Coordinates with federal consulting agencies and CDFG (under the Fish & Wildlife Coordination Act) for its permit process
- Initiates consultation with NOAA Fisheries and USFWS under the Endangered Species Act

NOAA Fisheries www.westcoast.fisheries.noaa.gov

- Responsible agency for almost all marine species, including protection of salmon and steelhead listed as threatened or endangered under the federal Endangered Species Act, and their designated critical habitat; also implements Essential Fish Habitat (EFH) under the Magnuson-Stevens Fishery Conservation and Management Act
- Issues Incidental Take Permits under Section 10 of the Endangered Species Act for non-federal projects involving a "take" of species federally listed as threatened or endangered; indirect take associated with otherwise lawfully authorized activities, and direct take for research and monitoring.
- Conducts ESA Section 7 consultation for any activity funded, carried out or permitted by a federal agency that might jeopardize the continued existence of a listed salmon or steelhead species or adversely affect their critical habitat.
- Consulting agency (not permit-issuing) for federal Clean Water Act permits (Sect. 404), and for any project (permits, funding, assistance, etc.) due to Fish and Wildlife Coordination Act requirement and/or involving other federal agencies such as FEMA, EPA, and Federal Highways.

U.S. Fish and Wildlife Service (USFWS) www.fws.gov

- Responsible agency for protection of terrestrial and non-marine (non-salmon) aquatic species listed as threatened or endangered under the federal Endangered Species Act
- Commenting agency (not permit-issuing) for federal Clean Water Act permits (Sect. 404) and for any project with federal involvement (permits, funding, assistance, etc.) due to Fish and Wildlife Coordination Act requirement.
- Issues Incidental Take Permits under Section 10 of the Endangered Species Act for non-federal projects involving a "take" of federally listed species. (definition of "take" in ESA section).
- Conducts ESA Section 7 consultation for any activity funded, carried out or permitted by a federal agency that might jeopardize the continued existence of a listed non-salmon species or adversely affect their critical habitat.

LESS COMMON PLAYERS IN THE PERMIT PROCESS

Only in limited instances do the following agencies require permits or get involved in the permit process for County road maintenance projects:

California Dept. of Conservation www.consrv.ca.gov/omr

- Office of Mine Reclamation implements reporting, compliance, and reclamation requirements of the Surface Mining and Reclamation Act (SMARA) for rock and gravel mines and quarries

State Lands Commission (SLC) www.slc.ca.gov

- Authorizes leases for use of the state's tide and submerged lands and beds of historically navigable rivers, including sites for bridge supports

State Water Resources Control Board (SWRCB) www.swrcb.ca.gov

- Responsible State agency for enforcement of Porter-Cologne Act and Clean Water Act.
- Delegates most federal and state water quality permit and enforcement activity to its Regional Water Quality Control Boards (RWQCB)
- Oversees water rights applications, allotments and permits for water diversions
- Adopts statewide General Permit for Storm Water Discharges, issued by SWRCB and enforced by the RWQCBs.
- Oversees and regulates statewide general permits which include construction, industrial, linear construction, and Small MS4 permits.

U.S. Environmental Protection Agency (EPA) www.epa.gov

- Delegates most federal water quality permit and enforcement activity to the State
- Reserves compliance authority for runoff ("nonpoint source") pollution unless delegated to the State (delegated to RWQCBs in California)
- Shares responsibility with RWQCB for developing Total Maximum Daily Load (TMDL) allocation for pollutants for water quality impaired (listed) waterbodies; gives final approval authority for each proposed TMDL.

Federal Highway Administration (FHWA) www.fhwa.dot.gov

- Funds many road and bridge rehabilitation projects and emergency repairs on Forest Highways, including (State Transportation Improvement Program (STIP) & (Highway Bridge Replacement and Rehabilitation (HBRR).
- Federal funding triggers environmental review under the National Environmental Policy Act (NEPA), Endangered Species Act (Section 7 Consultation), and Historic Preservation Act (Section 106 consultation).

U.S Forest Service (USFS) www.r5.fs.fed.us

- Requires an easement, encroachment, right-of-way or Special Use Permit on repairs to Forest Highways (local roads through National Forests) if working outside of the transportation easement.
- Administers projects under the Emergency Relief for Federally Owned Roads (ERFO). USFS involvement triggers NEPA, ESA Section 7, National Historic Preservation Act Section

106, and other requirements, depending on the Forest Plan or other land management plan.

Bureau of Land Management (BLM) www.blm.gov

- May own road right-of-way or adjacent land needed for road project staging and construction.
- BLM involvement triggers NEPA, ESA Section 7, National Historic Preservation Act Section 106, and other requirements, depending on the Forest Plan or other land management plan.

State Historic Preservation Office (SHPO) ohp.parks.ca.gov/?page_id=21755

- Consults with federal agencies regarding the significance of historic and archaeological resources in the projects' Area of Potential Effect for projects outside the County's right-of-way, with federal involvement. Historic bridges and buildings and archaeological sites are common concerns in Napa County.

Underground Service Alert (USA) http://usanorth811.org/

- Not an agency, this non-profit service helps locate underground facilities before excavation or drilling projects are begun. Requires at least 2 working days' notice before digging once excavation limits are marked. Contact 811.

HELPFUL REFERENCES

Bass, R., Herson, A., and K. Bogdan. (1999). CEQA Deskbook: A Step-By-Step Guide On How To Comply With The California Environmental Quality Act, (2nd edition) Solano Press Books, Pt. Arena, CA. [(707)884-4508]

California Dept. of Fish and Wildlife. (2000). "Lake & Streambed Alteration Agreement Process," Sacramento. 153 p. http://www.dfg.ca.gov/habcon/1600/

Cylinder, P.D., Bogdan, K.M., Davis, E.M., and A. I. Herson. (1995). Wetlands Regulation: A Complete Guide To Federal And California Programs, Solano Press Books, Pt. Arena, CA. 363 p. [(707)884-4508]

Jones & Stokes Associates, Inc. (1997). Handbook Of Regulatory Compliance For The Anadromous Fish Restoration Program. Sacramento, CA. Prepared for U.S. Fish and Wildlife Service, Stockton, CA. [(209)946-6400]

Mueller, T.L. (1996). Guide To Federal And California Endangered Species Laws, Planning And
Conservation League Foundation. Sacramento. [(916) 444-8726]

National Marine Fisheries Service. Endangered Species Act – Section 7 and Section 10 handbooks. //www.nwr.noaa.gov/

National Marine Fisheries. (June 2000). A Citizen's Guide to the 4(d) Rule for Salmon and Steelhead on the West Coast.

Oregon Association of Clean Water Agencies. (2000). Endangered Species Act Assessment Manual.
Prepared by CH2MHill. [(503)236-6722, or //www.oracwa.org]

U.S. Fish and Wildlife Service. "Habitat Conservation Plans and the Incidental Take Permitting Process." www.fws.gov/Midwest/endangered/permits/hcp/index.html

CHAPTER 3: WORKING IN THE WATERSHED

All rivers and streams drain from a basin- an area called a watershed (or drainage basin). What happens within each watershed (from ridgetop to ridgetop) affects the quality of the streams and the fish habitat they provide. This chapter gives a basic background on how watersheds work.

Watershed Basics

- Why use the Watershed Approach?
- What is a Watershed?
- Watershed Elements and Processes
- Water Quality

WHY USE THE WATERSHED APPROACH?

Understanding and managing watersheds is useful in the mitigation of local road-related environmental problems because:

- Steelhead trout in the Napa River watershed are listed as threatened under the Federal and State Endangered Species Act, leading to legal restrictions on watershed activities.
- Many streams in the region are listed under the federal Clean Water Act as “impaired” by excessive sediment & temperature, triggering a requirement for Total Maximum Daily Load (TMDL) non-point source pollution limits for each stream system. The Napa River watershed is considered impaired by excessive fine sediment and pathogens and TMDLs have been adopted for each of these pollutants. The RWQCB has, through the TMDL process and through adoption of a Basin Plan Amendment, identified certain required actions and standards related to County roads and County road maintenance in the Napa River watershed.
- Since water moves downstream in a watershed, road work and other watershed activities can affect water quality downstream.
- The watershed approach addresses direct causes of stream and fishery problems.

WHAT IS A WATERSHED?

Watershed – an area of land which drains water, sediment, and dissolved materials into waterways; defined by the ridge of the hills or mountains that divide them. “Basin,” “drainage,” and “catchment” are synonyms of “watershed.” The term ‘watershed’ can refer to any scale of water way. A system of standard terms exists for subdividing large watersheds into smaller ones, based on relative watershed size:

> **Basin –** A river system or a group of streams composing a drainage area.
>
> **Subbasin** - A geographic area representing part or all of a surface drainage area (basin), a combination of drainage areas, or a distinct hydrologic feature. Almost all subbasins are larger than 700 square miles in size, though some in Northern California are smaller.

Watershed – The next smallest subdivision of a subbasin.

Subwatershed – A logical subdivision of an area within a watershed, based on geography (major tributary) or a distinctive feature or use (municipal water supply).

Drainage – An area within a subwatershed based on the development of the stream channel network, including draws and swales.

WATERSHED ELEMENTS AND PROCESSES

Water ways

Water flowing through channels has many different names such as: river, stream, creek, wetlands, estuaries, gulch, and ditch. Water is stored on the surface in different types of water bodies such as lakes, lagoons, reservoirs, and ponds. Together, all flowing and stored surface water bodies are **waterways**. In contrast, water stored beneath the surface of the ground is called **groundwater.**

Stream Channels

Stream channels carry runoff flows from precipitation in the watershed. The channel is carved by flowing water. Bankful is defined as the typical flow that forms the shape of the existing channel (typically the two-year storm event - meaning that there is a 50% of that flow occurring in any given year). If the sediment load in a stream is greater than the stream's capacity to move sediment, it is deposited in the stream channel, causing it to fill or aggrade. Too little sediment, compared to what the stream was historically carrying, can cause the channel to downcut or degrade in elevation. When either of these conditions happens, the stream channel must adjust upstream and downstream. Streambank erosion, channel widening, and headcut erosion are some of the symptoms of this adjustment. Stream crossings on roads, particularly bridges, can be seriously impacted by changes in stream channel depth and width.

Stream Order

Stream channels connect like the veins on a leaf. The network of smaller tributaries flow into increasingly larger streams, and there are several numbering systems to describe the relationship. The stream "order" system refers to numbering tributaries starting in the headwaters.

1. First-order streams have no tributaries;

2. Second-order streams have only first order channels as tributaries, or they occur where two first- order streams come together;

3. A third-order stream is formed by the joining of two second-order streams, and so on.

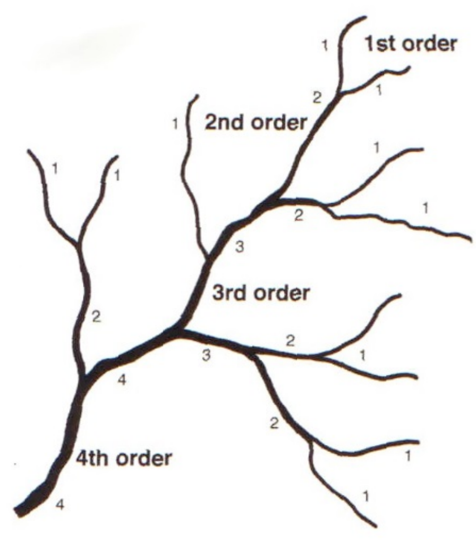

Figure 3.2 Stream order designation

Stream Categories

Streams are often identified by their flow condition:

- perennial – those streams which carry water the year round, except for infrequent and extended periods of severe drought.
- ephemeral – streams consisting of a dry channel throughout most of the year, bearing water only during or immediately after a rain..
- intermittent – stream channels which carry water only part of the year and are dry the other part, but which receive flow from the groundwater table when it is high enough.

These stream types are indicated on topographic ("topo") maps of the U.S. Geological Survey (USGS), with perennial streams identified by solid blue lines ("blue line streams") and intermittent streams by dash-dot blue lines. However, these USGS map indications are only estimates made at the date of the original map development, and they should not be used as a substitute for more accurate descriptions of current conditions – especially for smaller creeks. In Napa County more detailed stream mapping is available through the County's GIS.

Stream Class

Another way to categorize streams is by the water's use, such as for aquatic species or domestic water supply. The terms below are also commonly used, particularly by the California Department of Forestry and Fire Protection (Cal Fire), the California Department. of Fish and Wildlife (CDFW), and the San Francisco Bay Regional Water Quality Control Board to help define the degree of state forestry and water quality regulations.

Class I Waterway: A stream (or lake) that is used for a domestic water supply (including springs) on the site and/or within 100 feet downstream of the operations area; and/or fish always or seasonally present onsite, including habitat to sustain fish migration and spawning. (It typically flows year round, but may flow seasonally.)

Class II Waterway: A stream (or lake) that has fish always or seasonally present offsite within 1000 feet downstream, and/or aquatic habitat for nonfish aquatic species; excludes Class III waters that are tributary to Class I waters. (These streams may flow year round or seasonally; many springs and wetlands are also included.)

Class III Waterway: A stream channel (or lake) with no aquatic life present but showing evidence of being capable of sediment transport to Class I or II waters under normal high water flow conditions.

Class IV Waterway: Man-made waterways, usually downstream, for established domestic, agricultural, hydroelectric supply or other beneficial use.

Other stream terms are often based on legal definitions from one or more laws. The Clean Water Act refers to "Waters of the U.S.," and "Ordinary High Water Mark," both of which are defined under the Act in *Chapter 2 – Regulations and Permits.*

Flood Frequency and Floodplain Size

Floods are natural events and should be expected. Most rivers reach bankful stage, at approximately a two-year reoccurrence interval. Bankful is defined as the typical flow that forms the shape of the existing channel. While bankful flows are a common occurrence, catastrophic floods may occur any year. The probability of occurrence of a particular size flood, based on the years of record, is often used to predict the frequency of floods for planning purposes. Potential frequency of 25, 50, and 100 year flood events are commonly used. A 100-year event has a 1% chance of occurring in any given year, a 50-year event has a 2% chance of occurring in any given year, and a 25-year event has a 4% chance of occurring in any given year.

A river's floodplain becomes part of the river system during larger storms. Floodplains occur in large river valleys and in valleys of creeks just a few feet wide. They are usually not present along headwater tributaries. Structures that encroach onto the floodplain – such as roads and buildings – impede the stream's ability to move laterally under higher flows, and these structures may be damaged when high flows occur. The "100-year floodplain" is the area potentially inundated for a flood event with probability of occurring once every 100 years (a 1% chance of occurring in any given year). This potential 100-year flood scenario is becoming standard for engineering designs for structures within a stream channel or floodplain, including structures such as bridges and culverts.

<u>Flood Frequency & Size Concepts (Mount, 1995):</u>
1. The probability that a 100-year flood will strike a river in California is the same every year, regardless of how long it has been since the last 100-year flood.
2. It is not certain that the 100-year event will occur sometime in the next 100 years (although it is pretty likely).
3. In California, where historic data sets are small, the 100-year floodplain is likely to grow following a major flooding event.
4. It is a virtual certainty that the defined 100-year floodplain is not the actual 100-year floodplain.

WATERSHED PROCESSES

Understanding the physical processes that shape a watershed's condition can help in making better decisions about road management practices. The quality of the stream and its fish habitat is directly influenced by these watershed processes.

Rainfall, Stream flow, and Runoff

Hydrologic cycle is the term used to describe the continuous circulation of the Earth's waters from the ocean, to the atmosphere, to the land, and then back to the ocean.

Hydrology is the science of water, or the study of water and its environment in the hydrologic cycle. Water falling to earth, or **precipitation,** can be in the form of rainfall or snow. Rainfall or snowmelt entering a stream channel becomes stream flow.

Runoff occurs when the ground in the watershed is no longer capable of absorbing the precipitation.

- Some soils absorb water from rainfall more easily than others, so runoff occurs less rapidly.
- Vegetation can affect the rate of runoff, with more runoff usually coming off bare areas.
- Urban or paved areas speed the movement of water and shorten the time between rainfall and runoff. The effects of urbanization and deforestation can alter the hydrograph, increasing peak run-off flows in a watershed and increasing the chance or frequency of flooding.

Precipitation affects runoff based on the following aspects:

- <u>Intensity of rainfall</u> – measured in inches per hour – varies from low to high; high intensity rainfall leads to large amounts of runoff.
- <u>Duration of rainfall</u>, together with intensity, affects the runoff – the longer the rain storm, the greater the amount of water to runoff.
- <u>Frequency of rain storms</u> during a period of time – multiple storms over a short period of time create greater runoff than single storms or those spread out over a long period of time.
- <u>Type of precipitation</u> – rain or snow – controls the timing of runoff; snowpack spreads out the effects of storms, leading to delayed runoff in warmer months.

Geology and Soil Landscape

Geology is the science of the earth. **Geomorphology** is the study of the physical features of the surface of the earth.

Soils are weathered rocks mixed with other organic materials. The stability of soils in the region varies by type, and is closely associated with the qualities of their underlying rocks. Two soil types known for their high tendency for erosion are:

- “Blue goo” soils in the Coastal Franciscan formation; these soils are derived from incompetent schist high in clay content and tend to act very “slippery” on steep slopes. Slopes composed of this type of soil are often hummocky and grass-covered.
- Decomposed granite (or “DG”) soils; these soils do not stick together well (are “non- cohesive”) due to high sand and low silt and clay content.

Soil Erosion and Sedimentation

Erosion Processes

- Soil erosion is mainly caused by water and wind.
- Erosion is a natural process linked to the hydrologic cycle.
- Not all soil that is eroded enters the stream or drainage system. Streams do work by eroding, transporting, and depositing material (silt, sand, gravel, cobbles, boulders). Examples of this process include streambank erosion, muddy streams, and new gravel bars.
- Erosional processes can be accelerated and exacerbated by human activities in the landscape.

Types of Erosion

- Gully – An erosion channel formed by concentrated runoff, usually larger than one foot deep and wide. Gullies often form where road surface or ditch runoff is directed onto unprotected slopes.
- Sheet & Rill – Sheet erosion is the loss of soil in thin layers of soil across a large surface area, while rill erosion is a small erosion channel (larger channels are called gullies). Rill erosion can be seen where rainfall and surface runoff is concentrated on unprotected fillslopes, cutbanks, and ditches.
- Dry Ravel – On steeper slopes, gravity can bring dry soil downhill. Frost heaves can create this condition also. Raveling is most obvious along bare, steep road cuts.
- Landslides - The downslope movement of a mass of earth caused by gravity. Examples include debris slides, torrents, rock falls, debris avalanches, and soil creep. They may be caused by natural erosional processes, natural disturbances (earthquakes, floods, fires), or human disturbances.

Sedimentation

- Soil erosion that enters the stream channel or drainage system (ditches, storm water drains, etc.) becomes sediment.
- Natural levels of sediment in a stream system are referred to as “background levels”.
- Excessive levels of sediment are those amounts above background, and can cause habitat problems when pools and spawning gravels are filled with fine sediment.
- High levels of sediment suspended in the stream flow cause cloudy water, or turbidity. Persistent muddy appearance is usually due to high silt and clay content.
- Sediment becomes deposited in the stream channel when the flows slow down; such as in gravel or sand bars, pools, or other areas of the streambed. Floods can cause sediment to deposit outside of the channel in the flood plain.

With land use activity, the natural background rate of erosion can be accelerated or result in chronic delivery of sediment to stream channels over many decades. Three geomorphic processes are responsible for most sediment delivery from upland areas. These are:

- Chronic surface erosion from bare soil areas
- Fluvial erosion, including gully and stream channel erosion
- Mass wasting or landslides

Understanding these processes is necessary to conduct successful upslope assessment and restoration. Most of these processes, once initiated, result in erosion of sediment, which transports to hillslopes or stream channels. Whether the sediment remains in storage either on the hillslope or within the stream channel depends on the sediment types, and the timing, magnitude, and frequency of storm events within a region. Once sediment suspends in water, or is mobile in the streambed, sediment becomes part of the “net watershed sediment yield.”

Vegetation

The type and extent of vegetation throughout the watershed affects the amount and pattern of storm runoff in the watershed and influences the amount of erosion that occurs.

Upland Vegetation

- Vegetation on the slopes helps to slow runoff, which allows better seepage of rainfall into the
- soils and groundwater and better water storage for summer stream flows.
- Plant roots hold soil in place, with deeper-rooted trees helping to prevent deep seated erosion like landslides.
- Plant litter, such as dead leaves, needles and branches, provides a protective layer over the soil from the erosive impacts of rainfall and snowmelt.
- Loss of vegetation, from fires, disease, logging, grazing, or urbanization, can increase soil erosion and increase the rate of runoff.

Riparian Vegetation

Streams provide both surface and underground water to riparian vegetation. Streamside vegetation provides many benefits to a healthy stream, such as:

- Shade to the stream, which helps provide the cold water that salmonids need;
- Food for fish from insects, leaf litter and organic material falling into the stream (also known as allocthanus material);
- Protection from bank erosion through root strength;
- Structure for instream habitat when trees fall into the stream (also known as Large Woody Debris, or LWD), which helps create scour pools and traps sediment for slow release during storms;
- Filter or buffers from sources of surface erosion, thus minimizing instream sedimentation;
- During floods, slows the energy of the flow and causes sediment to deposit in the floodplain instead of in the channel.
- This narrow riparian plant zone offers habitat for many animal species dependent on its unique features.

Riparian Zone

The riparian zone borders the stream and is the transition area to the upper watershed. The zone interacts with the channel and bears strongly on the structure and function of the aquatic ecosystem. The structure and composition of the riparian zone can be affected by the stream type and its active channel, as well as by geologic and topographic features (Figure 3-3).

Functions of the riparian zone include:

- Controlling the amount of light reaching the stream which affects temperature and productivity.
- Providing litter and invertebrate fall.
- Providing stream bank cohesion and buffering impacts from adjacent uplands.
- Providing large woody debris.

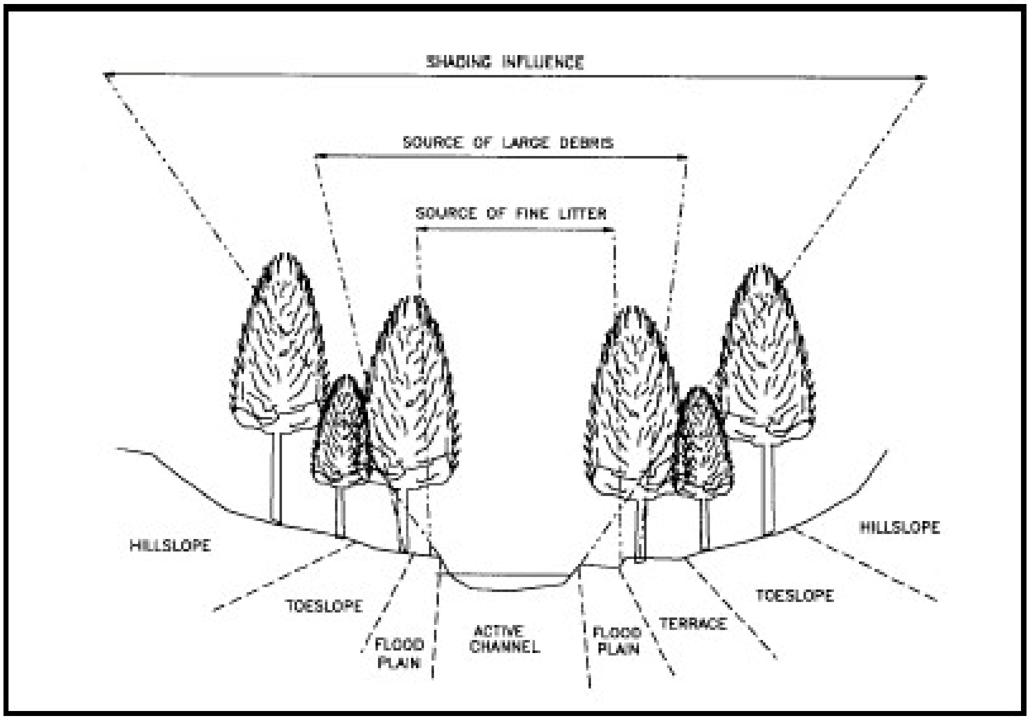

Figure 3.3 Riparian Zone

Wetlands

- These areas generally include, but are not limited to, marshes, bogs, estuaries, and similar areas. Some are near or directly connected to the stream channel system. They can also include manmade wetlands found in, but not limited to, ditches behind soil berms or shallow excavations. If a wetland area is encountered while working in the field, the appropriate regulatory agencies must be contacted.
- Wetland plants trap sediment and filter excess nutrients, which can improve water quality.
- Wetlands help slow floodwaters and function to recharge groundwater areas or aquifers.
- Many wildlife species are dependent upon wetlands for their habitat.

WATER QUALITY

Clean water means good water quality. Good water quality supports the natural and human uses dependent on the water. These natural and human uses are termed "beneficial uses" and include recreation, drinking water, and cold water for salmon fisheries. Control of the sources of water pollution is a major focus of state and federal laws.

Types of Water Pollution

Pollution from sewage and industrial wastes – usually entering the water from pipes – is known as point source pollution. Runoff or indirect pollution – from a variety of less obvious sources – is called nonpoint source (NPS) pollution. Rural roads and road maintenance activities have the potential to contribute to nonpoint pollution, the major type of water pollution problem in California today. Road maintenance yards and other "industrial" type facilities, if not managed well, can be the source of runoff or "storm water" pollution and even hazardous waste contamination of the surface (stream) and ground waters.

Water Quality Protection and Improvement
A watershed approach looks at both point and non-point sources of pollution and for solutions across all land ownerships. Solutions, especially for nonpoint runoff, need to be creative as traditional pollution treatment plants often will not work. Prevention is the first, best and often most cost-effective approach.

Water quality protection laws and programs seek to prevent or clean up pollution. For this region, water quality objectives are set, and beneficial uses are stated for each water body, in the Regional Basin Plans adopted by the Regional Water Quality Control Boards (RWQCB) and the State Water Resources Control Board (SWRCB). These objectives relate to many water quality factors, such as: temperature, sediment, turbidity, oil and grease, bacteria, pesticides, and specific chemicals. Regional Basin Plans are reviewed and amended regularly to assesses and include new water quality concerns and beneficial uses.

Finding cooperative ways to protect and restore watershed health among all of the owners and users of a watershed is becoming a common aspect of the "watershed approach." Community-based watershed groups form and seek common solutions to the watershed's - problems. Often, a watershed assessment of the current and historic conditions is performed, followed by a jointly prepared strategy or plan for solving identified problems. For County road issues, this cooperative approach can be of benefit when other road ownerships are part of the problem, or when non-county upslope or upstream sources, create erosion or runoff problems on County roads.

TOTAL MAXIMUM DAILY LOAD (TMDL)
When a river does not meet State and Federal water quality standards, it usually becomes earmarked for a remedial strategy under the federal Clean Water Act. The state has identified streams that are polluted. This list of "impaired water bodies" is adopted by the State Water Resources Control Board and the Regional Water Quality Control Boards, is referred to as the "303(d) list," which refers to a section of the Clean Water Act, and is updated every five years. As mandated by the Clean Water Act, Total Maximum Daily Loads (TMDLs), must be developed as a means to address each pollutant.

In 1990, based on evidence of widespread erosion and concern regarding resulting impacts to fish habitat, the Regional Water Quality Control Board listed the Napa River as impaired by sediment. The primary impetus for the listing was concern for the substantial decline since the 1940s in abundance and distribution of steelhead and salmon in the Napa River watershed (USFWS, 1968; Leidy et al., 2005). As a result of the listing, the Regional Water Quality Control Board was required to prepare a total maximum daily load (TMDL) for the Napa River watershed (Napolitano et. al. 2009). A TMDL involves assessing sources of the pollutant and developing a pollutant budget and a plan to restore the heath of a polluted water body. The RWQCB adopted a TMDL for sediment in the Napa River watershed and has identified County roads as one of several "sources" of sediment that is contributing to excessive sedimentation of the Napa River. Accordingly, the Napa River Sediment TMDL identifies actions and standards required of parties responsible for operation and maintenance of County roads. Therefore this manual will address road-related sediment sources and road-related fish barriers as they pertain to anadromous fish species in the Napa River watershed. Practices discussed here are pertinent to protecting water quality in general and are recommended for use throughout Napa County.

HELPFUL REFERENCES

Alt, David and Donald W. Hyndman. (2000). Roadside Geology of Northern and Central California.
Mountain Press Publishing, Missoula MT. [$20.00]

California Department of Fish and Wildlife (2002) California Salmonid Stream Habitat Restoration
Manual. Flosi et al. http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

California Division of Mines and Geology. "Geologic Hazards", "Geologic Mapping", "Watersheds
Mapping". www.consrv.ca.gov/CGS/Pages/Index.aspx

Leidy, R.A., G.S. Becker, and B.N. Harvey 2005. "Historical distribution and current status of steelhead/rainbow trout *(Oncorhynchus mykiss*) in *Streams of the San Francisco Estuary, California*." Oakland, California: Center for Ecosystem Management and Restoration.

Leopold, Luna B. (1994). A View of the River. Harvard University Press. Cambridge, MA.,298 pp. [@$35.00]

Leopold, Luna B. (1970. Water, Rivers and Creeks. University Science Books. Sausalito, CA. 185 pp. [@$25.00]

Mount, Jeffrey. (1995). California Rivers and Streams. University of California Press. Berkeley, CA. 359 pp. [@ $22.00]

Napolitano, M., Potter, S., Whytle D., 2009, Napa River Sediment TMDL and Habitat Enhancement Plan, Staff Report, California Regional Water Quality Control Board, San Francisco Bay Region.

National Association of Counties (NACo). (1999). "Leadership in Watershed Management: The County Role." NACo Watershed Management Advisory Committee. www.naco.org

National Marine Fisheries Service. (1996). "Factors for Decline: A Supplement to Notice of Determination for West Coast Steelhead Under the ESA". www.nwr.noaa.gov

Oregon Watershed Enhancement Board (OWEB). (1999). Oregon Watershed Assessment Manual. Salem, OR. www.oweb.state.or.us/publications

Spence, B. et al. (1996). "An Ecosystem Approach to Salmonid Conservation." ManTech Environmental Technology. Prepared for NOAA Fisheries. www.nwr.noaa.gov

Strahler, Arthur. (1957). "Quantitative Analysis of Watershed Geomorphology".

U.S. Fish and Wildlife Service (USFWS) 1968. *Analysis of fish habitat of the Napa River and tributaries,*
Napa County, California with emphasis given to steelhead trout production. Sacramento, California: USFWS.

CHAPTER 4: STREAM HABITAT AND SALMON FISHERIES

Chapter 3 described how actions within watersheds affect water quality and stream conditions. This chapter focuses on the fish populations within our Napa River watershed – primarily salmon and steelhead. Understanding the water quality and habitat needs of fish will help us understand why performing environmentally sensitive road maintenance practices is so important.

SALMON & STEELHEAD LIFE CYCLES

Chinook (king) salmon (Oncorhynchus tshawytscha) and Steelhead (rainbow) trout (Oncorhynchus mykiss) are species of concern due to their dwindling numbers in our region's streams. These species and others in the salmon and trout family are known as salmonids. The Napa River watershed has been identified as an "anchor" watershed, meaning that it essential for the continued health of the species in the San Francisco Bay Area.

Salmon and steelhead are born in freshwater river systems, then migrate to the ocean to live, feed and grow, then return to their native stream to reproduce or spawn (Figure 4.1). This river-to-ocean life cycle makes them **anadromous** fish. Table 4.1 gives the range of months when these species can be found in our streams. Besides spawning, the fish use the stream for months to years during the juvenile rearing stage.

Important Life Cycle Terminology

Anadromous (a-nad'-ru-mus) **-** Born in freshwater, anadromous fish return to the sea to grow to mature adults and return to their natal stream to reproduce once again.

Spawn- the act of creating a nest or "redd" in a gravel bed and subsequent mating between a mature female and often more than one male.

Alevin- the first stage of emergence from the egg into the gravel with a yolk sac attached.

Fry- the young fish that emerges from the gravels after about two weeks.

Juvenile- the period of time the young fish spends in freshwater until migrating

Smolt- the transformation stage as the juvenile fish prepares to migrate from fresh to salt water.

Figure 4.1. Life cycle of Salmonid

Table 4.1. Salmon Life Cycles in Central California Coastal Streams

Species	Spawning	Rearing	Out-Migration	Time in Freshwater
Chinook salmon - fall-run	Nov-Jan	Dec-Jun	Apr-Jun	1- 6 months
Steelhead trout - winter-	Jan - May	all year	Feb - Jun	1 to 3 yrs

Source: Napa County Resource Conservation District Fisheries Monitoring Program

<u>Steelhead trout (Oncorhynchus mykiss)</u> - Steelhead spend their first few years in the freshwater stream system where they hatched and then they migrate out to sea during late spring. After one to three years in saltwater, the adults return to the river to spawn after the first big rains, typically in January and February, but as late as May. Adult females are on average four to five years old and adult males are typically three to four years old.

The female steelhead makes a redd typically in the shallow riffle gravels at the tail end of a pool. The eggs that are deposited and fertilized in the redd will incubate for approximately six to eight weeks - the rule of thumb is approximately 50 days at 50 degrees Fahrenheit, After hatching, the *alevin* stay in the gravel for another two weeks or so while absorbing their egg yolk sac. During this stage, the alevins are approximately 3/4” long and are extremely vulnerable, particularly to excessive sedimentation that can deplete dissolved oxygen in their redd. After emerging from the gravel, they are called *fry* and will remain in the river system for one to three years before migrating to the sea between March and early June. While in the freshwater system, fry require year-round cool water, which during summer months can often be found in deep pools.

After spawning, some adults (usually females) can return immediately to the sea and spawn in subsequent years. Steelhead can return to freshwater repeatedly to spawn; a record nine year old steelhead was observed in the Carmel River. Steelhead spawning is difficult to document in natural river systems because adult fish migrate primarily at night and spawn during winter storm flows when visibility is low. Therefore, not much is known about the specific movement patterns of adult steelhead in the Napa River watershed. In order to maximize access to high-gradient and often intermittent streams, adult fish have been observed migrating upstream on the receding limbs of winter storm flows. In years with below average stream flows, access to small tributary streams, which this species prefers, can be limited or completely blocked. Steelhead spawning in the mainstem Napa River has been documented regularly in recent years, although it appears to be most prevalent in dry years when access to prime tributary spawning habitat is limited by low streamflow.

<u>Chinook salmon (Oncorhynchus tshawytscha)</u>- Chinook salmon are found from Northern Alaska to Central California. The spawning populations in the Sacramento-San Joaquin Rivers are the southernmost range of the species, and the Sacramento River and its tributaries is the only system in the world that supports four separate races or runs of Chinook, which use the system for spawning year round; the fall, late-fall, winter and spring runs. Chinook are larger than steelhead and other salmon and tend to be found in the bigger river systems, often spawning in the mainstems of those rivers. In the Napa River watershed, the best places to see

Chinook are in the mainstem Napa River near major bridge crossings and public access points (e.g. Napa River Ecological Preserve, Calistoga City Center).

Chinook salmon enter the lower Napa River in the fall, typically around late September and early October. Adult fish will hold in deep pools in the estuarine/tidal portion of the river near the City of Napa for a month or more waiting for the first rains of the season to generate runoff. Once a sufficient storm occurs, adult salmon swim upstream to suitable spawning areas before flows recede. During this part of the year, winter baseflow is usually not established, and the Napa River is subject to rapid increases and decreases in flow. As a result, Chinook salmon migration can be limited by rapidly changing flow conditions. Salmon that find suitable spawning areas construct spawning redds (nests) in the streambed gravels and cobbles, typically within a day or two. After spawning, spent salmon will protect their redds and remain in the area for several weeks until they ultimately die – unlike steelhead, salmon are not able to repeat spawn. Peak spawning activity occurs in the Napa River from November through early January, depending on flows.

Juvenile Chinook salmon spend several months rearing in the Napa River from January through June. Unlike steelhead, juvenile Chinook do not spend much time in freshwater, and migrate to the estuary when they are only a few months old and about three to four inches long. Outmigration occurs throughout the spring with a peak occurring in May as freshwater outflows diminish.

SALMON AND STEELHEAD HABITAT NEEDS

- **Access to stream habitat –** upstream for adults and up and downstream for juveniles
- **Clean gravels** in riffles and runs where adults build nests (redds) in which to lay their eggs, juveniles rear, and stream insects (macro-invertebrates) provide food for the fish
- **Pools** that are cool and deep where young can rear and adults can rest
- **Instream shelter** (created by large woody debris (LWD), boulders, undercut banks, etc.) where fish can hide from predators and avoid being swept downstream
- **Overhead cover** to provide shade and sources of insect food
- **Side channels and smaller tributaries** for summer rearing and over-wintering
- **Cool water** free of pollutants, with year-round temperatures below approximately 70° F and sufficient dissolved oxygen
- **Estuary** where salt and fresh water mix, for adjustment by adults moving upstream, and juveniles (smolts) moving into the ocean

Another way to look at salmon habitat needs is to remember the "**Four C's**":

- **COLD**: Water that is too warm (>65° F) for a prolonged time can be stressful to the health of these coldwater fish, while water that is too hot (>75° F) will kill them.
- **CLEAN**: Water, pools and gravels should be clean and not be polluted from excess sediment or nutrients or any chemicals.
- **COMPLEX**: A stream should not be cleaned or altered significantly of its naturally complex structure, such as large wood, overhanging riparian vegetation, meanders, flow patterns, and floodplain connections.
- **CONNECTED**: Adults must be able to get from the ocean to their spawning areas and juveniles to the ocean with no manmade impassable barriers preventing this migration.

FISH PASSAGE

Salmon and Steelhead Location in the Watershed

Salmon and steelhead use stream systems from the top to the bottom. Adults will go up as high in the system as they can physically reach, which depends upon the species. Steelhead are able to navigate steeper gradient streams and can go higher up in the drainages than Chinook. Steelhead can also use streams that only flow seasonally (winter and spring) during a part of their life cycle. Chinook salmon tend to spawn in the mainstem Napa River and the lower reaches of larger tributaries, such as Dry Creek and Conn Creek.

Salmon and steelhead are powerful jumpers and can ascend many potential barriers as long as there is a pool of sufficient depth below the obstacle and adequate resting areas between jumps. If a barrier is too high to jump or there is not a deep pool directly below it, salmon and steelhead will often repeatedly attempt to overcome it until they become exhausted or die trying. The Napa County Resource Conservation District has mapped the extent of stream miles that salmon and steelhead utilize in the Napa River watershed.

Table 4.2 describes minimum water depth requirements and recommended swimming and leaping abilities for several salmonid species and lifestages commonly found in California.

Table 4.2. Minimum water depth requirements and swimming and leaping ability inputs for *FishXing*

Species or Lifestage	Minimum Water Depth	Prolonged Swimming Mode		Burst Swimming Mode		
		Maximum Swim Speed	Time to Exhaustion	Maximum Swim Speed	Time to Exhaustion	Maximum Leap Speed
Adult anadromous salmonids	0.8 feet	6.0 ft/sec	30 minutes	10.0 ft/sec	5.0 sec	15.0 ft/sec
Resident trout and juvenile steelhead trout >6”	0.5 feet	4.0 ft/sec	30 minutes	5.0 ft/sec	5.0 sec	6.0 ft/sec
Juvenile salmonids <6”	0.3 feet	1.5 ft/sec	30 minutes	5.0 ft/sec	5.0 sec	4.0 ft/sec

California Salmonid Stream Habitat Restoration Manual; Chapter IX, California Dept. of Fish and Wildlife, Flosi et. al 2002.

Figure 4.2 shows typical passage problems created by undersized, improperly installed, or poorly maintained stream crossings, including:

- Excessive drop at outlet (entry leap is too high for fish)
- Excessive velocities within culvert
- Lack of depth within culvert
- Excessive velocity or turbulence at culvert inlet
- Debris accumulation at culvert inlet or within culvert barrel

Barriers may occur as temporal, partial or total depending upon flows and timing (Table 4.3).

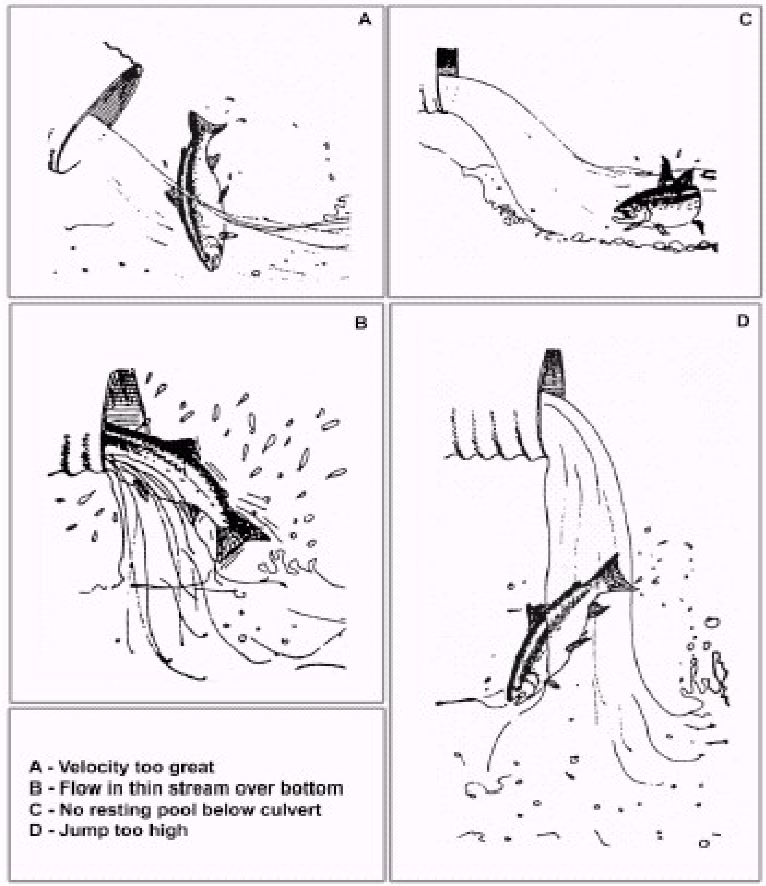

Figure 4.2 Fish passage barrier conditions at culverted stream crossings. *(California Salmonid Stream Habitat Restoration Manual; Chapter IX, California Dept. of Fish and Wildlife, Flosi et. al 2002.)*

Table 4.3. Definitions of barrier types and their potential impacts.

Barrier Category	**Definition**	**Potential Impacts**
Temporal	Impassable to all fish based on run timing and flow conditions	Delay in movement beyond the barrier for some period of time
Partial	Impassable to some fish at all times	Exclusion of certain species and lifestages from portions of a watershed
Total	Impassable to all fish at all times	Exclusion of all species from portions of a watershed

California Salmonid Stream Habitat Restoration Manual; Chapter IX, California Dept. of Fish and Wildlife, Flosi et. al 2002.

Barrier Forms:

- Physical Barriers (too tall or long)
- Flow Barriers (too little, too fast)
- Thermal Barriers (too hot)

Types of Physical Barriers:

- Natural waterfalls, steep channel reaches (generally >8% slope for >300ft)
- Water diversion dams and weirs (without fish ladders)
- Flood debris dams (without fish ladders)
- Water storage dams (without fish ladders)
- Landslides in stream
- Culverts & other types of stream crossings

When are they barriers?

- Seasonally, during low – or very high - flow periods
- Temporarily – if not maintained or improved
- Permanently – if not altered

Sources of Information on Local Salmon Habitat & Barrier Locations

Not all of the streams crossed by County roads provide habitat for salmon and steelhead. If you want to know specific stream areas used by salmon and steelhead contact Jonathan Koehler (Fisheries Biologist) with the Napa County RCD (707)252-4188 x 109 or jonathan@naparcd.org.

NOTE: Even if salmon or steelhead are not present, many streams may still be home to other native fish and other sensitive aquatic species that benefit from proper road maintenence.

ESUs AND THREATENED OR ENDANGERED STATUS

Not all salmon and steelhead populations are identical when it comes to being listed as “threatened” or “endangered” under the federal Endangered Species Act (ESA). NOAA Fisheries adopted the concept of an ESU “Evolutionarily Significant Unit” to define distinct population segments of anadromous salmonids, based on genetic similarities. Populations of genetically similar fish get listed together in an ESU. The intent is to conserve the genetic diversity of these species and the ecosystems they inhabit.

Steelhead in the Napa River watershed are part of the Central California Coast distinct population segment (DPS), which is listed as Threatened under the U.S. Endangered Species Act. The listing was based on a long-term decline in steelhead abundance throughout the DPS, which stretches from just north of Ukiah south to Santa Cruz, and includes all streams tributary to the San Francisco Estuary.

The Napa River Chinook salmon population is not included in either of the nearby Chinook salmon Evolutionarily Significant Units (ESU): the Central Valley Fall/Late Fall Run and the California Coastal Chinook Salmon ESUs. However, recent genetic analysis of Napa River Chinook samples found that ancestry of Chinook salmon spawning in the Napa River is primarily from the Central Valley Fall/Late Fall Run. This run is not listed under the federal or state endangered species act. Species status updates can be found at NOAA Fisheries website: //www.nwr.noaa.gov

OTHER AQUATIC OR RIPARIAN SPECIES OF CONCERN

Working around creeks puts you in contact with a wide variety of sensitive aquatic and riparian species. Federal and State resource agencies have specific seasonal limitations on when you can work around habitats for these species. Sensitive species in Napa County include Chinook salmon and steelhead trout, California red-legged frog, foothill yellow-legged frog, Pacific pond turtle, northern spotted owl and others.

The California Department of Fish and Wildlife designates some sensitive species as California Special Concern species (CSC): these species have declining population levels, limited ranges, and/or continuing threats that have made them vulnerable. There is also a Federal Special Concern (FSC) species list. Some of these species may soon reach the point where they meet the criteria for listing as threatened or endangered under the State and/or Federal Endangered Species Acts. Lists of these Species of Concern should be available through the County Department of Planning, Building, and Environmental Services. Whenever you are in doubt about a project's impact on an animal or plant species that is on this list- consult a local agency biologist for advice on avoiding impacts to these species.

HELPFUL REFERENCES

California Department of Fish and Wildlife (2002) California Salmonid Stream Habitat Restoration Manual. Flosi et al. http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

National Marine Fisheries Service. (June 2000). A Citizen's Guide to the 4(d) Rule for Salmon and Steelhead on the West Coast. http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/section4d/4d-citizens-guide.pdf

National Marine Fisheries Service. (1996). "Factors for Decline: A Supplement to Notice of Determination for West Coast Steelhead Under the ESA". www.nwr.noaa.gov

Spence, B. et al. (1996). "An Ecosystem Approach to Salmonid Conservation." ManTech Environmental Technology. Prepared for NOAA Fisheries.

CHAPTER 5: ROAD MAINTENANCE

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5.1 ROAD TREATMENT AND DESIGN PRINCIPLES

GOALS OF TREATING COUNTY ROADS

In addition to the goal of providing a safe transportation network, the following resource management goals should be considered for each road-related activity:

- Prevent or minimize delivery of sediment and chemicals to streams.
- Prevent or minimize the interruption of natural hillslope and stream runoff patterns (hydromodification).
- Protect aquatic and riparian habitat.
- Restore and/or provide access for adult and juvenile fish migration on all salmon and steelhead streams.

To accomplish these goals, we need:

- Solutions based on treating the causes of erosion and sediment delivery
- Low impact solutions that protect water quality
- Low cost, effective solutions
- Permanent, low maintenance solutions

INTRODUCTION

Watersheds and streams have a natural background rate of erosion that can be substantially increased by human activities. Delivery of eroded sediment to stream systems occurs through various processes that operate in all watersheds. Natural erosion and sediment delivery varies from relatively low amounts in stable watersheds underlain by resistant rock types, to high amounts in watersheds with soft rock types.

During large storm events or extremely wet winters, mass wasting or landsliding, large-scale gully erosion, stream crossing failure, and stream bank erosion are more likely to occur. Between large storm events or during poor water years, erosion rates are generally lower and overall sediment delivery is low, although sediment may still enter the stream from various erosion processes, particularly associated with road and inboard ditch drainage practices.

Native salmonids are adapted stream conditions that result from storms, floods and natural geologic events within the dynamic environment. However, human-caused sediment delivery can combine with natural sediment production and delivery to streams to create negative effects on salmonids by filling in pool habitat and embedding spawning substrate. Roads are often identified in sediment source assessments and water quality investigations because they are typically a disproportionately significant source of accelerated sediment delivery in managed watersheds and they can often be cost-effectively fixed to reduce their impacts.

EROSION AND SEDIMENT DELIVERY

Roads accelerate the natural background rate of erosion. They are subject to failures and severe erosion during large, infrequent storms, as well as chronic surface erosion every time it rains and runoff occurs. Three processes are responsible for most erosion from roads and are usually looked at in two broad categories:

- *Chronic surface erosion* from bare soil areas including unpaved road beds, turnouts, road ditches, and road cutbanks. This erosional process is termed chronic because it occurs annually during any storm event that produces runoff.

- *Episodic erosion* occurs when soils fail in response to storm events or other triggers. These erosion volumes are a **potential** volumes that may or may not occur during a given storm event. The erosion may occur once, or in pulses over an indeterminate time period. Stream crossing washouts, cutbank failures, road-related landslides, and gullying are examples of episodic erosion sources.

A portion of eroded sediment is delivered to stream channels either directly, when a stream crossing washout or landslide fails into a stream channel, or indirectly, when eroded sediment is carried by runoff through ditches, drains or gullies before entering a stream. Eroded sediments that are not discharged into a stream are either permanently stored or temporarily stored until the next storm delivers it to a stream. Sediments that are identified as permanently stored are usually referred to as 'non-delivery' sediments and achieve low priority with TMDL and water quality requirements.

Once sediment is delivered to a stream it is seldom retrievable. Therefore management of sediment originating from County roads must take place along the roads before eroded sediment gets delivered to a stream channel. Recognizing and understanding which of these erosion processes is occurring at a given location is crucial to designing and prioritizing the appropriate treatments.

The Napa River Sediment TMDL states that of all the erosion processes in a watershed, road-related erosion is often the most easily identified and cost effective to treat. Successful treatments for erosion prevention and erosion control along County roads should be designed to treat the erosion process (episodic vs. chronic erosion). Not every source of road-related sediment can be completely eliminated or prevented, but much of it can be managed if a prioritized plan of action is developed using the most effective and cost-effective methods for reducing the risk of erosion or reducing the volume of eroded sediment that is delivered to streams. In the Napa River watershed, an assessment of County roads at locations where they cross major streams has been conducted in conjunction with the County Roads Department and a prioritized action/treatment list has been developed with possible treatment options. (Birmingham, Napa County Resource Conservation District, 2014)

Chronic Erosion

Surface erosion results from raindrop impact and un-channeled water flowing over bare soil during and after rainstorms. Exposed soil is a common feature along roads, and anywhere there is bare soil there will be surface erosion. This includes cutbanks, ditches, turnouts and unpaved sections of road. Surface erosion turns into sediment delivery when the runoff discharges into a stream channel, often through rills or small gullies, or directly through road ditches. Road lengths that discharge flow or sediment to stream channels are termed "*Hydrologically connected roads*".

<u>Sediment Control Principles for Surface Erosion</u>

- Keep bare soil to an absolute minimum when conducting land use activities.
  This is the single most effective method for preventing land use related surface erosion.

- Mulch or vegetate bare soil adjacent to stream channels, or other flow transport paths, to the break-in-slope near those areas.
- Keep runoff from bare soil areas well dispersed. Dispersing runoff keeps sediment on-site and prevents sediment delivery to streams.
- Direct any concentrated runoff from bare soil areas into natural buffers of vegetation or to gentler sloping areas where sediment can settle out.
- Prevent rills by breaking large or long bare areas up into smaller patches that can be effectively drained before rills can develop.
- Disconnect and disperse flow paths, including roadside ditches, which might otherwise deliver fine sediment to stream channels.

Episodic Erosion

Stream Crossing Washout

A *stream crossing* is a ford or structure on a road (such as a culvert or bridge) installed across a stream or waterway (USDA Forest Service, 2000). When they erode, sediment delivery from stream crossings is always assumed to be 100%, because any sediment eroded is delivered directly to the stream. The size of the stream affects the rate of sediment movement, but any sediment delivered to small ephemeral streams could eventually be transported to downstream fish-bearing stream channels.

Large volumes of erosion may occur at stream crossings when the crossing is too small for the drainage area and storm flows exceed capacity, or when crossings become plugged by sediment and debris. In these instances, flood runoff will spill across the road, allowing erosion of the stream crossing fill and development of a *washout crossing*.

Serious erosion problems may occur at a stream crossing that has *diversion potential*. This is usually associated with stream crossings whose void space is smaller than the area of the flowing stream channel (e.g., culverted stream crossings). Stream diversion can occur at stream crossings when, if flooded, the stream flow spills onto the road surface and flows down the road outside the natural hingelines of the stream channel. When this occurs the roadbed, hillslope, and/or stream channel that receive the diverted flow may become deeply gullied or destabilized. Hillslope gullies can develop and enlarge quickly and deliver large quantities of sediment to stream channels (Hagans et al., 1986). Stream flow that is diverted onto steep unstable slopes may also trigger hillslope landslides and large debris flows. Because of the variability of erosion that can occur due to diverted stream flows, it is difficult to accurately determine the future erosion volume at these sites.

Sediment Control Principles for Stream Crossings

- Where feasible, size the stream crossing to pass 100-year peak storm flow
- At culverted stream crossings install the culvert at channel grade and base of fill.
- At cuvlerted stream crossings install a ‘single post trash rack’ above the culvert inlet to reduce plug potential (Appendix A).
- At culverted stream crossings, on paved roads, with diversion potential, install a ‘critical culvert’ on the lower hingeline to capture diverted flows and return the flow back into to the natural stream channel (Appendix A).
- At culverted stream crossings on unpaved roads, with diversion potential, install a

‘critical dip’ on the lower hingeline to capture diverted flows and return the flow back into the natural stream channel (Appendix A).

Gully Erosion

Gullies, eroding channels greater than 1 ft^2 cross section, form when concentrated runoff scours and erodes soil along its path. Along County roads, gullies are commonly found where road surface runoff has been collected and then discharged on adjacent hillslopes, where “shot-gun” culverts discharge onto erodible fill slopes, or where stream crossing culverts have plugged and overtopped.

Gullies are most commonly located below the outlets of ditch relief culverts, berm drains and below berm breaks; at shotgun culverts; on stream crossing fill slopes; and where runoff from upslope private properties flow over the road cut slope. The largest gullies often form when a stream-crossing culvert plugs and flow overtops the road.

The rate at which a gully can form is a combined function of the flow volume or flow velocity and soil erodibility. All else equal, the greater the flow, the greater the gullying or bank erosion. Similarly, the more erodible the soil type the more soil loss will occur. Fine grained granular soils, like silt and sand, are most likely to erode; and rocky soils and bedrock are the least likely to erode.

Gullies usually form during large storm events, but they can also be a chronic source of sediment where gullies gradually increase in size or stream banks continue to erode during small and moderate runoff events. The large storm events usually trigger greatly increased fluvial erosion, as new gullies form and existing gullies enlarge.

Gully erosion is generally a very efficient sediment delivery mechanism. The larger a gully system, the more likely the eroded sediment will be delivered directly to a stream channel. Erosion rates can vary greatly between watersheds, depending on soil types, land use and land management practices. Finally, even gullies that have been stable for years can serve as efficient conduits for fine sediment delivered from other sources, such as road surfaces and ditches. Gullies are like conveyor belts; any sediment delivered to a gully system from another sediment source such as road surface runoff or cut bank erosion, is likely to deliver to a stream channel somewhere down slope.

<u>Sediment Control Principles for Gully Erosion</u>

- Prevent gullies by dispersing runoff from road surfaces, ditches and construction sites, by correctly designing, installing and maintaining drainage structures (e.g., road shape, ditch relief culverts, etc.) and by keeping streams in their natural channels. No single point of discharge from a road or other disturbed area should carry sufficient flow to create gullies. If gullies continue to develop, additional drainage structures are needed to further disperse the runoff.
- Direct any concentrated runoff from bare soil areas, such as road surfaces, into natural buffers of vegetation, or to areas where sediment can settle out of the runoff.
- Dewater active gullies to prevent their enlargement and to reduce their capacity for sediment transport.

- Dewater old gullies, even if they are not actively eroding, so they no longer carry fine sediment to streams.
- When dewatering is not possible, options include channel armoring and grade control structures. However, these specialized erosion control techniques are more costly and less effective than prevention and dewatering gullies. Channel armoring and grade control structures typically require specific design, proper installation, and a commitment to maintenance.

Mass Wasting

The two most common road-related types of mass wasting / landslides are fill slope failures along the outer half of a road built on steep slopes and cutbank failures where the natural hillslope has been undercut by road construction. Where roads are unstable, it is usually because of poor construction or maintenance practices (e.g., the use of uncompacted fills, fills containing organic debris or sidecast spoil disposal) or because of the location where they are built (e.g., steep slopes, unstable geologic materials or soils, or undercutting by stream bank erosion). Unstable roads are most commonly located on steep hillslope areas, and on soils or geologic materials that are regionally know to be unstable. Roads, especially wide roads, increase the frequency of landsliding by undercutting hill slopes, sidecasting poorly compacted fill onto steep slopes, and discharging road runoff onto potentially unstable slopes.

In many watersheds in California, mass wasting is a very important process of episodic (storm-triggered) sediment production and delivery to streams. Bigger storms are noted for increasing numbers of landslides, and this is especially true along roads. Some unstable fill slopes and cut banks fail all at once, while others show signs of instability for years before suddenly sliding. Signs of unstable road fillslope include cracks and scarps in the roadbed, and leaning trees on the fill slope. Signs of cutbank instability include leaning trees, scarps and the occurrence of failures, slumps and gullies that deposit material on the roadbed. These signs can be used to predict the location of road failures and to implement preventive treatments.

Landsliding creates sediment delivery when material slides into a stream channel. Some types of landslides are efficient at delivering sediment to streams while others rarely result in sediment delivery. Factors affecting direct sediment delivery from fill slope landslides include proximity to a stream, slope steepness, slope shape, moisture content, and soil composition. Road cutbank landslides are notoriously frequent where roads cross steep hillslopes, but typically lack major amounts of sediment delivery unless the material is transported by inboard ditch flows or they are large enough to pass over the road and continue downslope. In contrast, road fill-slope failures are less frequent but result in direct sediment delivery when they are located close to a stream channel. Very few landslides deliver all their material to a stream. Some sediment is usually stored on the hillslope before reaching the stream.

<u>Sediment Control Principles for Mass Wasting</u>

- In general, the smaller the landslide, the more easily it can be prevented or controlled. In contrast, larger management-related landslides may be preventable, but they are very expensive to control once they begin sliding.
- Prevent accelerated landsliding by avoiding, minimizing or eliminating the practice of “sidecasting” to steep or streamside hillslopes.

- Divert surface runoff and subsurface drainage to stable sites away from steep, unstable or potentially unstable slopes.
- Small fill slope landslides are often effectively prevented or controlled by direct excavation of all or most of the potentially unstable material. This is often the most effective and cost-effective technique for preventing road-related fillslope landslides. If the roadbed is too narrow, move the road into the cutbank (cheapest) or rebuild the road with a structurally reinforced fill (most expensive).
- Control sediment delivery from some medium and large size fill slope landslides by excavating and removing material at the head of the slide. Removal of mass from the top of a slide may unload the slide sufficiently to stabilize the remaining mass. The amount of unloading required is a technical question that requires professional analysis, and the outcome of the unloading is not a certainty. A trained engineer or geologist should be consulted.
- The most cost-effective sediment control treatment for large, uncontrollable landslides is often direct excavation and removal of slide material poised for delivery to a stream. This is the one-for-one rule where every cubic yard of material removed is a cubic yard not delivered to a stream by continued landsliding. This technique reduces sediment delivery but does not prevent or control landslide movement.
- Sediment delivery from most cutbank landslides is not as great as fillslope failures. Excavate landslide debris that is deposited on the road or in the ditch and haul it to a stable disposal site.
- Large, old landslide scars are ugly but the main process is often surface erosion and gullying of the surface. These processes are often difficult and costly to control due to the extremely steep slopes and harsh site growing conditions.
- Revegetation is a valid long-term restoration technique for unstable and potentially unstable slopes, but revegetation is sometimes very difficult and the benefits may take decades to occur.

HYDROMODIFICATION

In rural watersheds, road systems may be a significant source of sediment to streams and they may also be significant in their ability to alter the hydrology of the watershed. Road lengths that discharge flow or sediment to stream channels are termed "*hydrologically connected roads.*" Many constructed roads collect surface flow from the landscape and concentrate that runoff into discrete discharge points thereby increasing the flow volumes that the stream channel would normally experience relative to the storm event. Increasing the volume of water to a stream channel causes the stream to incise and erode its banks to accommodate the larger flows. Channel incision and bank failures are an erosional concern identified in the sediment TMDL for the Napa River.

Along with channel incision and bank failures, concentrating surface runoff into stream channels can cause higher stream flows during the wet season and less stream flow during the dry season. If surface runoff is allowed to percolate into surrounding soils then the groundwater system can be recharged, which may contribute to sustaining flows during summer months. These summertime flows are necessary to sustain various aquatic species until the following years rain brings increased flows to the watershed. Sizing stream crossings for the 100-year storm event and dispersing road runoff as frequently as possible are some of the ways to allows the road system to become hydrologically invisible in the watershed.

"BIG THREE" COUNTY ROAD MAINTENANCE AND DESIGN CHALLENGES

Public roads are often at a disadvantage in meeting today's water quality objectives. They were usually designed and constructed many decades ago, and many are located in riparian zones so close to streams that water quality impacts cannot be avoided. They were often built to follow early private road alignments, for convenience, and to minimize construction costs. Water quality protection was not likely an important consideration. Although elements of poor location cannot be easily addressed, design deficiencies can be solved through a program of gradual upgrading and long-term maintenance activities.

Three of the most common sources of road-related water quality impacts are often exhibited in County roads: 1) road surface drainage, 2) stream crossings, and 3) slope stability.

1) Road Surface Drainage Design

Standard drainage engineering practice calls for the collection, concentration and rapid discharge of road runoff into natural stream channels. This is the way roads have historically been designed. County roads often have long ditches that are hydrologically connected to nearby stream channels. That is, they carry surface runoff and fine sediment in ditches and these ditches discharge the flow into stream channels, either directly or through points of connectivity such as ditch relief culverts and gullies.

Four types of road features contribute to the continuing problem of "hydrologic connectivity" and its impacts on water quality. These include features or structures that collect and concentrate road surface runoff, and structures that then deliver the runoff and fine sediment to stream channels. These collecting and delivering road drainage structures are the very things that can be redesigned and modified to reduce water quality impacts from County roads while still satisfying requirements for public safety.

- *Road surface shape* (i.e. insloped, outsloped or crowned) determines whether all or a portion of the runoff, including road-related sediment and chemical pollutants are delivered to inboard ditches or dispersed onto the adjacent hillslopes. Most of the County roads are paved, and this limits the amount of surface erosion that occurs throughout the road system. However, cutbanks, turnouts, ditches and many private drives are not surfaced, and they contribute storm runoff and eroded fine sediment to the road's surface drainage system, and ultimately to local stream channels.
- *Inboard ditches* are designed to collect and deliver road run-off and road- and cutbank-derived sediment directly to ditch relief culverts or road-stream crossings. This is classical engineering design for road surface drainage systems. Problems with inboard ditches from a water quality perspective include erosion and down-cutting within the ditch, plugging of ditch relief culverts, alteration of natural hillslope drainage patterns, collection of emergent groundwater, and increased volume and velocity of runoff in both the ditches and adjacent stream channels. In more urbanized areas, road drainage can deliver pollution from private driveways, as well as fertilizers, insecticides and herbicides from yards.
- *Cross-road drainage structures,* such as ditch relief culverts, often collect and discharge sufficient water to create gullies on hillslopes below the road. Likewise, water rapidly discharged from road ditches into natural drainage channels can increase a channel's normal water load and force the channel to adjust by eroding its banks.

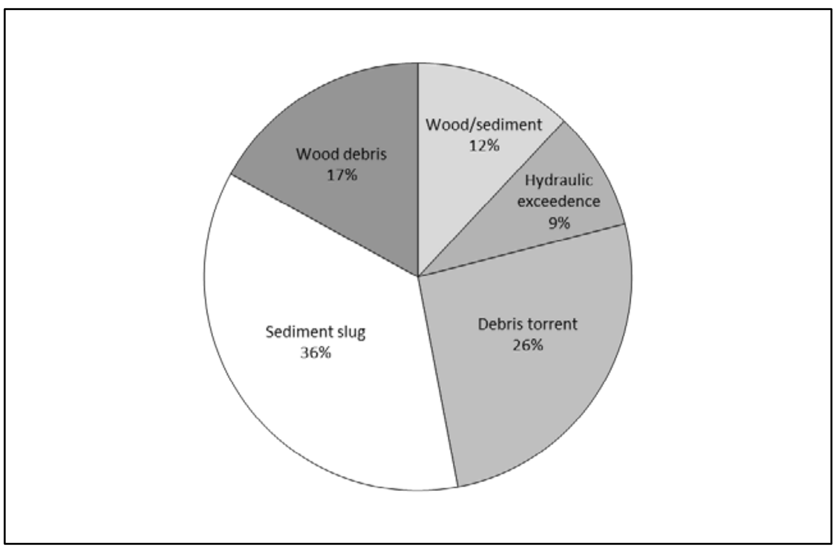
- *Berms* created along the outside edge of County roads can retain and concentrate runoff over long road distances, similar to a ditch. Infrequent or inadequate berm breaches concentrates runoff and can cause the creation of hillslope gullies or deliver road-derived sediment and pollutants directly to stream channels.

2) Stream Crossings

Most existing stream crossings on County roads were built decades ago, and many impact water quality and aquatic resources, including listed salmon species. In the Napa River watershed, an assessment of County roads at locations where they cross major streams has been conducted in conjunction with the County Roads Department and a prioritized action/treatment list has been developed with possible treatment options. (Birmingham, Napa County Resource Conservation District, 2014)

Culverted stream crossings are the weak-points in most road systems. Only a small percentage of culverts are sized to pass the 100-year design flow that is the current standard across California's wild lands. In addition, culverts that are undersized are more likely to fail by *plugging* with organic debris and sediment (Figure 5.1). Many County road stream crossing culverts have not been designed to accommodate (pass) organic debris and heavy sediment loads. Finally, culverts installed decades ago were often set high in the fill, not at natural channel grade, and often out-of-line with the natural channel. Culverts set in shallow relative to channel grade encourage plugging, increases maintenance, and can result in severe outlet erosion where shotgun culverts discharge onto unprotected fillslopes or streambanks.

Figure 5.1 Failure mechanisms at culverted stream crossings n = 258 (Furniss et al. 1998)



Stream diversion potential is a design flaw in culverted stream crossings on County roads, and elsewhere. When a culvert plugs, or its capacity is exceeded during a flood event, flood waters can only go two places: 1) across the road, over the fillslope, and back into the natural stream channel, or 2) divert down the road and into another culvert or onto an adjacent hillslope. In general, the diverted stream is much more likely to cause severe off-site erosion, property damage, and water quality impacts. Park et al.(1998), reported that "…diversions increased sediment delivery 2 to 3 times over sediment that is delivered if the water is not diverted and erodes only the road fill at the crossing." Stream diversions can lead to inboard ditch erosion, additional stream crossing failures or diversions where diverted stream flow overwhelms culverts down the road, erosion and enlargement of natural stream channel dimensions, severe hillslope gully erosion, or it can trigger off-site road fillslope and hillside landsliding.

Fish passage is a stream crossing design consideration that must be considered today in much of the Napa River watershed. Because of their location, County roads often parallel and cross streams that are, or once were, used by anadromous salmon and trout for spawning or rearing. Until recently, stream crossing designs did not consider fish passage requirements, let alone the need for passage at all stages of the salmon's life cycle. By not considering this design element in their original construction or in subsequent culvert replacements, many stream crossings on County roads could be upgraded to provide for improved fish passage.

Ford and Armored fill crossings work well on unpaved, seasonal-use roads at small to medium sized streams where there is a stable stream bottom and traffic is light. These crossing types may be needed if there is insufficient channel depth to install a culvert. In fact, a rock lined rolling dip with a rock apron face is generally more desirable than permanent culverts on these swales and small waterways. These crossing types have the advantage of never plugging, not rusting out, not having diversion potential, and, if designed properly, being constructed to pass the 100-year peak flow event. However, "construction" of these types of crossings on well-traveled roads should be avoided where water is flowing because of their potential to impact water quality. Therefore, this crossing type should be considered carefully before being selected for a County-maintained road. See Chapter *6.7 Ford and Armored Fill Crossings.*

A Ford crossing is a crossing where no fill material is put into the stream channel. Fords of live streams, called "wet fords," are typically composed of streambed gravels, or concrete structures built in contact with the streambed so that vehicles can cross the channel. See *Appendix A* for typical drawings and construction details.

Streams with high stream banks that would require the excavation of substantial ramps to get vehicles down to the streambed may be good candidates for the construction of an 'Armored Fill' crossing. The fill material that is imported into the streams crossing needs to be rock armored to prevent erosion during periods of runoff. The fill face on the downstream side of the fill should be protected with rock armor of a large enough size class that it cannot be moved by stream flows. See *Appendix A* for typical drawings and construction details. If possible, a stable, rocky (or bedrock) portion of the channel should be selected for these crossings. These crossings could be a barrier to migrating fish and installation requires approval by the Department of Fish and Wildlife.

Ford and armored fill crossings can be vulnerable to erosion and can create pollution from several sources. High traffic levels and/or high water flows can cause erosion of both natural and artificial streambed materials. Material placed in the stream or moved about by vehicle traffic can create a barrier to fish migration. Deep water crossings can cause oil products to be released from vehicles as they pass through a wet ford. Streams with high stream banks require the excavation of substantial ramps to get vehicles down to the streambed. These through-cut ramps are often sites of substantial surface erosion and rilling that enters the stream during periods of winter rain.

3) Slope Stability

Landslides are usually triggered by storms and floods. They episodically contribute sediment directly to stream channels via fill failures or indirectly through cutbank landslide cleanup and other spoil management or road maintenance practices. Historically landslide prevention work has been designed and undertaken to keep roads open and not with the explicit goal of water quality protection. Similarly, spoil management was a maintenance practice designed and conducted to keep roads clear, and not as a tool to protect and maintain water quality and fish habitat. Design standards and maintenance practices for county roads now need to actively consider water quality protection when identifying and treating potential fill failures and when planning and conducting spoils disposal from road-related landslides.

Fillslopes exhibiting tension cracks or scarps along the outer half of a road may forecast a future landslides that can deliver sediment to nearby streams below the road, especially on very steep slopes. Water focused improperly onto fillslopes by ditch relief culverts or berm breaches may further destabilize the road edge and cause erosion below the road shoulder. Some roads are so close to streams that the fillslope encroaches on the stream and fill failures are quickly delivered to the channel.

Cutbank slope failures are unpredictable yet common along County roads. They deposit most of the slide material on the road prism and in the inboard ditch. As slope failures, cutbank slides usually deliver low volumes of material to streams, except for minor surface and gully erosion of the slide deposit washing fine sediment into inboard ditches and then into streams. The major concern with cutbank slides is spoil disposal: the slide material must be placed in a location and in such a way that it will not impact water quality.

Spoil disposal from all landslide and road-related maintenance and clean-up activities is a concern for the County road system, as County road management actions must be confined to the road right-of-way. Standards for spoil disposal have gone from free sidecasting prior to about 1985, regardless of location, to today's near total prohibition of sidecasting of spoil materials. Where spoils are stored, it is important to periodically monitor the storage sites before and throughout the winter season and to utilize appropriate practices such as straw wattles or spoil covers to prevent runoff from the disposal site.

PRINCIPLES FOR REDESIGNING COUNTY ROADS FOR WATER QUALITY PROTECTION

In this section a three-pronged process is proposed, called "storm-proofing," for redesigning and treating County roads to lessen their impact on water quality, while still meeting transportation and safety objectives. This approach is complemented by a series of principles that can be used to identify, prescribe, prioritize and implement road- upgrading techniques. Storm-proofing consists of specific road upgrading and maintenance practices designed to lower the frequency and magnitude of stream crossing and road fillslope failures, and to reduce both episodic and chronic sediment delivery to streams.

The poor location of some County roads contributes to their impact on water quality. Designing for better locations is generally not a practical solution to road-related water quality problems because property lines and rights-of-way are legally fixed. With few exceptions, such as road alignments through public lands, County roads will remain where they are. For this reason, the main tools that are available to protect water quality include specific practices designed to make roads more resilient to infrequent, large storms and erosion, and to reduce their chronic discharge of fine sediment and turbid runoff.

Storm-Proofing County Roads

The fundamental design components of a storm-proofed County road are simple in concept, and there are a number of alternative methods or practices that can be used to achieve these objectives. See the Table below for a simplified check list of features to help in determining if a road is storm-proofed.

Characteristics of Storm Proofed Roads
The following abbreviated criteria identify common characteristics of storm-proofed roads. Roads are storm-proofed when delivery to streams is strictly minimized. This is accomplished by dispersing road surface drainage, preventing road erosion from entering streams, protecting stream crossings from failure or diversion, and preventing failure of unstable fills from delivering sediment to a stream. All bare soils with potential to deliver sediment to streams should be seeded and straw mulched before any rain events occur.
Storm-proofed stream crossings ✓ All stream crossings have a drainage structure designed for the 100-year peak storm flow (including debris). ✓ Culverts are set-in at base of fill and at channel grade. ✓ Culvert inlet, outlet, and bottom are open and in sound condition. ✓ Stream crossings have no diversion potential (functional critical dip/critical culverts are in place). ✓ Stream crossing inlets have low plug potential (debris / trash barriers installed). ✓ Stream crossing outlets are protected from erosion (extended beyond the base of fill and/or dissipated with rock armor). ✓ Bridges have stable, non-eroding abutments and do not significantly restrict 100-year flood flow. ✓ Stream crossings on fish bearing streams meet CDFW and NMFS fish passage criteria. ✓ Decommissioned stream crossings have been completely excavated to original grade and side slopes are laid back to 2:1 where possible.
Storm-proofed fills ✓ Unstable and potentially unstable stream crossing and road fills are excavated or structurally stabilized. ✓ Excavated spoil is placed in locations where it will not enter a stream. ✓ Excavated spoil is placed where it will not cause a slope failure or landslide.
Road surface drainage

- ✓ Year round use roads are either paved or rocked well enough so that none of the native surface is visible and raindrop impact is absorbed by the applied surface.
- ✓ Un-surfaced roads are either closed during rainy periods of the year or are not used when the road surface is wet.
- ✓ All road surfaces are disconnected from streams by implementing a variety of surface drainage techniques including berm removal, road surface shaping (outsloping, insloping, or crowning) and installing rolling dips, ditch relief culverts, and /or waterbars.
- ✓ Ditches and cutbanks are disconnected from streams by frequently draining them with rolling dips &/or ditch relief culverts.
- ✓ Outflow from rolling dips and ditch relief culverts do not discharge to streams or onto active (or potentially active) landslides.
- ✓ Gullies (including those below ditch relief culverts) are dewatered to the extent possible.
- ✓ Decommissioned roads have been de-compacted (ripped) and have frequently installed permanent drainage structures (cross road drain) to prevent runoff contribution to streams.

A STRATEGY FOR IMPLEMENTING CHANGE

A three-step process can be used for achieving storm-proofed roads:
- Identifying problems and prescribing treatments
- Prioritizing proposed erosion prevention activities (to take advantage of limited funds)
- Implementing upgrading work

A forward-looking sediment inventory, one that identifies treatable sites of future erosion and sediment delivery, is first conducted along a County road system. This inventory utilizes field assessments that are based on logical, standardized, science-based observations, measurements, and deductive reasoning (CDFW, 2004). The goal of this uniform data collection and resultant inventory is to deliver a storm-proofing and road upgrading plan that:
- Identifies the nature and magnitude of the erosion and sediment delivery problems;
- Provides quantified risk assessment data;
- Estimates the volume of sediment that could be prevented from delivery to streams;
- Develops a prioritized list of treatment prescriptions and associated cost estimates.

Data analysis is performed when all the inventory information has been collected and properly entered into a database. The use of a database allows for rapid data analysis, cost analysis, and prioritization. Data tables developed for a restoration plan should contain summary information regarding the number of sites recommended for treatment, erosion potential, treatment immediacy (priority), potential sediment savings, recommended treatments, materials costs, estimated heavy equipment and labor hours and costs. This information will help managers to schedule and prioritize future projects.

Cost effectiveness should also play a part in the prioritization of treatment sites. The cost-effectiveness of treating a site is usually defined as the amount of money needed to prevent the amount (cubic yards) of sediment from entering stream system (Weaver and Sonnevil, 1984). Cost-effectiveness is determined by dividing the cost ($) of treating a site, or group of sites, by the volume of sediment prevented from being delivered to local stream channels ($/yd^3). The key elements in determining cost-effectiveness are a fair and accurate estimate of future sediment delivery (in the absence of treatment) and a reasonable estimate of treatment costs.

Once sites are prescribed and prioritized, and funding has been secured, storm-proofing projects are implemented. For water quality and fisheries protection, the goal of upgrading County roads is to minimize the contributions of fine sediment from roads and ditches to stream channels, as well as to minimize the risk of episodic erosion and sediment delivery when storms and floods occur. The most important of these include upgrading stream crossings to meet a desired storm event (e.g. 100- year storm event), preventing culvert plugging and failure, eliminating stream diversion potential, removing unstable sidecast and fill materials from steep slopes, and applying drainage techniques to improve dispersion of road surface runoff. A complete assessment plan will define which are the most critical and most cost-effective projects to undertake first. In the Napa River watershed, through the sediment TMDL process, the Regional Water Board identified stream crossings as a priority for Napa County roads. Hence, an assessment of crossings was conducted and a prioritized implementation plan was developed. (Birmingham, Napa County Resource Conservation District, 2014).

Principles of Storm-Proofing Implementation

Below are six fundamental road assessment and treatment principles, which if observed, will go far in protecting water quality and stream habitat. Ensuring that roads are open and safe to the traveling public remains the number one priority, and water quality and habitat goals can be concurrently achievable.

These principles are straightforward and sometimes obvious, but many are not systematically or routinely applied. Most principles are simple procedures or ways of thinking about and seeing road-related problems in a new light, and formulating long- term solutions. Developing these thoughts and supporting these principles through in- house training, education, field trips, and implementation practices will encourage managers and field maintenance staff to think about ways they can achieve their transportation, safety and environmental goals. Conducting road storm-proofing requires both recognition of problems and solutions, as well as a long term commitment to gradually chip away at prioritized projects, and to seek needed funding, in a process that will likely be measured in decades, not years.

<u>Principle #1. Treat causes, not symptoms</u> – Learn to recognize the true cause of erosion and attack the cause, not the symptom, of erosion and sediment delivery.

If the cause of culvert failures, stream diversions, fillslope failures and road connectivity are not addressed, water quality degradation and road failures will continue to occur.

For example, repeatedly cleaning undersized culverts of accumulated sediment and debris is treating the symptom of the problem. The problem is that the culvert is not properly designed to effectively handle woody debris or heavy sediment loads, and treating the cause would entail the installation of a larger culvert or a debris barrier. Another example would be the treatment of gullying below a ditch relief culvert or berm drain outlet. Armoring the slope or gully to prevent continued erosion on the hillslope would be a symptomatic treatment, whereas reducing the volume of flow to the culvert or berm drain, by installing additional drainage structures along the road, would address the cause of the problem.

In order to begin the process of lowering the risk of future erosion and sediment delivery, many counties in California have undertaken comprehensive inventories and assessments along their roads. The assessment of both chronic and episodic sediment sources utilize Fish and Wildlife approved road assessment, erosion control, and storm-proofing protocols (CDFW, 2004, Chapter 10) and culvert inventory protocols to evaluate and correct fish passage (CDFW, 2003, Chapter 9).

These approved approaches provide managers and engineers with a prioritized “action plan” which defines which stream crossing sites or road reaches pose a higher risk of ongoing or future sediment delivery to streams and impacts to water quality. Likewise, the methods provide a systematic method for identifying and correcting County stream crossings that restrict or prevent fish passage. These procedures allow County staff to evaluate the extent and magnitude of the sediment production risk or fish passage problems, and serves as a long term planning tool for identifying and prioritizing road storm-proofing and upgrading activities, and correcting fish passage problems. In the Napa River watershed refer to an assessment of stream crossings that was conducted in 2014.

<u>Principle #2. Fix problems, don’t apply band aides</u> - Changing things that don’t work is the only way to improve road performance and protect water quality - if you don’t change things, reoccurring problems will reoccur.
The only sure way to improve the response or behavior of a road and prevent water quality problems is to change site conditions so that they are less susceptible to failure. For example, cleaning plugged culverts during a winter storm does not solve the problem of a high plugging potential. In contrast, culvert plugging potential nay be permanently reduced by the installation of a larger culvert sized to pass the 100-year flood flow, placement of a debris trash rack upstream from the culvert inlet, or installation of a flared inlet.

<u>Principle #3. Be forward-looking and use prevention strategies</u> - It’s generally more effective and less expensive to prevent erosion than to control, repair or potentially pay fines for road damage and sedimentation.
Once erosion gets started, it can be very costly, or even impossible, to control. A properly designed and upgraded road or construction site saves money in the long run; it needs less short- and long-term maintenance, and it prevents catastrophic failures and expensive repairs. Once sediment is introduced to a stream channel, it can rarely be efficiently removed. Both state and federal agencies with responsibility to enforce the Clean Water Act and the Endangered Species Act are increasingly looking at County road practices and activities that impact water quality. Water quality violation can result in large fines that should be viewed as part of the cost of not preventing erosion. Consequently, effort should be made to recognize where sediment is being delivered to any stream, and to develop a treatment prescription that either prevents future sediment delivery or minimizes the volume of sediment delivery.

<u>Principle #4 – Expect and anticipate floods</u> – Apply practices and install structures that have been designed to withstand 100-year flood events.
Large magnitude winter storms create the most havoc with road systems. Don’t design your roads to “get by” during the average winter, and don’t guess at what needs to be done to storm-proof your road. Don’t replace what’s already there with the same thing or with what you might

have available in the culvert yard simply because you have the correct size. Similarly, if a stream-crossing culvert is undersized and is to be replaced, don't guess what size culvert should be installed. Conduct road assessments in advance and then consult and use these assessments in the normal course of road upgrading and maintenance work. It is important that road supervisors know how to use and apply these plans. Such foresight and planning will minimize future stream crossing failures, prevent stream diversions, and reduce the number and size of road fill failures.

Principle #5. Disconnect and disperse runoff – Where possible disperse road and ditch runoff frequently to prevent gullying and to disconnect road surface runoff and ditch flow from natural stream channels.
Chronic erosion and sediment delivery from roads impacts stream channels every year. In order to disperse (not collect) roadbed runoff, convert insloped and flat roadbed shapes to outsloped or crowned road beds to provide for regular drainage. Likewise, install frequent drainage structures (rolling dips on unpaved roads, ditch relief culverts, berm breaks) along roadbeds and inboard ditches to disperse road runoff.

Principal #6 – Think and act long-term - Envision how your project will function in the first storm, and in the "big" storm; recognize ways you can anticipate and avoid potential negative impacts or future problems while increasing resource protection resulting from road upgrading and road maintenance practices.

- Predicting performance - Envision project performance and how your project will function in the first storm, and in the "big" storm. Don't just do things because you've always done it that way. Always consider the unintentional effect and impact of your work. Envision your project or maintenance work as it responds to heavy winter rainfall and runoff events; where will runoff go and how much will occur? See your work through the "eyes" of a raindrop and a rivulet of runoff during the first winter storm, and through the "eyes" of the fish in the stream that may receive that runoff.
- Riparian protection - The riparian zone is the land and vegetation adjacent to lakes, waterway, estuaries, and wetland areas. Protecting and restoring healthy riparian zones is the best defense for maintaining a healthy stream. The plants in the riparian zone create cool water temperature, supply large wood needed for fish habitat, and filter sediment and pollution before it reaches the stream. Riparian zones also provide stream bank and hillslope stability, help with channel stability and promote high quality fish and wildlife habitat.
- Vegetation and revegetation - Protect and retain existing vegetative cover. Plant cover provides your cheapest form of effective and long-term erosion control. Native grasses, shrubs and trees help stabilize cut and fill slopes. Make sure a revegetation plan is included as a final element of all road-upgrading projects, especially those involving vegetation removal. A vegetation management plan should address the removal of invasive non-natives.
- Fish passage - When replacing or upgrading stream crossings on salmon and steelhead bearing streams, your project needs to provide for fish passage. No stream crossings should block the upstream or downstream migration of salmon and steelhead at any life stage. Monitor structures for performance during the winter season. Consult with a qualified fisheries biologist or engineer who is trained in evaluating and implementing fish passage projects.

- <u>Maintenance monitoring</u> - Monitor conditions and record and report your observations to appropriate division supervisors. Prioritize your response to problems to prevent more serious failures and sediment problems. Develop a “maintenance-monitoring” system for recording problems and tracking maintenance performed at sites, and keep these records in an electronic database. Over the years, as personnel come and go, this record will become the institutional memory of the County road system. Storm inspections, repairs, and maintenance monitoring are critically important tools to prevent serious damage to resources. County road engineers and transportation planners may not be aware of recurring problems on a road. It is crucial that the County road maintenance department promptly alert engineering staff or management about significant problems and the potential impact on waterways so that alternative solutions to address the problem can be developed and evaluated. Maintenance monitoring is a tool to help accomplish this. Balancing the public’s need for safe and open roads with the environment’s need for clean water and healthy streams are challenging but not impossible.

For further reference on protecting aquatic habitat while conducting road and culvert related restoration projects, see the Department of Fish and Wildlife Salmonid Stream Habitat Restoration Manual, Chapters IX and X. Flosi et al, 2002.

HELPFUL REFERENCES

Birmingham, Bill, Napa County Resource Conservation District (2014). Assessment of the Stream Crossings along County-Maintained Roads in the Napa River Watershed.

California Department of Fish and Wildlife (2002) California Salmonid Stream Habitat Restoration Manual. Flosi et al. https://www.wildlife.ca.gov/

Hagans, D.K., Weaver, W.E., and Madej, M.A. (1986). Long-term on-site and off-site effects of logging and erosion in the Redwood Creek Basin, Northern California, *in* Papers presented at the American Geophysical Union meeting on cumulative effects (December 1985): New York, NY, National Council for Air and Stream Improvement Technical Bulletin, no. 490, p. 38-66.

Park, C., C. Ricks, C. Risley, M. Weinhold, J. McHugh, E. Gross, R. Wiedenbeck, and R. Frick. 1998. *Storms of November and December 1996, Siskiyou National Forest, Grants Pass, OR.* Preliminary Assessment Report.

USDA Forest Service (2000). Water/Road interaction field guide: San Dimas, CA, San Dimas Technology and Development Center, 68 p.

USDA Forest Service (1998). Response of Road-Stream Crosings to Large Flood Events in Oregon, and Northern California. Furniss et al.

Weaver and Sonnevil. 1984. Assessment and Implementation Techniques for Road-related Sediment Inventories.

5.2 PAVED ROAD SURFACES

DESCRIPTION

Paved road provides a safe roadway surface for the traveling public and prevents roadway deterioration or failure. Repair activities include: pothole and square cut patching; replacing base and surfacing; repaving; extending pavement edge; paving graveled shoulder; crack sealing; overlay; chip seal; slurry seal; pavement marking; traffic channelization; addition of traffic control features and removal of excess material for disposal or recycling. See *5.4 - Shoulder Maintenance*, 6.2 *–Culvert Cleaning, Repair and Replacement*, and Appendix A *Road Drainage BMPs* for best road design and drainage engineering techniques to use to prevent erosion and protect habitat.

ENVIRONMENTAL CONCERNS

The major risks during maintenance of paved road surfaces are:

- Harm to riparian vegetation.
- Discharge of the following materials into a stream channel, stormwater drainage or riparian area:

Sediment, asphalt concrete binder, liquid asphalt, asphalt concrete (AC), asphalt emulsion, sealant material, Portland cement concrete (PCC), concrete rinse water, concrete grindings and cuttings, concrete waste, and diesel oil.

BMP OBJECTIVES

- Minimize road-related materials entering storm drain inlets and waterways.
- Reduce sediment entering storm drain inlets and waterways.
- Prevent or minimize interruption of natural hillslope and stream runoff patterns (hydromodification).

BEST MANAGEMENT PRACTICES

<u>GENERAL</u>

1) Inspect all road and drainage facilities after the 25-year storm event. Document locations of road surfaces, drainage features, cutslopes, and fillslopes that appear to be failing and contributing sediment to streams. Provide a report of failures to road managers so that a prioritized maintenance or repair schedule can be developed. Standardize the monitoring documents and reports so that they can be used and compared over time.

2) Regularly inspect equipment for leaks, damage, and oil or grease buildup before starting work, and periodically re-check the equipment in the field as it is being used. Use non-organophostate hydraulic fluid. Place drip pans under any equipment needing emergency service or repair in the field. Except in emergencies, always take equipment and vehicles to a repair facility for maintenance.

3) Set-up work area to minimize environmental impacts:

- Identify riparian areas (areas adjacent to waterways) and keep equipment out of them.
- Designate areas for parking, fueling and minor equipment maintenance (during and after shifts) where pollutants will not be discharged to waterways or storm drains.
- Park paving equipment over drip pans or absorbent materials.

4) Identify storm drain inlets, manholes, ditches and waterways before beginning work. If there is any risk of discharge of sediment or road-related material, protect storm drains and the work site with appropriate erosion control and sediment management BMPs. Make sure any wash water is contained locally, and that none is discharged into a storm drain, ditch, or waterway.

5) Make sure personnel are trained to respond appropriately to spills. Carry a spill kit for immediate cleanup of any spills related to equipment failure. Do not hose down the work area or pour any materials down drains or into ditches.

6) Dispose of all excess materials from paved road maintenance activities at designated sites consistent with spoil disposal and stockpile requirements for various materials (see *Chapter 7.3 Spoils Handling and Disposal*). Recycle excess materials.

SEASONAL CONCERNS

7) Since rain and flooding greatly increase the risk of pollutant runoff, perform routine maintenance during the dry season. Avoid working in wet conditions or during the wet season (October 15-April 15), except for emergencies such as pothole patching.

SPOILS AND SIDECASTING (See *Chapter 7.3- Spoils Handling and Disposal.*)

8) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of the County right- of-way, without landowner's permission. In some instances, under the following guidelines (see table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. The presence of vegetation helps to slow the travel of sediment downslope, so good judgment is needed to assess the situation. *Do not sidecast at all* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed at all*, however there may be rare instances on slopes greater than 2:1 where sidecasting is acceptable given very long distances from waterbodies and good vegetative cover. Seek advice from the California Department of Fish and Wildlife when in doubt. Avoid concentrating sidecasting repeatedly in the same place. Never sidecast large amounts of soil from major landslides.

Slope gradient	Distance from waterway, stream crossing,	Sidecasting rule

	riparian area, roadside ditch, storm drain	
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope long distance from waterway	Allowed using good judgment
Greater than 5:1 (20%)	Sparsely vegetated slope and it appears that sediment will travel with rain into waterway	Not allowed

9) Temporary spoils stockpiles should be located in areas that are relatively level; relatively free of vegetation, and away from streams and wetlands areas. The primary concern is to keep stockpiled materials from eroding into stream or wetland systems. Apply erosion control BMPs when needed. Do not place temporary spoils piles at the top of unstable slopes or at the edges of slopes where water will carry sediment into waterways. Remove temporary stockpiles to permanent disposal locations before the rainy season. If emergency work is conducted during the rainy season, remove stockpile as soon as feasible and before the next rain storm.

BERMS (See *5.4- Shoulder Maintenance*.)
10) Do not leave loose soil piled in berms alongside the road or ditch. Loose or exposed soil berms are erodible and readily transported into waterways and storm drains.

11) If any berm is left in place for public safety it must be compacted and stabilized with seeding or asphalt. Frequent well placed breaks in the berms are necessary to allow water to drain from road, preserving the natural drainage pattern of the slope.

ROAD DRAINAGE (See *5.1-Road Treatment and Design Principles and 5.6- Drainage Systems* for specifications.)
12) Note areas of natural cross drainage. Document in writing any significant changes to drainage patterns resulting from road surface maintenance and report to County road engineering staff.

13) In some instances where road surface is sufficiently outsloped and hillslopes above do not experience surface flow (forested settings) it may be appropriate to remove the inboard ditch and allow road surface runoff to sheet across road.

BMP TOOLBOX

Planning and Prevention BMPs

- ➢ Seasonal Planning
- ➢ Small Spill Kit

Road Drainage

- ➢ Ditch Relief Culvert
- ➢ Road Surface Shaping
- ➢ Ditch Removal
- ➢ Berm Removal
- ➢ Berm Breaches

Erosion Control BMPs

- ➢ Blankets/Geotextile Fabrics
- ➢ Mulching
- ➢ Planting
- ➢ Plastic Covering
- ➢ Seeding

Sediment Control BMPs

- ➢ Coir Log/Straw Roll
- ➢ Storm Drain Inlet Protection
- ➢ Silt Mat/Vegetated Grassy Swale
- ➢ Sand Bag
- ➢ Silt Fence
- ➢ Siltation Pond/Settling Pond

* Note: Some of these are temporary measures that need to be removed upon completion of work and replaced with more permanent structures.

PERMITS

Activity or Condition	**Required permit or limitation**
Replacement of road base or surfacing next to sensitive habitats	Consult with CDFW or NOAA Fisheries as appropriate.

5.3 UNPAVED ROAD SURFACES

DESCRIPTION

Good maintenance practices on unpaved road surfaces can prevent roadway erosion, deterioration or failure; help with sediment and dust control, and provide a safe roadway surface for the traveling public. Unpaved road maintenance includes grading, repairing, or maintaining unpaved road surfaces. In Napa County most County-maintained roads are paved, however some unpaved County roads exist in the Putah Creek watershed and possibly in the Suisun Creek watershed.

See *California Salmonid Stream Habitat Restoration Manual* (CDFW Chapter X, 4th Edition Ford and Armored Fill). See *Handbook for Forest and Ranch Roads* (Mendocino County Resource Conservation District). See *5.4 -Shoulder Maintenance,* 6.2 *–Culvert Cleaning, Repair and Replacement*, and *Appendix A Road Drainage BMPs* for best road design and drainage engineering techniques to use to prevent erosion and protect salmon and aquatic habitat.

ENVIRONMENTAL CONCERNS

- Discharge of sediment or dust abatement chemicals into a stream or storm water drainage system.
- Harm to fish and aquatic life as a result of pumping water from streams for dust abatement.
- Concentrated runoff and sediment delivering to the stream system.

BMP OBJECTIVES

- Preserve or improve surface drainage in the vicinity of the road.
- Disconnect road drainage features from watershed hydrology.
- Make sure drainage is self-maintaining.
- Minimize amount of road-related sediment that gets into waterways.
- Prevent dust abatement chemicals from getting into waterways or riparian areas.
- Prevent or minimize interruption of natural hillslope and stream runoff patterns (hydromodification)

BEST MANAGEMENT PRACTICES

SEASONAL CONCERNS

1) Perform routine road surface maintenance when soil conditions are naturally conducive to compaction, but not when additional wet weather is anticipated. Use compaction and soil conditioning equipment where and when practical. Avoid working in wet conditions and during the wet season (October 15- April 15), except for emergencies. Disturbed soil combined with rainfall, greatly increase the risk of exposed sediment runoff into streams.

2) Inspect roads and associated drainage facilities for signs of erosion or deterioration at least twice annually with at least one inspection during or after first storm events of the season with follow-up for severe storm events. Inspect all road and drainage facilities after a 25-year storm event. Report locations of road surfaces, drainage features, cutslopes, and fillslopes that

appear to be failing and contributing sediment to streams in order to prioritize maintenance or repair. Standardize and document reports.

SURFACE GRADING (ROAD SHAPING)

3) In general, maintain unpaved roads to obtain a less erosive running surface and to minimize the need for frequent surface grading. Blade and compact a smooth surface and compact loose soils as needed.

4) Crown or slope the road to avoid ponding or concentration of runoff. Outslope all roads where possible and safe, consulting with County Engineering on specifications (See *5.1 - Road Treatment and Design Principles*.).

5) Construct *Rolling dips* along unpaved road surfaces. Rolling dips are likely the most cost-effective way to disperse runoff. While an insloped, outsloped, or crowned road surface can disperse runoff, their functionality can be reduced by wheel rutting from vehicle use. Construction of frequently installed rolling dips will ensure the most reliant form of road drainage with the least amount of maintenance in the future. Also, rolling dips can be constructed to drain the cutbank and inboard ditch as well as the road surface.

6) Repair rutting/failing areas, if needed.

SPOILS AND SIDECASTING (See Chapter 7.3-*Spoils Handling and Disposal*.)

7) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of the County right- of-way, without landowner's permission. In some instances, under the following guidelines (See Table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. The presence of vegetation helps to slow the travel of sediment downslope, so good judgment is needed to assess the situation. *Do not sidecast at all* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed at all*, however there may be rare instances on slopes greater than 2:1 where sidecasting is acceptable given very long distances from waterbodies and good vegetative cover. Seek advice from the California Department of Fish and Wildlife when in doubt. Avoid concentrating sidecasting repeatedly in the same place. Never sidecast large amounts of soil from major landslides.

8) Temporary spoils stockpiles should be located in areas that are relatively level; relatively free of vegetation and away from streams and wetlands areas. The primary concern is to keep stockpiled materials from eroding into stream or wetland systems. Apply erosion control BMPs when needed. Do not place temporary spoils piles at the top of unstable slopes or at the edges of slopes where water will carry sediment into waterways. Remove temporary stockpiles to permanent disposal locations before the rainy season. If emergency work is

conducted during the rainy season, remove stockpile as soon as feasible and before the next rain storm.

Slope gradient	Distance from waterway, stream crossing, riparian area, roadside ditch, storm drain	Sidecasting rule
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope long distance from waterway	Allowed using good judgment
Greater than 5:1 (20%)	Sparsely vegetated slope and it appears that sediment will travel via rain into waterway	Not allowed

BERMS (See *5.4- Shoulder Maintenance*.)
9) Do not leave loose soil piled in berms alongside the road or ditch. Loose or exposed soil berms are erodible and readily flushed into waterways and storm drains. Seek opportunities to remove berms and to outslope roads.

10) If a berm is left in place for public safety reasons it needs be compacted and stabilized with seeding. Frequent well placed breaks in the berms are necessary to allow water to drain from road, preserving the natural drainage pattern of the slope.

ROAD DRAINAGE (See *5.1-Road Treatment and Design Principles and 5.6- Drainage Systems* for specifications.)
11) Note areas of natural cross drainage. Document in writing any significant changes to drainage patterns resulting from road surface maintenance and report to County road engineering staff.

12) On problem roads, look for opportunities to reconstruct and/or reshape the road to improve and maintain natural drainage patterns; for example, add rolling dips, emergency water bars, and additional cross drains. (See *5.1-Road Treatment and Design Principles*).

DUST CONTROL (See *Appendix C- Dust Palliative Application Guidelines*.)
13) Do not apply chemical dust palliatives during rain or immediately before anticipated rain. Approved dust control agents are preferred over water drafting and application.

14) Follow manufacturer's recommendations when applying chemical dust palliatives. Do not apply chemical or petroleum-based palliatives where they may enter a stream or waterway unless specifically approved for such use.

15) Dispose of excess dust abatement materials at designated sites (see *Chapter 9.4 – Maintenance Facilities- Waste Handling, Storage, and Disposal*).

16) Make sure personnel are trained to respond appropriately to spills during use of chemical dust palliatives. Carry a spill kit for prompt cleanup (see *Appendix A* - Planning and Prevention BMPs: Small Spill Kit), using appropriate procedures. Do not hose down the work area or pour any materials down drains or into ditches.

WATER DRAFTING (See *Appendix C-Technical References, Water Drafting Guidelines.*)
17) Notify California Department of Fish and Wildlife, before drafting water from streams or other waterbodies for dust control or moisture conditioning. CDFW permits drafting if certain basic protectionary conditions are in place. If a work site is to be temporarily dewatered by pumping, intakes should be completely screened with wire mesh not larger than 5 millimeters to prevent amphibians from entering the pump system.

18) Appendix C contains both *NOAA Fisheries Water Drafting Specifications* and *CDFW Guidelines for Temporary Water Drafting*. The requirements and specifications are detailed and can be found in both of these documents- a helpful resource when preparing permit applications and working with agency staff.

19) Check appropriative water rights for stream that is used for drafting, set by the Division of Water Rights: http://www.swrcb.ca.gov/waterrights/

BMP TOOLBOX

Planning and Prevention BMPs
- Seasonal Planning
- Small Spill Kit

Road Drainage
- Ditch Relief Culvert
- Rolling Dip
- Road shaping (outslope, inslope, crown)
- Berm removal
- Critical dip

Erosion Control BMPs
- Blankets/Geotextile Fabrics
- Mulching
- Planting
- Plastic Covering
- Seeding

Sediment Control BMPs
- Coir Log/Straw Roll
- Storm Drain Inlet Protection

- ➢ Silt Mat/Vegetated Grassy Swale
- ➢ Sand Bag
- ➢ Silt Fence
- ➢ Siltation Pond/Settling Pond

* Note: Some of these are temporary measures that need to be removed upon completion of work and replaced with more permanent structures. See Appendix A for details on removal.

PERMITS

Activity or Condition	**Required permit or limitation**
Diverting or obstructing flow from streams or waterways (including water drafting for dust control or moisture conditioning)	Fish and Game Code Section 1600 requires: • Formal notification to CDFW • 1602 Standard Streambed Alteration Agreement (with CDFW's recommended protectionary steps) if CDFW determines need.
Any activities covered by local regulations	Local permits
Use of serpentine rock and asbestos-containing aggregate for unpaved surfacing.	Use is prohibited by CA Air Resources Board air quality rules. To ensure aggregate is asbestos-free, contractors that resize or crush rock must have MSHA (Mining Safety and Health Administration) 46 Identification number.

5.4 SHOULDER MAINTENANCE

DESCRIPTION

Areas adjacent to roads require maintenance to provide a usable area for vehicles to pull off the traveled way, to prevent the loss of lateral road support and the deterioration or failure of the edge of road surfaces, and to maintain roadside drainage patterns. Shoulder maintenance activities include shoulder blading and rebuilding, and smoothing ruts. See Appendix A *Road Drainage BMPs* for best road design and drainage engineering techniques to prevent erosion and protect salmon and aquatic habitat.

ENVIRONMENTAL CONCERNS

- Delivery of sediment from grading or improper disposal of spoils into streams or storm drains.
- Damage to vegetation that provides erosion control on slopes.
- Harm to riparian areas and rare plant populations.

BMP OBJECIVES

- Reduce amount of sediment and debris entering streams or storm drains.

BEST MANAGEMENT PRACTICES

1) Perform routine maintenance during the dry season, between April 15 and Oct 15. If emergency work must be performed during the rainy season, perform work during dry weather.

2) Avoid disturbing vegetation outside the essential shoulder area, especially near ditches, streams or waterways. Vegetated areas help filter sediment from run-off and help prevent erosion.

3) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of County right- of-way, without landowner's permission. In some instances, under the following guidelines (See Table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. Vegetation slows the travel of sediment downslope, so judgment is needed to assess the situation. *Do not sidecast* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed*, however there may be rare instances where sidecasting is acceptable given very long distances from waterbodies and good vegetative cover. Seek advice from local fisheries agency staff when in doubt. Avoid concentrating sidecasting repeatedly in the same place. Never sidecast large amounts of soil from major landslides.

Slope gradient	Distance from waterway, stream crossing, riparian area, roadside ditch, storm drain	Sidecasting rule
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope far from waterway	Allowed
Greater than 5:1 (20%)	Sparsely vegetated slope and it appears that sediment will travel with rain into waterway	Not allowed

4) Except as provided in #5 below, do not leave loose soil piled in berms alongside the road or ditch. Loose or exposed soil berms are erodible and readily flushed into waterways and storm drains. Remove excess berm material before rainy season. If placed in emergency during rainy season, remove as soon as possible. Dispose excess materials from shoulder maintenance activities in appropriate spoil disposal sites (see *Chapter 7.3:Spoils Handling and Disposal*).

5) Berms are used in some places for traffic delineation or public safety (i.e. line of sight along soft shoulders with steep drop-offs). If any berm is left in place it must be kept to a minimum height and be compacted and stabilized with native seeding or asphalt. Use Erosion Control BMPs to stabilize berms that are being left in place for road delineation.

6) Frequent well placed breaks (on average every 150ft.) in the berms are necessary to allow water to drain from road and back into its original channel, preserving the natural drainage pattern of the slope. Check the areas breached to make sure they are stable. If erosion occurs at berm breaching areas, or the seeding is not in yet and rains are approaching, apply Erosion Control BMPs directly.

7) Stabilize disturbed or bare soils along cutslopes and fillslopes with Erosion Control BMPs. If not otherwise recycled, asphalt concrete pieces and pavement grindings may be used in embankments and road shoulders when these materials are placed where they will not enter waterways or storm drains. Do not place recycled road materials on the stream bank.

8) Report to County Engineering the locations of cutslopes and fillslopes that appear to be failing or contributing significant amounts of sediment to streams so that maintenance/repair may be prioritized.

BMP TOOLBOX

<u>Planning and Prevention BMPs</u>

- Seasonal Planning
- Small Spill Kit

Erosion Control BMPs
- Mulching
- Planting
- Seeding

Sediment Control BMPs
- Storm Drain Inlet Protection
- Silt Mat/Vegetated Grassy Swale
- Sand Bag

* Note: Some of these are temporary measures that need to be removed upon completion of work and replaced with more permanent structures.

PERMITS

Activity or Condition	**Required permit or limitation**
Any re-grading in sensitive habitat areas	Consult with CDFW or NOAA

5.5 ROADSIDE DITCHES

DESCRIPTION
Roadside ditches carry runoff to designated outfall locations. They are periodically cleaned, reshaped, or stabilized. Ditch maintenance activities include: shoulder blading and rebuilding to correct rutting; reshaping of ditches to maintain the flowline and centerline or to improve the carrying capacity; mowing; and removal of weeds and built-up materials to maintain proper grade or capacity. Follow-up activities include hauling and disposal of excess soil, debris or vegetation to an appropriate spoils disposal location.

Although ditches are considered utilitarian, built for the purpose of draining water from roads, they may contain wetland vegetation and may be classified as "jurisdictional wetlands" or "Waters of the U.S." Additionally, if a natural drainage channel that is a "Water of the U.S." (e.g,. an ephemeral stream) flows into drainage ditch, the ditch thereby becomes a "Water of the U.S." Examples of "Waters of the U.S." include tidal drainage ditches and ditches through wetlands. See Appendix A *Road Drainage BMPs* for best road design and drainage engineering techniques to use to prevent erosion and protect salmon and aquatic habitat.

ENVIRONMENTAL CONCERNS
- Delivery of sediment related to ditch maintenance to streams or waterways from:
  - runoff that flows into the ditch
  - erosion within the ditch itself
  - erosion adjacent to the road *or*
  - road failure due to a plugged ditch or ditch relief culvert
- Excessive erosion or stream channel changes due to concentrated water runoff from a ditch into a waterway, often exceeding the channels normal carrying capacity. See Chapter 5.1 *Hydromodification* for further description.
- Harm to aquatic habitat during ditch maintenance.
- Loss of wetland vegetation.
- Disposal of spoils and debris from ditch maintenance where materials may enter a waterway.

BMP OBJECIVES
- Avoid sediment delivery from ditches into connected waterways.
- Where possible disconnect drainage ditches from stream channels to reduce potential for sediment delivery and stream channel changes.
- Stabilize bare soils after maintenance.

BEST MANAGEMENT PRACTICES

1) Schedule ditch activity in dry conditions. Avoid working in wet conditions or the wet season, except for emergencies. Due to direct proximity and connectivity, rain and flooding greatly increase the risk of sediment and pollutant runoff.

2) Grade ditches only when necessary to keep the ditchline free flowing and restore capacity. Unnecessary mechanical grading can cause excess erosion, undermine banks, and expose the

toe of the cutslope to erosion or slope failure.

3) Where feasible, install frequent drainage structures such as ditch relief culverts along inboard ditch to disperse road runoff. More frequent ditches reduce chance of water concentrating and causing erosion.

- Ditch relief culvert should be a minimum 18 inches in diameter.
- A 10% drop in grade from the culvert inlet to the outlet will usually promote self-cleaning. The culvert grade should also be at least 2% greater than the inboard ditch.
- The culvert should be placed at a 30 degree skew to the inboard ditch to prevent plugging

4) Avoid removing more grass and vegetation than necessary.

- To control vegetation (rather than remove it entirely), use methods like mowing or weed-whacking when feasible. Vegetation prevents scour and filters out sediment.
- Whenever feasible, maintain a buffer of vegetation between the ditch and the road. This helps filter sediment from runoff and can be accomplished by using a steeper angle on the grader blade.
- Avoid harming existing vegetation on the cutbank above the ditch to reduce erosion and prevent slope failure.

5) Stabilize bare soils after maintenance. Ground disturbance activities within drainage ways have a high potential for causing sediment discharges. To reduce or prevent erosion in retained ditches:

- rip-rap with appropriate sized rock
- utilize cover crop
- apply well-anchored matting or geofabric (e.g., as ditch lining)
- apply a hardened surface such as asphaltic cement or concrete.

6) Dispose of all materials from ditch cleaning at designated sites or acceptable roadside areas (see *Chapter 7.3 - Spoils Handling and Disposal* regarding acceptable disposal of excess materials).

7) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of the County right- of-way, without landowner's permission. In some instances, under the following guidelines (See Table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. The presence of vegetation helps to slow the travel of sediment downslope, so good judgment is needed to assess the situation. *Do not sidecast at all* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed at all*, however there may be rare instances on slopes greater than 2:1 where sidecasting is acceptable given very long distances from waterbodies and good vegetative cover. Seek advice from California Department of Fish and Wildlife agency staff when in doubt. Avoid

concentrating sidecasting repeatedly in the same place. Never sidecast large amounts of soil from major landslides.

Slope gradient	**Distance from waterway, stream crossing, riparian area, roadside ditch, storm drain**	**Sidecasting rule**
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope far from waterway	Allowed using good judgment
Greater than 5:1 (20%)	Sparsely vegetated slope, appears sediment will travel via rain into waterways	Not allowed

8) When constructing or reconstructing a ditch, work with designs for outlet locations and terrain that avoid directly dumping ditch water into streams, when practical. If not practical, implement sediment management BMPs such as sediment basins, check dams, sand and gravel bag barriers, and other acceptable techniques to trap sediment before it reaches a stream. Remove temporary BMPs and replace with permanent BMPs as soon as practical.

9) Be alert for abnormal ditch water (e.g. summer months or high flow during winter months), which may be indicative of other issues. Try to find the source of the water first. There may be an adjacent spring exposed in the bank cut and thus have biological resources that need addressing or a failed ditch relief culvert upslope that needs fixing.

10) Implement routine maintenance for sediment trapping BMPS to ensure they maintain their function. Initially, check BMPs after each storm event. If BMPs are performing adequately, reduce frequency of checks to annually or after major (e.g., 10-year) storm events.

11) For ditches with ongoing sedimentation problems, it may be more cost-effective and environmentally less damaging to implement upslope erosion control BMPs to reduce sediment delivery into ditches, rather than conducting seasonal ditch cleaning. Sediment basins are another alternative.

12) In some instances where road surface is sufficiently outsloped and hillslopes above do not experience surface flow (forested settings) it may be feasible to remove the inboard ditch and allow road surface runoff to sheet across road.

BMP TOOLBOX

<u>Planning and Prevention BMPs</u>

- Seasonal Planning
- Small Spill Kit

Road Drainage

- Ditch Relief Culvert
- Ditch Maintenance
- Ditch Construction
- Ditch Removal

Sediment Control BMPs

- Mowing/ Weed Whacking
- Herbicide Application
- Silt Mat/Vegetated Grassy Swale
- Grading
- Storm Drain Inlet Protection
- Curb Inlet Sediment Barrier
- Storm Drain Inlet Protection
- Sand Bag
- Sediment Basin/ Siltation Pond/Settling Pond

* Note: Some of these are temporary measures that need to be removed upon completion of work and replaced with more permanent structures.

PERMITS

Activity or Condition	Required permit or limitation
Reshaping of ditch to other than original dimensions and configuration if: • ditch itself is a "Water of the U.S." • a natural drainage channel that is a "Water of the U.S." (e.g., an ephemeral stream) flows into drainage ditch; the ditch thereby becomes a "Water of the U.S." Examples of Waters of the U.S.: • Tidal drainage ditches and ditches through wetlands • An ephemeral stream – triggers this permit requirement if it has an Ordinary High Water Mark (OHWM) as defined in 33 CFR 328.3(e)	(If in doubt as to whether permit is required, consult with COE.) CWA 404 permit; specifically, the COE's Nationwide Permit 41, "Reshaping Existing Drainage Ditches". This permit is subject to the following conditions: • Ditch must be returned to its original dimensions and configuration • Design capacity or area drained cannot be expanded • Centerline of reshaped ditch must be essentially in the same location as existing ditch's centerline • County must notify COE if portion reshaped is greater than 500 feet in length **Note:** This permit does *not* authorize reconstruction of drainage ditches that have become ineffective through lack of regular maintenance. CWA 401 Water Quality Certification permit from the RWQCB (always required with 404 permit)

Cleaning only (including removal of sediment, debris and vegetation), without reshaping. A ditch that only collects rainfall off the road is not jurisdictional water, and permitting is not required for any maintenance	Exempt from CWA 404 permit process; cleaning is considered maintenance only. However, the ditch must maintain its original dimensions and configuration.
In a Coastal Zone: • Any work subject to review under Section 1601 of the Fish and Wildlife Code ***and/or*** • Excavation or disposal of fill is outside of the roadway prism	Coastal development permit (Other than listed activities, ditch maintenance work is exempt from this permit requirement.)

5.6 DRAINAGE SYSTEMS

DESCRIPTION
Drainage system maintenance includes inspection, repair or replacement of components: including retention facilities, pollution control devices, manholes, catch basins, inlets, vaults, drains, and cross drains. For the purpose of this manual, culverts and crossings constructed in natural stream channels are discussed separately in *Chapter 6 –Working In or Near Streams*. Ditch maintenance is also discussed separately in *5.5 - Roadside Ditches*.

While these structures are not naturally occurring waterways, streams or wetlands, some storm or surface water runoff facilities become wetlands, or were wetlands prior to their conversion, and are regulated as “jurisdictional wetlands” or “Waters of the State.”

ENVIRONMENTAL CONCERNS
- Discharge of sediment or debris to streams or waterways.
- Water pollution from leakage of petroleum products from equipment used for maintenance.
- Plugging that results in overtopping.
- Excessive erosion resulting from alteration of natural hydrologic patterns.
- Increased peak flows due to runoff from impermeable surfaces and roadside ditches.

BMP OBJECTIVES
- Minimize road-related sedimentation.
- Reduce sedimentation to waterways.
- Reduce stormwater pollution.
- Preserve or improve surface drainage characteristics in the vicinity of the road.

BEST MANAGEMENT PRACTICES

<u>GENERAL</u>
1) Perform routine maintenance and repairs during the dry season whenever possible. If work must be performed during the rainy season, perform work during dry weather. Report erosion problems to County engineers for repairs.

2) Stabilize disturbed or bare soils around work areas with erosion control BMPs. Stabilize bare soils after maintenance. Ground disturbance activities within drainage ways have a high potential for causing sediment discharges. Implement sediment control BMPs at drainage system features as necessary during maintenance to reduce downstream discharge of sediment.

3) Inspect critical and problem culverts, drain inlets, and detention facilities annually before the rainy season (prior to October 15), and after the first major rainfall event (2 year event), when feasible. Inspect suspected problem culverts as necessary after, depending on intensity and frequency of rains.

4) When vegetation removal or reduction is necessary, dispose of waste according to County

standards (see *Chapter 8- Vegetation Management*).

5) If using herbicides close to the "normal" start of the rainy season or in early springtime, use only aquatic approved formulations as approved by the State of California regulations and the Napa County Agricultural Commissioner. Timing, rate and volume of spraying should be included in a schedule for herbicide treatment. See Chapter 8-*Vegetation Management* for details, and when in doubt, contact the Napa County Agricultural Commissioner's office.

6) Look for opportunities to restore natural drainage patterns. Install culverts to retain water in its drainage of origin, which will decrease the potential for erosion. On problem road sections, look for opportunities to reconstruct the road segment to improve and maintain natural drainage patterns.

7) The recommended minimum diameter for all new ditch relief culverts, but exclusive of driveway culverts, is 18 inches. Often, small diameter culverts (12 inches or less) can easily plug with debris, causing the flow to flood onto the road surface. They are also difficult to clean. See *Chapters 5.1- Road Treatment and Design Principles* and *6.2- Culvert Cleaning, Repair and Replacement* for additional information.

8) When installing ditch relief culverts implement the following where possible

- Construct at least a 10% drop in grade from the inlet to the outlet to promote self-cleaning.
- Place the culvert at a 30 degree skew to the inboard ditch to reduce plugging potential.
- Construct a positive reverse in grade to the inboard ditch around the inlet to prevent ditch flow from diverting past the culvert.

9) Implement energy dissipation BMPs at outlets where there is gullyings or where it may occur. Discharges from cross drains onto road fill or other erosive areas often cause significant erosion and slope failure.

SEDIMENT BASINS, SILTATION PONDS AND SEDIMENT TRAPS

10) Monitor accumulation of sediment in the sediment basins or siltation ponds. Manage water release from ponds to maximize sediment retention and eventual removal. Develop and implement a routine maintenance schedule for cleaning sediment trapping BMPs to ensure they maintain their function. Keep structures clear of litter and debris and dispose of all wastes appropriately.

11) If function of the system is compromised by sediment accumulation and removal of sediment is warranted, dispose of appropriately (see *Chapter 7.3-Spoils Handling and Disposal).*

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning
- Small Spill Kit

Culvert BMPs

- Energy Dissipater
- Rock Armor
- Culvert Inlet Sediment Trap

Road Drainage
- Ditch Relief Culvert
- Road Surface Shaping
- Ditch Maintenance
- Ditch Construction
- Ditch Removal
- Berm Removal
- Berm Breaches

Erosion Control BMPs
- Blankets/Geotextile Fabrics
- Coir Log/Roll
- Mulching
- Planting
- Plastic Covering
- Rock Breast Wall
- Seeding
- Surface Roughening & Soil Tracking
- Stepped or Terraced Slope
- Coir Log/Straw Roll

Sediment Control BMPs
- Storm Drain Inlet Protection
- Silt Mat/Vegetated Grassy Swale
- Silt Fence
- Sediment Basin/Siltation Pond/Settling Pond
- Turbidity Curtain

* Note: Some of these are temporary measures that need to be removed upon completion of work and replaced with more permanent structures. See Appendix A for details on removal.

PERMITS

Activity or Condition	Required permit or limitation
• Drainage system being worked on is in a ditch that qualifies as Water of the U.S, ***and*** • Activity alters shape or configuration of the ditch or drainage feature. If drainage system has temporary measures, such as a coffer dam (BMP), a 404 permit is required if fill is being placed within the ordinary high water mark.	• CWA Section 404 permit • CWA 401 Water Quality Certification permit from RWQCB (required with CWA 404 permit)
• Cleaning only (including removal of sediment, debris and vegetation), with no reshaping of ditch.	• Cleaning is considered maintenance and is always exempt from the CWA 404 permit process; however, the ditch must maintain its original dimensions and configuration.
• In a Coastal Zone, drainage system maintenance work	Exempt from a Coastal Development Permit unless: • subject to review under Section 1600 of the Fish and Wildlife Code, ***or*** excavation or disposal of fill is outside of the roadway prism.
• Any work covered by local regulations.	Consult your supervisor about local permits.

5.7 STREET SURFACE CLEANING

DISCRIPTION

Street cleaning activities are performed to provide a safe roadway surface for the public and to keep sediment and debris from accumulating on the roadway or in the gutters and getting washed into waterways via storm drains. Street cleaning typically consists of sweeping with pickup sweeper units and to a lesser extent power brooms and washing with water trucks.

ENVIRONMENTAL CONCERNS

- Discharge of the following materials into the storm water drainage system or waterways:
  - Litter and debris
  - Equipment wash water
  - Sediment and pollutants from the road surface

BMP OBJECTIVES

- Reduce amount of sediment, organics, chemicals, and debris entering waterways.
- Reduce potential for airborne emissions from sweeping operations.

BEST MANAGEMENT PRACTICES

1) Control sweeper speed to minimize airborne particulates and remove maximum amount of debris – slower is better.

2) Use water spray system on the sweeper to reduce dust generation. Prioritize use of pickup sweepers in sensitive areas (e.g., near waterways) or when large amounts of debris/sediment are present.

3) Adjust the brooms frequently to maximize the efficiency of sweeping operations. After pickup sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

4) Street sweepings are often contaminated with petroleum hydrocarbons and heavy metals including lead, copper, and zinc. **Do not compost sweepings!**

5) Watch for the presence of potential hazardous materials so that these can be properly collected and the possibility of spills is reduced.

6) Clean sweepers in a maintenance yard or an approved area to capture solid materials.

7) Make sure personnel are trained to respond appropriately to hazardous materials that may be encountered and spills that may occur during street cleaning. Carry a spill kit for prompt cleanup of spills (Small Spill Kit BMP), and clean up spills of petroleum products immediately using the appropriate procedures. Notify County Engineering immediately regarding other spills, so that appropriate notification and response may be made. Do not hose down the work area or pour any materials down drains or into ditches.

8) Increase frequency of pickup sweeping as practical and particularly in the fall.

9) Once frost/freeze period is over street sweep any remaining cinders from road lengths that contribute sediment to a stream system. Cinders can pollute waters as a fine sediment source. See *Chapter 5.9 Snow and Ice Control* for more details.

10) When washing down pavement, employ *Erosion Control and Sediment Management BMPs* in adjacent roadside ditches if wash water can reach streams or storm drain systems.

BMP TOOLBOX

<u>Planning and Prevention BMPs</u>

- Seasonal Planning
- Small Spill Kit

<u>Sediment Control BMPs</u>

- Storm Drain Inlet Protection

PERMITS

Activity or Condition	**Required permit or limitation**
Street cleaning in general	Addressed as part of the County’s NPDES General Storm Water Permit.

5.8 CONCRETE WORK

DISCRIPTION

Maintenance and repair of concrete surfaces, such as bridges, concrete roadways, sidewalks, driveways, parking lots, and curb and gutter sections are performed to provide a safe roadway for the traveling public; maintain safe pedestrian access; and maintain proper functioning drainage features. Concrete work includes: concrete removal, crack sealing, concrete grinding, saw cutting, replacement of removed sections and installation of new structures.

ENVIRONMENTAL CONCERNS

- Discharge of the following materials into the storm water drainage system or waterways:
    - Portland cement concrete (PCC), concrete or cement rinse water, concrete grindings and cuttings, sediment, form release agents.

BMP OBJECTIVES

- Eliminate run-off of pollutants from maintenance/repair area.
- Eliminate discharge of sediment to streams and waterways.
- Eliminate discharge of concrete debris or rubble resulting from concrete repair work into creeks or waterways. Dispose of debris appropriately.

BEST MANAGEMENT PRACTICES

1) Inspect equipment for leaks or damage prior to performing concrete work. Perform maintenance at designated repair facilities.

2) Prior to concrete work, identify storm drain inlets, manholes, and waterways. Protect storm drains with appropriate Sediment Management BMPs.

3) Designate areas to be used for concrete washout and perform washout only in properly constructed containments. When washing equipment or vehicles to remove cement or concrete residue, use only as much water as is needed so that rinse water can be properly contained. For example, use a positive shutoff on the washout hose. Construct the washout area in accordance with the Concrete Washout BMP.

4) Follow these procedures for concrete mixing on site.

- Ensure that contractors who fuel and operate cement mixing operations on-site have an adequate spill plan and materials for spill containment.
- Avoid mixing excess amounts of fresh concrete or cement on-site.
- Establish mixing plants outside of riparian corridors or near waterways.
- Dry and wet materials should be stored away from waterways and storm drains and should be covered and contained to prevent runoff from rainfall.

5) Remove concrete grindings, rubble, and debris from the site for proper disposal and do not discharge into drain inlets, the storm water drainage system, waterways, or ditches.

6) Contain coolant water from concrete cutting and do not discharge into drain inlets, the

storm water drainage system, waterways, or ditches.

7) When fresh concrete may be exposed to water, (e.g. rainy weather work), use concrete sealants that are approved by the California Department of Fish and Wildlife for this purpose.

8) For the duration of concrete work, make inspections an ongoing practice.

- After rainfall events, inspect drainage protection measures. In the case of an extended storm, inspect at least once per day. If the protection measures are subjected to non-stormwater flows, inspect daily
- Inspect inlet protection to prevent water from backing up. If back-up occurs, the protection needs to be replaced with an alternative device.
- Monitor the concrete wash-out, waste storage, disposal sites, and on-site procedures at least weekly.
- Make sure employees and contractors are following pollution control measures.

BMP TOOLBOX

Planning and Prevention BMPs

- ➢ Seasonal Planning
- ➢ Small Spill Kit

Sediment Control BMPs

- ➢ Concrete Containment
- ➢ Concrete Washout
- ➢ Storm Drain Inlet Protection
- ➢ Sand Bag
- ➢ Sedimentation Sump

PERMITS

Activity or Condition	**Required permit or limitation**
Concrete work in streams and on stream banks	• U.S. Army Corps of Engineers 404 Permit • Regional Water Quality Control Board 401 Water Quality Certification • California Department of Fish and Wildlife Streambed Alteration Agreement DFW 1602 • NOAA Fisheries Service consultation
Temporary concrete batch plant	• May need County Use Permit

5.9 SNOW AND ICE CONTROL

DESCRIPTION

Road maintenance crews are responsible for sanding, de-icing, and plowing operations during periods of freezing weather. Snow and ice removal is necessary to provide a safe roadway surface for the traveling public. Materials may include sand, cinders, salts, and de-icing agents.

ENVIRONMENTAL CONCERNS

- Discharge of sediment (sand and cinders) and de-icing agents into the waterway or stormdrains.
- Impacts of particulates from sand and cinders on air quality.
- Degradation of stream water quality by increased dissolved solids (salts).
- Salt damage to trees or other vegetation adjacent to a road or in a location affected by runoff.

BMP OBJECTIVES

- Reduce road-related sediment (including sand and cinders) to sensitive areas and waterways.
- Minimize impacts from application of sand, cinders, salts and de-icing agents.

BEST MANAGEMENT PRACTICES

1) Minimize use of salt by reducing sand, cinders, salts and de-icing agents' ratios to the maximum extent feasible (See Snow and Ice Control BMP referenced below).

2) Once frost season is over, street sweep remaining sand and cinders from road lengths that contribute sediment to stream system where feasible. Sand and cinders can pollute waters as a fine sediment source.

3) Plow snow into areas that allow vegetation to filter and contain sand and cinders if feasible.

4) Prioritize clean up efforts to aquatic habitat areas once road safety hazards from snow/ice are gone.

5) Prioritize clean-up of areas that lack sediment collection systems.

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning
- Small Spill Kit

Sediment Management BMPs

- Storm Drain Inlet Protection
- Sedimentation Sump
- Sediment Basin/Siltation Pond/Settling Pond
- Sweeping

PERMITS

Activity or Condition	Required permit or limitation
Sand, cinders and chemical use	May need to be addressed as part of the County's NPDES General Storm Water Permit

5.10 ROAD CLOSURE AND DECOMMISSIONING

DISCRIPTION

There are many reasons for closing or proactively "decommissioning" a road, most of which involve excessive maintenance costs, lack of continued need, or continuing water quality problems. Not all roads need to be part of the permanent or seasonal road system. For example, temporary roads are used once, and then decommissioned until they are needed again. In addition to newly built temporary roads, there are many miles of existing roads that may no longer be needed, and older abandoned roads that are now overgrown. Techniques can be used to "storm-proof" these older roads to prevent future erosion and sediment yield, and, as an added benefit or incentive, save the work and expense of continued maintenance, see table below.

Conditions commonly leading to road closure
1. Roads constructed for temporary access (designated temporary roads)
2. Spur roads which are no longer needed for management for the next few years or for many years (e.g., all timber has been cut)
3. Roads with excessively high maintenance costs
4. Roads which have persistent erosion and water quality problems, often located in areas of extremely erodible soils
5. Roads crossing extremely steep slopes or inner gorge locations where land sliding risk is high and sediment could enter stream channels
6. Roads crossing slopes with high or extreme landslide risk or on-going landslide activity caused by incompetent bedrock or unstable soils
7. Roads exhibiting potential for large fillslope or cutbank failures, often showing tension cracks and scarps in the roadbed
8. Roads built with excessive sidecast or fill in unstable locations or perched above stream channels
9. Old roads built in, along, or immediately adjacent to stream channels or up narrow stream channel valleys
10. Old, abandoned roads which have overgrown with vegetation and now have washed-out stream crossings and/or fill failures

ENVIRONMENTAL CONCERNS

- Discharge of sediment or debris to streams or waterways.
- Water pollution from leakage of petroleum products from equipment used for maintenance.
- Plugging that results in overtopping.
- Excessive erosion resulting from alteration of natural hydrologic patterns.
- Increased peak flows due to runoff from impermeable surfaces and roadside ditches.

BMP OBJECTIVES

- Minimize road-related sedimentation.
- Reduce sedimentation to waterways.
- Reduce stormwater pollution.
- Preserve or improve surface drainage in the vicinity of the road.
- Disconnect road drainage features from watershed hydrology.
- Make sure drainage is self-maintaining.
- Prevent or minimize the interruption of natural hillslope and stream runoff patterns (Hydromodification)

BEST MANAGEMENT PRACTICES

It is no longer enough to close roads by simply closing a gate or blocking a road, because these actions will not prevent future road failure and future water quality problems. Specific techniques, described in Appendix A (Road Decommissioning), are available to successfully prevent road-related erosion, such as stream diversions (the leading cause of serious gullying in many areas), stream crossing washouts, fill failures, dewater gullies and landslides fed by road runoff, and to control surface erosion (riling and raveling) from abandoned road surfaces and fillslopes. See Table below for a generalized checklist of treatments.

1) All stream crossings on temporary or decommissioned roads should be removed *before* the first winter following their installation or closure (if not, they should accommodate 50-year flood flow for that channel). Removing a stream crossing involves excavating and removing all materials placed in the stream channel when the crossing was built. Fill material should be excavated to recreate the original channel grade (slope) and orientation, with a channel bed that is as wide as or slightly wider than the original waterway. Channel sideslopes should be graded ("pulled" or excavated) back to a stable angle (generally less than 50%) to prevent slumping and soil movement. The bare soils should then be mulched, seeded and/or armored to minimize erosion until vegetation can protect the surface, and the approaching road segments should be cross-road drained to prevent road runoff from discharging across the freshly excavated channel sideslopes. See Appendix A (Road Decommissioning).

2) Any unstable or potentially unstable road fills (or sidecast) should be excavated and stabilized so material does not fail and enter a waterway or destroy down-slope vegetation. Such areas include sidecast and fill materials which show recently developed scarps or cracks. These sites occur most often:

- on sidecast constructed roads built on steep slopes,
- where roads have been built on steep slopes over springs or seeps,
- where roads have been cut into steep headwater swales or "dips" in the hillside.

Cribbed fills which were installed at unstable areas during road construction or reconstruction should also be removed and outsloped if they could fail into a downslope stream channel. All spoil material should be placed in a stable location and revegetated. Spoil disposal sites can include the cut portion of closed roads and the inside portion of landings or turnouts. Wet, spring-fed cutbanks along closed roads should not be covered with spoil materials. See Appendix A (Road Decommissioning).

Cutbank failure materials are often completely caught and stored on the adjacent road prism. For this reason, cutbank instabilities often do not need the same amount of "storm-proofing" and stabilizing as is needed on fillslopes and stream crossings. Some buttressing, revegetation and upslope drainage control may be required to prevent larger failures and erosion that could affect water quality. No active ditches or diversions should be left at the base of an unstable or raveling cutbank on a decommissioned road. In fact, ditches should not be left open and functioning because all ditches are likely to eventually become plugged with sediment or vegetation and cause water to be diverted onto the road surface.

3) Roads that are to be decommissioned should have adequate, self-maintaining surface drainage so that the road surface is stable and will not erode and deliver sediment to a stream. Road surfaces should be decompacted (ripped to a depth of 15-24 inches). Any ditched segments of roads should be filled so that water is not diverted and gullies do not form. Outside road berms should be removed to encourage continuous drainage off the road surface. All road lengths should be drained with frequently spaced cross-road drains that are constructed from the cutbank to the outside edge of the road. Cross-road drains should be made deeper than standard waterbars in order to not only to intercept all road surface flow but to prevent any unauthorized use of the road. See Appendix A (Road Decommissioning).

On steep sections of road (>10%), cross drains should be skewed at 45% to the road alignment (instead of the usual 30%) to reduce the threat of erosion at the inlet. Since inside ditches will be breached and no longer carry runoff, ditch relief culverts are no longer needed on closed roads and can be either removed and salvaged or left in-place. Cross-road drains should be placed frequently enough such that flow through individual drains will not require the use of rock armor energy dissipaters to prevent erosion at the outlet. However, cross drains that carry spring flow or flow from small upslope gullies may require armoring at their outlet and should be discharged into vegetation to filter water and sediment before runoff reaches a stream.

Characteristics of Storm Proofed Roads
The following abbreviated criteria identify common characteristics of storm-proofed roads. Roads are storm-proofed when delivery to streams is strictly minimized. This is accomplished by dispersing road surface drainage, preventing road erosion from entering streams, protecting stream crossings from failure or diversion, and preventing failure of unstable fills from delivering sediment to a stream. All bare soils with potential to deliver sediment to streams should be seeded and straw mulched before any rain events occur.
Storm-proofed stream crossings ✓ All stream crossings have a drainage structure designed for the 100-year peak storm flow (with debris). ✓ Culverts are set in at base of fill and at channel grade. ✓ Culvert inlet, outlet, and bottom are open and in sound condition. ✓ Stream crossings have no diversion potential (functional critical dip/critical culverts are in place). ✓ Stream crossing inlets have low plug potential (trash barriers installed). ✓ Stream crossing outlets are protected from erosion (extended beyond the base of fill and/or dissipated with rock armor). ✓ Bridges have stable, non-eroding abutments and do not significantly restrict 100-year flood flow. ✓ Stream crossings on fish bearing streams meet CDFW and NMFS fish passage criteria. Decommissioned stream crossings have been completely excavated to original grade and side slopes are laid back to 2:1 where possible.
Storm-proofed fills ✓ Unstable and potentially unstable stream crossing and road fills are excavated or structurally stabilized. ✓ Excavated spoil is placed in locations where it will not enter a stream. ✓ Excavated spoil is placed where it will not cause a slope failure or landslide.
Road surface drainage ✓ Year round use roads are either paved or rocked well enough so that none of the native surface is visible and raindrop impact is absorbed by the applied surface. ✓ Un-surfaced roads are either closed during rainy periods of the year or are not used when the road surface is wet. ✓ All road surfaces are disconnected from streams by implementing a variety of surface drainage techniques including berm removal, road surface shaping (outsloping, insloping, or crowning) and installing rolling dips, ditch relief culverts, and /or waterbars. ✓ Ditches and cutbanks are disconnected from streams by frequently draining them with rolling dips &/or ditch relief culverts. ✓ Outflow from rolling dips and ditch relief culverts do not discharge to streams or onto active (or potentially active) landslides. ✓ Gullies (including those below ditch relief culverts) are dewatered to the extent possible. ✓ Decommissioned roads have been de-compacted (ripped) and have frequently installed permanent drainage structures (cross road drain) to prevent runoff contribution to streams.

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning
- Small Spill Kit

Road Drainage

- Road Surface Decompaction
- Cross-road Drains
- Stream Crossing Excavation
- Unstable Fill Slope Excavation

Erosion Control BMPs

- Blankets/Geotextile Fabrics
- Mulching
- Planting
- Seeding

Sediment Control BMPs

- Coir Log/Straw Roll
- Silt Mat/Vegetated Grassy Swale

PERMITS

Activity or Condition	**Required permit or limitation**
In a Coastal Zone, conducting unpaved road maintenance activities below the high tide line.	Coastal Zone Development Permit or Coastal Development Exception from County Planning or the California Coastal
Diverting or obstructing flow from streams or waterways (including water drafting for dust control or moisture conditioning)	Fish and Game Code Section 1600 requires: • formal notification to DFG • 1602 Standard Streambed Alteration Agreement (with CDFW's recommended protectionary steps) if CDFW determines it is needed.
Any activities covered by local regulations	Local permits

Source: Weaver, William E. PhD and Danny Hagans, Pacific Watershed Associates. Handbook for Forest and Ranch Roads. Prepared for the Mendocino County Resource Conservation District, June 1994.

CHAPTER 6: WORKING IN OR NEAR STREAM CHANNELS

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6.1 GENERAL PRINICPALS FOR WORKING IN OR NEAR STREAM CHANNELS

DESCRIPTION

This chapter provides aquatic protection guidelines when performing road maintenance activities in or near stream channels, ponds, estuaries and wetlands. Activities include culvert cleaning, repair and replacement, streambank stabilization, woody debris management, and dewatering. While some of these activities may be considered *projects*, versus *routine maintenance*, it is critical to expand the scope of this chapter to cover these important subjects which are critical to salmon fisheries protection and restoration (e.g., culvert replacement for fish passage). Adopting best management practices when conducting routine maintenance or implementing projects in or near the streams, is the first line of defense for protecting salmon fisheries and other aquatic life.

In this chapter we refer to channels as *natural waterways* that provide aquatic habitat for salmonids, or are connected to streams that do so. Culverts and crossings on natural stream channels are covered in *6.2 - Culvert Cleaning, Repair and Replacement.* For the purpose of this manual, cross drains and roadside ditches are considered separately from natural channels. Although ditches often function similarly to channels, and may be considered "Waters of the U.S." under certain conditions, they are part of a man-made road system and are covered in *Chapter 5.5 Roadside Ditches.* Cross drain culverts are covered in *Chapter 5.6 Drainage Systems.*

Note- The maintenance practices covered in this chapter *do not* include channel maintenance or flood control activities. For information on flood control or channel maintenance BMPs, please refer to Napa County Flood Control and Water Conservation District Stream Maintenance Manual www.countyofnapa.org/FloodDistrict/

ENVIRONMENTAL CONCERNS

- Discharge of sediment or debris to streams or waterways.
- Harm to instream aquatic habitat or aquatic species.
- Harm to riparian areas and riparian species.
- Alteration of natural channel function or shape or destabilization of stream banks.
- Water pollution from equipment operation.
- Alteration of stream hydraulics and diversion of stream energies that may cause downstream erosion or structural damage.
- Dewatering of stream or stream segments.
- Loss of instream habitat due to wood removal

BMP OBJECTIVES

- Protect water quality by reducing erosion and sedimentation.
- Avoid negative impacts to aquatic and riparian habitat and species.
- Maintain or restore fish passage.

BEST MANAGEMENT PRACTICES

1) Schedule channel-related road maintenance work during the dry season, avoiding periods which may be more harmful to fish or other aquatic species of concern, such as California red-legged frogs, and fresh water shrimp. Consult with a fisheries biologist to ensure compliance with seasonal constraints. For further details per species see Seasonal Planning BMP.

MEASURES TO MINIMIZE DISTURBANCE FROM INSTREAM CONSTRUCTION

(CA Salmonid Stream Habitat Restoration Manual: Chapter IX 2003)

2) Construction should generally occur during the lowest flow period of the year.

3) Construction should occur during the dry period if the channel is seasonally dry.

4) Prevent any construction debris from falling into the stream channel. Any material that does fall into a stream during construction should be immediately removed in a manner that has minimal impact to the streambed and water quality.

5) Where feasible, construction should occur from the bank, or on a temporary pad underlain with filter fabric.

6) Temporary fill must be removed in its entirety prior to close of work-window.

7) Areas for fuel storage, refueling, and servicing of construction equipment must be located in an upland location.

8) Prior to use, clean all equipment to remove external oil, grease, dirt, or mud.

9) Wash sites must be located in upland locations so that dirty wash water does not flow into stream channel or wetlands.

10) All construction equipment must be in good working condition, showing no signs of fuel or oil leaks.

11) Petroleum products, fresh cement, or deleterious materials must not enter the stream channel.

12) Operators must have spill clean-up supplies on site and be knowledgeable in their proper use and deployment.

13) In the event of a spill, operators must immediately cease work, start clean-up, and notify the appropriate authorities.

MEASURES TO MINIMIZE DEGRADATION OF WATER QUALITY

(CA Salmonid Stream Habitat Restoration Manual: Chapter IX 2003)

14) Isolate the construction area from flowing water until project materials are installed and

erosion protection is in place. See *Chapter 6.5 Dewatering* for more details.

15) Erosion control measures shall be in place at all times during construction. Do not start construction until all temporary control devices (straw bales, silt fences, etc.) are in place downslope or downstream of project site.

16) Maintain a supply of erosion control materials onsite, to facilitate a quick response to unanticipated storm events or emergencies.

17) Use erosion controls to protect and stabilize stockpiles and exposed soils to prevent movement of materials. Use devices such as plastic sheeting held down with rocks or sandbags over stockpiles, silt fences, or berms of hay bales to minimize movement of exposed or stockpiled soils.

18) Stockpile excavated material in areas where it cannot enter the stream channel.

19) Prior to start of construction, determine whether safe locations for excavation materials are available at or near the project location. If unavailable, determine location where material will be deposited. If feasible, conserve topsoil for reuse at project location or use in other areas.

20) Minimize temporary stockpiling of excavated material.

21) When needed, utilize instream grade control structures to control channel scour, sediment routing, and headwall cutting.

22) Immediately after project completion and before close of seasonal work window, stabilize all exposed soil with mulch, seeding, and/or placement of erosion control blankets.

MEASURES TO MINIMIZE LOSS OR DISTURBANCE OF RIPARIAN VEGETATION

(CA Salmonid Stream Habitat Restoration Manual: Chapter IX 2003)

23) Prior to construction, determine locations and equipment access points that minimize riparian disturbance. Avoid affecting less stable areas.

24) Retain as much understory brush and as many trees as feasible, emphasizing shade producing and bank stabilizing vegetation.

25) Minimize soil compaction by using equipment with a greater reach or that exerts less pressure per square inch on the ground, resulting in less overall area disturbed or less compaction of disturbed areas.

26) If riparian vegetation is to be removed with chainsaws, consider using saws currently available that operate with vegetable-based bar oil.

27) Decompact disturbed soils at project completion as the heavy equipment exits the construction area.

28) Revegetate disturbed and decompacted areas with native species specific to the project location that comprise a diverse community of woody and herbaceous species.

MEASURES TO MINIMIZE IMPACTS TO AQUATIC HABITAT AND SPECIES DURING DEWATERING OF PROJECT SITE - See *Chapter 6.5 Dewatering*

BMP TOOLBOX

Streambank Protection - Biotechnical BMPs
- Brush Mattress
- Joint Planting
- Large Woody Debris Revetment
- Willow Wall Revetment
- Live Fascine
- Live Stakes
- Fabric Reinforced Earth Fill with Brush Layering

Streambank Protection - Hardscape BMPs
- Boulder/Riprap
- Vegetated Concrete Cribwall
- Streambed Gravel

Water Management BMPs
- Aqua Barrier
- Coffer Dam
- Dewatering
- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside
- Stream Bypass

Erosion / Sediment Control BMPs
- Silt Fence
- Turbidity Curtain
- Branch Packing

Culvert BMPs
- Energy Dissipater

Planning and Prevention BMPs
- Seasonal Planning

PERMITS

Activity or Condition	Required permit or limitation
• Replacing riprap • Removing or altering large woody debris (non-emergency debris maintenance) ***or*** •Otherwise altering a channel	• CWA 404 - COE • CWA 401 – RWQCB • CDFW 1601 • NOAA Fisheries consultation
In a Coastal Zone, work is exempt from a coastal development permit unless: • subject to review under Section 1601 of the Fish and Wildlife Code • excavation or disposal of fill is outside of the roadway prism	Coastal Zone Development Permit (County or City planning department)
BMPs that may involve “take” which includes but is not limited to dewatering, coffer dams, diversion berms, and stream bypass structures.	• (NOAA Fisheries or USFWS) ESA Section 10 Incidental Take Permit • (CDFW) CESA Section 2081 Incidental Take Permit

6.2 CULVERT CLEANING, REPAIR AND REPLACEMENT AT STREAM CROSSINGS

DESCRIPTION

Water Quality

Culverts, bridges, and other stream crossing structures must be periodically maintained or replaced to preserve their function of passing stream flows and wood, to prevent flooding, to prevent damage to the structure, and to avoid sediment inputs to the stream channel by eroding or "washed-out" culverts. Using best management practices when maintaining these structures will help in a "first line defense" to protect and improve water quality.

See *California Salmonid Stream Habitat Restoration Manual* (CDFW Chapter X, 4th Edition Ford and Armored Fill). See *Handbook for Forest and Ranch Roads* (Mendocino County Resource Conservation District). Cal Fire *Designing Waterway Crossings for Passage of 100-year Flood Flows, Wood and Sediment*. Best Management Practices in *Section 6.1- General Principles for Working In or Near Stream Channels* should be adhered to during routine culvert maintenance or project implementation.

Stream Crossings on Salmon Streams

Many of today's culverts were installed long ago on salmonid bearing streams before standards were developed for fish passage. Many of these culverts now present problems for salmon that need to swim upstream to spawn or find colder water in the upper tributaries during hot summer months. Fish passage barriers also cause problems when juvenile salmon leave the river to migrate out to sea in the spring. See *Chapter 4 Stream Habitat and Salmon Fisheries* for more details on salmon habitat needs and lifecycles.

Fish Passage Projects

The best management practices presented in this chapter will assist County staff in preparing projects for fish passage in consultation with permitting agencies. Also see the following publications for further details: Guidelines for Salmonid Passage at Stream Crossings, NOAA Fisheries 2001 and Culvert Criteria for Fish Passage; CDFW Salmonid Stream Habitat Restoration Manual; CH IX 2002.

Culvert sizing

Where feasible, when replacing existing drainage structures at stream crossings, size the new structure for the 100-year storm event. Determine sizing needs by calculations using procedures such as the Rational Method or the USGS Regression method (Cal Fire 2004). Consult County engineers for stream crossing sizing protocols.

Diversion Potential at Stream Crossings

Diversion potential is usually only considered at culverted stream crossings. Stream crossings should be constructed to prevent diversion of flood overflow if the culvert were to become plugged. A stream crossing has diversion potential if the road climbs through the crossing and one approach slopes away from the crossing. A 'critical dip/culvert' in the road surface will capture the overflow from the flooded crossing and redirect the flow back into the original channel below the road. A critical dip/culvert is installed higher in the fill than crossing culvert and on the downhill side of the crossing, usually the location where the flood waters would overtop the road. Also if a road is outsloped or banked steeper than the road grade through the crossing may be the best way to redirect flood flows back into the original channel downstream of the road. See *Appendix A*, BMP-Critical Dip/Culvert for details. See *Diversion Potential at Road-Stream Crossings* Furniss et al (1997).

Plug Potential of Stream Crossings

Most culverted stream crossings have not been designed to accommodate (or pass) organic debris and heavy sediment loads. Culverts installed decades ago were often set high in the fill, not at the natural channel grade, and out-of-line with the natural channel. Culverts set in shallow relative to channel grade encourage culvert plugging, increase maintenance requirements and can result in severe outlet erosion where shotgun culverts discharge onto unprotected fillslopes. Installation of a single post trash rack should be considered above the inlet of all culverted stream crossings.

ENVIRONMENTAL CONCERNS

- Discharge of sediment or debris to streams or waterways.
- Impeding or altering fish or amphibian passage.
- Altered flows (e.g. by dewatering), changes in channel shape, (e.g. widening by removal of sandbars and vegetation), changes in channel carrying capacity or ability to pass debris, increased potential for flooding, or damage to road or other structures.
- Harm to aquatic or riparian vegetation, or aquatic or riparian species; for example removing sediment from a culvert in a waterway that has fish may directly harm salmonids or their habitat.

BMP OBJECTIVES

- Restore or improve fish passage for all life stages of salmonids, providing fish access to valuable upstream habitat.
- Improve channel’s ability to convey debris flows, including sediment, gravel, cobbles and woody debris, without removing sandbars and vegetation (which often leads to channel widening).
- Upgrade size of new and replacement culverts to 100-year storm capacity where feasible.
- Install a single post trash rack above culvert inlet to reduce plug potential.
- Install a critical culvert or dip road to reduce diversion potential at culverted stream crossing.
- Restore or improve stream flow conveyance function of culverts.
- Properly identify potential blockages based on fish passage criteria approved by DFW.
- Reduce potential for erosion at stream crossings.
- Protect stream bank root habitat and riparian vegetation

BEST MANAGEMENT PRACTICES

<u>CULVERT CLEANING</u>

1) Inspect culverts and other crossings annually before the rainy season (prior to October 15th), and after the first major rainfall event (2 year event), when feasible. Inspect suspected problematic culverts as necessary after that, depending on intensity and frequency of rain events.

2) Schedule work to take into account the life cycles of salmon and steelhead and any other pertinent threatened or endangered species such as California red-legged frogs, and fresh water shrimp. Consult with a fisheries biologists to identify seasonal work restrictions or limitations on procedures to protect threatened or endangered species in the work area.

3) Perform all work in dry conditions, and do not work in flowing waters. If a stream is flowing, use Coffer Dam or Dewatering BMPs as needed.

4) Identify riparian areas and potential fish habitat before cleaning culverts. Consult with appropriate staff or agency biologists with questions about the extent of riparian areas or fish at the crossing.

5) Exercise caution when using equipment in riparian areas and potential fish habitat. Inspect equipment for leaks, damage and buildup of oils and grease prior to performing work. Monitor frequently for leaks and equipment failure, and avoid causing damage to vegetation, sandbars, and surrounding environment. If leaks are detected during operation, equipment should be immediately removed from the area, and the spill properly cleaned.

6) Report to supervisors the locations of culverts that appear damaged, may impede fish passage, or may cause erosion. This is a critical first step to protecting fish-bearing streams. NOAA Fisheries and CDFW have established fish passage criteria for culverts. Typical problems to watch for during inspection of culverts and other crossings are:

- Excessive velocities in a culvert (culvert set at too steep a slope for juvenile fish to swim through at high flows);
- Lack of water depth in a culvert;
- Perched culvert outlet (i.e. outlet is physically above the streambed);
- Lack of depth in an outlet pool preventing fish from jumping up into culvert;
- Obstructions within a culvert; and
- Physical damage to fish from deteriorating and jagged corrugated metal.

7) Dispose of all sediment and debris from culvert cleaning according to *Chapter 7.3- Spoils Handling and Disposal*. Never dispose of material along the banks or in the floodplain where it could be delivered back to the channel during the next rainstorm.

CULVERT REPAIR AND REPLACEMENT *See Chapter 6.5 Dewatering for instruction when replacing stream crossing.*

8) The minimum diameter recommended for all new stream crossing culverts is 24 inches. Small diameter culverts can easily plug with debris, causing flow to flood the road surface. They are also difficult to clean.

9) Except during emergency conditions, schedule culvert repair or replacement during the dry season (between April 15th and October 15th). Do not perform culvert repair or replacement in wet conditions or during the rainy season unless permitted. Rain and flooding greatly increase the risk of pollutant runoff.

10) Schedule work to take into account the life cycles of salmon and steelhead and any other pertinent threatened or endangered species such as California red-legged frogs and fresh water shrimp. Consult with a fisheries biologists to identify seasonal work restrictions or limitations on procedures to protect threatened or endangered species in your area. These limitations will be part of the permits you will need to complete this work.

11) Where feasible replace existing drainage structures with a new structure sized for the 100-year storm event. Determine sizing needs by calculations using procedures such as the Rational Method or the USGS Regional Regression Equations. Consult County engineers for stream crossing sizing protocols.

12) New stream crossing culverts should be aligned with the natural stream channel to ensure proper function and to prevent bank erosion. Culverts should be installed at the base of the road fill and at the grade of the original streambed to reduce plug potential at the inlet and scour at the outlet. If culvert cannot be placed at stream grade then outboard fillslope should be rock armored to prevent erosion.

13) All culverted stream crossing should have a single post trash rack installed above the inlet to reduce plug potential. See Appendix A for typical drawing.

- Trash rack should be installed center to the culvert inlet and at a distance up channel of the inlet that is equal to the diameter of the culvert.
- The single post should be at least as high as the top of the culvert.
- T-post trash rack can be used for any culvert less than or equal to a 30” culvert. At stream crossings with larger culverts, the size of the bedload being transported should be looked at to determine appropriate material needed for the single post.

14) Before replacing or altering culverts or bridges on fish-bearing streams, consult appropriate engineering and design staff familiar with NOAA Fisheries and CDFW criteria. *Guidelines for Salmonid Passage at Stream Crossings*, NOAA, 2001. The proposed design and mitigations will be part of the NOAA Fisheries and CDFW permit applications. Fish passage can be computed by Roads Engineers by using Fish Xing Software for culvert design and assessment, at www.stream.fs.fed.us/fishxing/

15) Options for anadromous fish-bearing stream crossings, in order of preference are:
(Bates et al. 1999; Robison et al. 1999; NOAA, 2001.)

a. No crossing – realign road to avoid crossing the stream.
b. Bridge spanning the stream to allow for long-term dynamic channel stability; making sure there is no encroachment into the channel or 100-year flood plain. When installing or replacing a stream crossing, bridges are strongly preferred for fish-bearing streams.
c. Streambed simulation strategies: Bottomless arch, or embedded culvert.
d. Culvert set below stream-grade (countersunk or embedded).
e. Non-embedded culvert set at a low gradient (less than 0.5%) to allow for fish passage.
f. Baffled culvert, or structure designed with a fishway – for steeper slopes (greater than 0.5%). Baffles are not generally recommended because they require continual clearing of debris and maintenance to function properly, and require a longer, more difficult

permit process.

g. Culvert set at grade with baffles installed to allow low-flow passage and reduced velocities during higher migration flows.
h. Culvert perched with outlet pool weirs and baffles throughout culvert. Entry jumps should never exceed 1 foot for adults or 0.5 feet for juveniles.

16) Design criteria for anadromous fish-bearing stream crossings' proper sizing and alignment are: (Bates et al. 1999; Robison et al. 1999)

- Pass a 100-year storm flow at less than 100 percent of the culvert's height, to allow passage of large wood and channel substrate during high flows.
- Culvert width sized at least equal to active channel width, or ordinary high water flow (OHW), which is approximately at line of annual vegetation growth. Reduce or eliminate constriction of flows at the inlet associated with fish migration.
- Align culvert with upstream channel direction – avoid sharp bends in channel at approach to inlet.
- If there are channel constraints at the crossing, the culvert is likely undersized or placed in an inappropriate location.
- Use channel alterations judiciously and avoid channel confinement in fish bearing streams.

17) Implement appropriate Water Management and Culvert BMPs while replacing or retrofitting culverts, and Stream bank Protection BMPs and Erosion and Sediment Control BMPs to control sediment discharge during work.

18) When restoring the surrounding site after culvert replacement or retrofitting, stabilize the work area and prevent erosion by using appropriate Stream bank Protection BMPs and Erosion Control BMPs.

19) Use of biotechnical BMPs and native vegetation is preferable over hardscape techniques when appropriate for the site conditions and engineering constraints. For biotechnical BMPs that require the establishment of vegetative cover, plan and implement ongoing vegetation maintenance and irrigation as needed.

20) When using hardscape BMPs for streambank stabilization, work to incorporate planting of trees, shrubs or erosion control grasses into designs.

21) In pools downstream of culverts, bridges, and other structures, always leave vegetation to provide cooling shade, shelter and cover for aquatic animals. (See *Chapter 8-Vegetation Management*.)

22) Using Water and Sediment Management BMPs, capture runoff from bridge structures with long or wide spans.

23) After completion of construction, monitor the performance of long-term BMPs periodically, particularly after significant storm events. Perform immediate repairs or upgrades as necessary.

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning

Culvert BMPs

- Back-Flooding Weirs
- Baffles for Fish Passage Improvement
- Energy Dissipater
- Culvert Sizing
- Single Post Trash Rack
- Critical Culvert

Stream bank Protection - Preferred Biotechnical BMPs

- Brush Mattress
- Joint Planting
- Large Woody Debris
- Live Fascine
- Live Stakes
- Fabric Reinforced Earth Fill with Brush Layering

Stream bank Protection - Hardscape BMPs

- Boulder/Riprap
- Vegetated Concrete Cribwall
- Streambed Gravel

Water Management BMPs

- Aqua Barrier
- Coffer Dam
- Dewatering (Pumping or Draining)
- Diversion Berm
- Sandbag
- Stream Bypass

Erosion / Sediment Control BMPs

- Silt Fence
- Turbidity Curtain
- Energy Dissipater
- Concrete Containment

Note: Before replacing or altering culverts or bridges, consult agency biologists and obtain appropriate permits from CDFW, RWQCB, COE, and NOAA Fisheries. In stream channels with anadramous fish habitat, state and federal permits require culverts be designed for fish passage. CDFW's Fish Passage Criteria and Guidelines (Chapter X, DFW Stream Restoration Manual) address the passage needs of all aquatic animals, not just anadramous fish. NOAA Fisheries': Guidelines for Salmonid Passage on Stream Crossings, address the needs of migrating salmonid fish.

PERMITS

Activity or Condition	Required permit or limitation
Culvert replacement.	(CDFW) Fish & Wildlife Code Section 1602 Streambed Alteration Agreement with CEQA compliance. Maintenance requires an annual or multi-year agreement. CESA 2081 incidental take permit from CDFW if state-listed *endangered* species are in the stream and if an ESA Section 10 incidental take permit has not already been obtained. RWQCB CWA 401 permit Under CWA 404, consultation with NOAA Fisheries and/or US Fish and Wildlife Service, (through the ACOE) is triggered under ESA Section 7, for federally-funded and permitted activities. Take authority is required if take of listed salmonid
Placement of any fill in streams (e.g. rock in pools below culverts), or any material into wetlands.	U.S. Army COE 404 CWA
Sediment reduction projects at stream crossings with potential to affect fish passage	Under CWA 404: • NOAA Fisheries consultation, triggered under ESA Section 7 for federally-funded and permitted activities ***and either*** • (COE) General-Nationwide Permit (#14) – "Linear Sediment Reduction Projects at Water Crossings" ***or*** • (COE) General-Regional Permit (#1) – "Fish Passage / Sediment Reduction Projects at Water Crossings"
Activities in the Coastal Zone are exempt from permit unless: • subject to review under Section 1601 of the Fish and Wildlife Code, OR • excavation or disposal of fill is outside of the roadway prism.	Coastal development permit from County or City Planning Departments.

HELPFUL REFERENCES

Bates et al. 1999. Fish Passage Design at Road Culverts. Washing Department of Fish and Wildlife. http://wdfw.wa.gov/publications/00049/wdfw00049.pdf

CDFW 2002, Salmonid Stream Habitat Restoration Manual; Culvert Criteria for Fish Passage CH IX http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

Cal Fire, 2004. Designing Waterway Crossings for Passage of 100-year Flood Flows, Wood and Sediment. http://www.calfire.ca.gov/resource_mgt/downloads/reports/ForestryReport1.pdf

Furniss, M.J., T.S. Ledwith, M.A. Love, B. McFadin, S.A. Flanagan. 1998. Response of road-stream crossings to large flood events in Washington, Oregon, and Northern California. USDA Forest Service. Technology and Development Program. 9877--1806—SDTDC. 14 p. http://www.stream.fs.fed.us/water-road/w-r-pdf/floodeffects.pdf

Furniss, M.J., M. Love, and S.A. Flanagan. 1997. Diversion potential at road-stream crossings. Water/Road Interaction Technology Series 9777 1814-SDTDC. San Dimas CA: U.S. Department of Agriculture, Forest Service, Technology and Development Program. http://www.stream.fs.fed.us/water-road/w-r-pdf/diversionpntl.pdf

Robison, E. G., Mirati, A., and Allen, M., 1999. Oregon Road/Stream Crossing Restoration Guide. Washing Department of Fish and Wildlife. http://www.oregon.gov/ODF/privateforests/docs/rdstrmcrossrestorguide.pdf

Weaver, W.E. and D.K. Hagans. 1994, Handbook for Forest and Ranch Roads. Prepared for Mendocino County Resource Conservation District. http://www.krisweb.com/biblio/gen_mcrcd_weaveretal_1994_handbook.pdf

NOAA Fisheries 2001, Guidelines for Salmonid Passage at Stream Crossings. http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_passage_at_stream_crossings_guidance.pdf

6.3 WOODY DEBRIS

DESCRIPTION

A healthy salmon stream is chock full of large wood - big logs and rootwads - that dig into the banks and help form channel complexity, making pools and providing food and shelter. Wood is a key link in the ecosystem of salmonids. Restorationists and public agencies have taken on the task of placing large woody debris (LWD) structures into creeks to benefit salmon. While restoration certainly helps***, our goal in this section is to provide guidelines on how to keep wood in the creek in the first place*****.**

For the purpose of this manual Large Woody Debris (LWD), is defined as stumps, rootwads and logs having an average diameter greater than 6 inches and a length greater than 10 feet. In reference to woody debris management it is best to think about ***modification***, rather than removal, whenever feasible. Removal of wood from creeks has such a negative impact on salmon, that as a general practice, it should not be done unless there is a very real threat to County property or public safety. Best Management practices outlined below will help guide crews in avoiding or minimizing this impact.

One of the very best ways to allow wood to stay in the creek is to maintain culverts and bridges that pass the 100-year flood flows. This ensures that large debris flows will also pass, creating more natural channel conditions overall. See *6.2 Culvert Cleaning, Repair and Replacement*.

Note*:* The maintenance practices covered in this section *do not* include traditional channel maintenance or flood control activities. For information on flood control or channel maintenance BMPs, please refer to Napa County Flood Control and Water Conservation District Stream Maintenance Manual (http://www.countyofnapa.org/FloodDistrict/).

ENVIRONMENTAL CONCERNS

- Loss of instream habitat due to wood removal.
- Harm to instream aquatic habitat or aquatic species.
- Harm to riparian areas and riparian species.
- Alteration of natural channel function or shape or destabilization of stream banks.
- Water pollution from equipment operation.
- Alteration of stream hydraulics and diversion of stream energies that may cause downstream erosion or structural damage.

BMP OBJECTIVES

- Preserve and protect important woody debris in creeks to the extent possible.
- Prevent potential water pollution from equipment operations.

BEST MANAGEMENT PRACTICES

1) Only remove (as opposed to modify) logs and debris from streams as a “last resort” when accumulation of debris poses a threat to road stability and bridges, culverts or other instream structures.

2) Have both a biologist and an engineer conduct a full review of the situation. The biologist should be familiar with the life histories and habitat needs of federally listed plants and animals in the area and be able to identify any of the life stages of these species. If in doubt as to the best way to handle large woody debris in a stream, consult with CDFW personnel.

3) If log jams immediately threaten, or are damaging the integrity of roads, bridges, other public facilities during high flows, consider opportunities to ***modify*** the debris jam to halt damage and direct flow toward a more desirable path.

4) Take precautions to ensure that modifications of logs or debris jams will not cause damage downstream to culverts and other structures.

5) Limit modifications and/or removal to materials that extend higher than approximately two feet above the streambed (i.e., above knee height) to preserve some instream habitat features, *unless* the log or debris jam is immediately upstream and threatening a culvert or bridge, or if permit conditions require otherwise.

6) When modifying log jams, leave trees, logs and/or stumps in the longest lengths and diameters practicable for removal and hauling. If logs must be cut from fallen trees, leave as much as possible of the main trunk (12 feet plus is desirable) attached to the rootball and only cut branches obstructing flow. Log jams create suitable habitat for salmonids, California red-legged frogs, and fresh water shrimp so where applicable this should be considered before removing or modifying any logjams.

7) Whenever feasible, incorporate LWD removed from water bodies into stream bank repairs or cribbing at a nearby location, and/or transport any removed LWD to an approved storage site and make available for later use (e.g., in stream restoration activities).

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning

PERMITS

Activity or Condition	**Required permit or limitation**
Removing or modifying large woody debris within the stream channel	California Fish & Wildlife Code Section 1602 Streambed Alteration Agreement with CEQA compliance. Maintenance requires an annual or multi-year agreement. Discuss possibilities with Napa County Flood Control and Water Conservation District prior to taking action.

6.4 STREAM BANK STABILIZATION

DESCRIPTION
Many County roads wind along the edge of important salmon streams. Crews, as part of their work to maintain these roads need to implement streambank stabilization projects, in order to repair road-related slipouts, washouts, and slides. When the stream is so nearby, it is especially critical to consider bio-engineered alternatives, in order to create streambank habitat that salmon need to survive. Bio-engineering also allows a more natural channel and prevents scour of downstream areas. The Napa County Flood Control and Water Conservation District should be contacted prior to performing stabilization activities. While these activities might be considered *projects*, versus *routine maintenance*, it is critical to expand the scope of this chapter to cover this important subject which is critical to stream and salmon fisheries protection.

Note*:* The maintenance practices covered in this section *do not* include traditional channel maintenance or flood control activities. For information on flood control or channel maintenance BMPs, please refer to Napa County Flood Control and Water Conservation District Stream Maintenance Manual (http://www.countyofnapa.org/FloodDistrict/).

Activities may include:
- removal of slide debris from the bank, channel, or roadway,
- construction of terraces with willow walls or other bioengineered solutions,
- construction of crib walls or retaining structures,
- use of rip rap or other hardscape materials,
- backfilling or reshaping the bank,
- re-establishing damaged roadway features,
- repairing and cleaning drainage systems,
- applying erosion controls,
- replanting and monitoring of revegetation.

Bank stabilization may be an emergency response to mitigate ongoing or imminent damage, or a planned project. Refer to *Chapter 10.2- Emergency Slide and Washout Repair* for bank stabilization activities under Emergency Conditions.

ENVIRONMENTAL CONCERNS
- Discharge of sediment or debris to streams or waterways.
- Harm to or loss of streamside aquatic habitat.
- Harm to or loss of riparian areas.
- Water pollution from equipment operations.
- Hardening of stream bank channel and alteration in channel hydraulics that may increase water velocities and downstream erosional forces, and lead to loss of riparian habitat.

BMP OBJECTIVES
- Protect water quality by reducing erosion/sedimentation.
- Prevent potential water pollution from equipment operations.

- Encourage revegetation to stabilize slope and protect aquatic and riparian habitat.

BEST MANAGEMENT PRACTICES

1) Schedule work to accommodate the life cycles of salmon, steelhead and other threatened or endangered species such as California red-legged frogs and freshwater shrimp. Consult with a fisheries biologists to identify seasonal work restrictions or limitations to protect threatened or endangered species. These limitations will be part of the permits you will need to complete this work.

2) In order to create a natural stream bank environment, use biotechnical repairs, versus riprap or other hardscape repairs, if site conditions allow.

3) Inspect equipment for leaks, damage and buildup of oils and grease prior to performing work; and perform maintenance at designated repair facilities. If equipment must be refueled in the field, perform fueling in identified staging areas well away from stream or riparian areas and maintain an absorbent spill kit.

4) Implement appropriate Erosion Control and Water and Sediment Management BMPs as referenced in the BMP Toolbox section below during bank stabilization projects.

5) Set up the work and staging area to minimize the area of soil that will be disturbed and the tracking of soil out of the work area by vehicles and equipment. Avoid staging projects in areas where runoff will be concentrated or may run into a waterway.

6) When installation of riprap or other hardscape repairs is required to protect structures:
- Consult with qualified engineering or planning staff about the appropriate size of hardscape protection needed, the appropriate placement techniques, and the potential usage of biotechnical protection in conjunction with the hardscape protection;
- Attempt to limit hardscape protection to below the ordinary high water mark;
- Incorporate plantings, designed to allow tree growth, into hardscape designs; and
- Key into the bank as appropriate.

7) Minimize erosion and impacts to bank toe during stabilization by:
- Leaving as much vegetation as possible
- Using downstream energy dissipation features such as pools or grade control structures, and other protection BMPs such as riparian enhancement planting, strategic placement of rock, and flow deflectors. Hardscape often causes increased flow velocity at bank protection sites, thereby increasing erosion downstream. (For more information on appropriate Erosion Control, Water and Sediment Management BMPs. (see *BMP Toolbox* below, and *Chapter 7 Erosion Control – General*.)

8) When excavating slide material, minimize the size of the disturbed area by removing only the amount of slide debris needed to prevent future slope failure and delivery of material to the stream. Dispose of slide debris and other spoils according to procedures discussed in *Chapter 7.3 Spoils Handling and Disposal*.

9) For biotechnical BMPs that require the establishment of vegetative cover, plan and implement ongoing vegetation monitoring, maintenance and irrigation as needed.

10) After completing construction, monitor the performance of long-term BMPs periodically, particularly after significant storm events. Perform immediate repairs or upgrades as necessary.

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning

Streambank Protection - Preferred Biotechnical BMPs

- Brush mattress
- Joint Planting
- Large Woody Debris
- Live Fascine
- Live Stakes
- Fabric Reinforced Earth Fill with Brush Layering

Streambank Protection - Hardscape BMPs

- Boulder/Riprap
- Streambed Gravel

Water Management BMPs

- Aqua Barrier
- Coffer Dam
- Dewatering
- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside
- Stream Bypass

Erosion / Sediment Control BMPs

- Silt Fence
- Brush packing
- Turbidity Curtain
- Energy Dissipater

PERMITS

Activity or Condition	Required permit or limitation
Any non-emergency bank stabilization work	Complete ***before*** work starts: • U.S. Army Corps of Engineers 404 Permit • Regional Water Quality Control Board 401 Water Quality Certification • California Department of Fish and Wildlife Streambed Alteration Agreement 1602. • NOAA Fisheries consultation
Emergency work	See *Chapter 10.2- Emergency Slide and Washout Repair*, for documentation protocol and permit requirements.

6.5 DEWATERING

DESCRIPTION

When work in flowing streams is unavoidable, stream flow may be diverted around the work area by construction of a temporary dam or bypass. Dewatering is the removal of water from the work area. The purpose is to prevent water from interfering with the work (e.g., culvert repair, excavation, bank stabilization, etc.), and to prevent the discharge of contaminants such as suspended sediment and concrete. Dewatering may include damming, creating a stream bypass, pumping or draining. The dewatering of anadromous fish streams must be conducted in consultation with the California Department of Fish and Wildlife and NOAA fisheries. A fisheries biologist with state and federal "take" permits will be required to be on-site to relocate any salmonids that become stranded during the dewatering process. An individual project permit may include incidental take requirements specific to dewatering.

ENVIRONMENTAL CONCERNS

- Discharge of sediment or debris to streams or waterways.
- Harm to instream aquatic habitat or aquatic species such as fish and amphibians.
- Temporal disruption of fish passage.

BMP OBJECTIVES

- Protect water quality by reducing erosion and sedimentation.
- Avoid negative impacts to aquatic and riparian habitat and species.
- Maintain or restore fish passage.

BEST MANAGEMENT PRACTICES

1) Consult with agency biologists and obtain necessary permits before beginning project (see *Permits* below). Schedule work to take into account the life cycles of salmon and steelhead and any other threatened or endangered species such as California red-legged frogs and fresh water shrimp. Consult with agency biologists to identify seasonal work restrictions or limitations on procedures to protect threatened or endangered species in your area. These limitations will be part of the permits you will need to complete this work.

2) If salmonids are present, a fisheries biologist needs to be on site before work begins to net fish and move them downstream. Fish relocation will continue as dewatering proceeds until all fish are removed from the work area.

3) Prior to dewatering, the best means to bypass flow through the work area will be determined to minimize disturbance to the channel and avoid direct mortality of fish and other aquatic vertebrates.

4) The area to be dewatered will encompass the minimum area necessary to perform maintenance activity.

5) The period of dewatering will encompass the minimum amount of time needed to perform the maintenance activity.

6) If salmonids are present, pump intakes must be screened according to NOAA Fisheries guidelines (Fish Screening Criteria for Anadromous Salmonids 1997). Pump screens should be constructed of sturdy metal mesh material (preferably stainless steel) and must be large enough to prevent suction from impinging small fish on the screen surface.

7) If a work site is to be temporarily dewatered after fish relocation has been completed, pump intakes should be completely screened with wire mesh not larger than 5 millimeters to prevent amphibians from entering the pump system.

8) Pump discharge pipes and hoses should be designed to minimize turbidity and the potential to wash contaminants into the stream. A filtration/settling system must also be included to reduce downstream turbidity (e.g. filter fabric, turbidity curtain, etc.). The selection of an appropriate system is based on the rate of discharge. If feasible, water that is pumped into a pipe should discharge onto the top of bank into a densely vegetated area. This may require extra hose length.

9) Note pre-construction grade prior to placement and return channel bottom, cofferdam areas and discharge sites to preconstruction grades.

10) Once the project work is complete, release water slowly back into the work area to prevent erosion and increased turbidity. If salmonids are present upstream of the site, a fisheries biologist should be onsite during the rewatering phase to ensure no fish are stranded as water levels drop.

EXAMPLE DEWATERING REQUIREMENTS THAT MAY BE INCLUDED IN PERMITS

11) Work must be performed in isolation from the flowing stream. If there is any flow when the work is done, the operator shall construct coffer dams upstream and downstream of the excavation site and divert all flow from upstream of the upstream dam to downstream of the downstream dam. The coffer dams may be constructed with clean river gravel or sand bags, and may be sealed with sheet plastic. Sand bags and any sheet plastic shall be removed from the stream upon project completion. Clean river gravel may be left in the stream, but the coffer dams must be breached to return the stream flow to its natural channel.

12) For minor actions, where the disturbance to construct coffer dams to isolate the work site would be greater than to complete the action (for example, placement of a single boulder cluster), measures will be put in place immediately downstream of the work site to capture suspended sediment. This may include installation of silt catchment fences across the stream, or placement of a filter berm of clean river gravel. Silt fences and other non-native materials will be removed from the stream following completion of the activity. Remove sediment behind the silt fence before removing the fence. Gravel berms may be left in place after breaching, provided they do not impede the stream flow.

13) If it is necessary to divert flow around the work site, either by pump or by gravity flow, the suction end of the intake pipe shall be fitted with fish screens meeting DFW and NMFS

criteria to prevent entrainment or impingement of small fish. Any turbid water pumped from the work site itself to maintain it in a dewatered state shall be disposed of in an upland location where it will not drain directly into any stream channel.

14) Measures shall be taken to minimize harm and mortality to listed salmonids resulting from fish relocation and dewatering activities:

a) Fish relocation and dewatering activities shall only occur between June 15 and November 1 of each year.
b) The amount of wetted stream channel that is dewatered at each individual project site shall be minimized to the fullest extent possible.
c) All electrofishing shall be performed by a qualified fisheries biologist and conducted according to the National Marine Fisheries Service *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act*, June 2000.

MEASURES TO MINIMIZE IMPACTS TO AQUATIC HABITAT AND SPECIES DURING DEWATERING OF PROJECT SITE

(California Salmonid Stream Habitat Restoration Manual Fish Passage Evaluation CH IX 2003)

15) Prior to dewatering, determine the best means to bypass flow through the work area to minimize disturbance to the channel and avoid direct mortality of fish and other aquatic vertebrates.

16) Coordinate project site dewatering with a fisheries biologist qualified to perform fish and amphibian relocation activities.

17) Minimize the length of the dewatered stream channel and duration of dewatering.

18) Bypass stream flow around work area and maintain flow to channel below construction site.

19) The work area must often be periodically pumped dry of seepage. Place pumps in flat areas, well away from the stream channel. Secure pumps by tying off to a tree or stake in place to prevent movement by vibration. Refuel in area well away from stream channel and place fuel absorbent mats under pump while refueling. Pump intakes should be covered with 1/8" mesh to prevent entrainment of fish or amphibians that failed to be removed. Check intake periodically for fish or amphibians.

20) Discharge wastewater from construction area to an upland location where it will not drain sediment-laden water back to stream channel.

MEASURES TO MINIMIZE INJURY AND MORTALITY OF FISH AND AMPHIBIAN SPECIES DURING DEWATERING

(California Salmonid Stream Habitat Restoration Manual Fish Passage Evaluation CH IX 2003)

Prior to dewatering a construction site, fish and amphibian species should be captured and relocated to avoid direct mortality and minimize take. This is especially important if listed species are present within the project site. The following measures are consistent with those defined as *reasonable and prudent* by NOAA for projects concerning several northern California Evolutionary Significant Units for coho salmon, chinook salmon, and steelhead trout.

21) Fish relocation activities must be performed only by qualified fisheries biologists, with a current CDFW collectors permit, and experience with fish capture and handling. Check with the Napa County Resource Conservation District or your local CDFW biologist for assistance.

22) In regions of California with high summer air temperatures, perform relocation activities during morning periods.

23) Periodically measure air and water temperatures. Cease activities when water temperatures exceed temperatures allowed by CDFW and NOAA.

24) Exclude fish from re-entering work area by blocking the stream channel above and below the work area with fine-meshed net or screens. Mesh should be no greater than 1/8 inch. It is vital to completely secure bottom edge of net or screen to channel bed to prevent fish from re-entering work area. Exclusion screening should be placed in areas of low water velocity to minimize impingement of fish. Screens should be checked periodically and cleaned of debris to permit free flow of water.

25) Prior to capturing fish, determine the most appropriate release location(s). Consider the following when selecting release site(s):

- Similar water temperature as capture location
- Ample habitat for captured fish
- Low likelihood of fish re-entering work site or becoming impinged on exclusion net or screen.

26) Determine the most efficient means for capturing fish. Complex stream habitat generally requires the use of electrofishing equipment, whereas in outlet pools, fish may be concentrated by pumping-down pool and then seining or dip-netting fish. Electrofishing is discouraged in Napa County.

27) Electrofishing should only be conducted by properly trained personnel following CDFW and NOAA guidelines. It is discouraged in Napa County.

28) Minimize handling of salmonids. However, when handling is necessary, always wet hands or nets prior to touching fish.

29) Temporarily hold fish in cool, shaded, aerated water in a container with a lid.

30) Provide aeration with a battery-powered external bubbler. Protect fish from jostling and noise and do not remove fish from this container until time of release.

31) Place a thermometer in holding containers and, if necessary, periodically conduct partial

water changes to maintain a stable water temperature. If water temperature reaches or exceeds those allowed by CDFW and NOAA, fish should be released and rescue operations ceased.

32) Avoid overcrowding in containers. Have at least two containers and segregate young-of- year (YOY) fish from larger age-classes to avoid predation. Place larger amphibians, such as Pacific giant salamanders, in container with larger fish.

33) If fish are abundant, periodically cease capture, and release fish at predetermined locations.

34) Visually identify species and estimate year-classes of fish at time of release.

35) Count and record the number of fish captured. Avoid anesthetizing or measuring fish.

36) Submit reports of fish relocation activities to CDFW and NOAA in a timely fashion.

37) If feasible, plan on performing initial fish relocation efforts several days prior to the start of construction. This provides the fisheries biologist an opportunity to return to the work area and perform additional electrofishing passes immediately prior to construction. In many instances, additional fish will be captured that eluded the previous days efforts.

38) If mortality during relocation exceeds 5 percent, stop efforts and immediately contact the appropriate agencies.

BMP TOOLBOX

Water Management BMPs
- Coffer Dam
- Aqua Barrier
- Dewatering (pumping or draining)
- Stream Bypass

Planning and Prevention BMPs
- Seasonal Planning

Erosion / Sediment Control BMPs
- Silt Fence
- Turbidity Curtain
- Energy dissipater

PERMITS

Activity or Condition	Required permit or limitation
Installation of dewatering system in concurrence with a stream bank and/or channel activity	• U.S. Army Corps of Engineers 404 Permit • Regional Water Quality Control Board 401 Water Quality Certification • Consult CDFW biologists and obtain Streambed Alteration Agreement DFW1602 and 2081 incidental Take Permit with CESA/CEQA compliance if anadromous salmonids are present. • NOAA Fisheries Consultation

6.6 TEMPORARY LOW WATER CROSSING INSTALLATION AND MAINTENANCE

DESCRIPTION

Temporary stream crossings are used to allow vehicles to cross a drainage or stream without entering the water. Placing temporary stream crossings, typically during the summer or dry season, can protect sensitive areas subject to vehicle traffic by minimizing impacts to the stream bottom, and reducing erosion. Regrading and slope stabilization are necessary during installation and removal of the crossing and occasionally as maintenance activities when the crossings are impacted by excessive vehicle traffic or flooding.

The installation of low water crossings on salmon streams is a highly regulated type of project, subject to Federal and State ESA and Clean Water Act provisions. During the permit process, you will be working with agency biologists, hydrologists, fish passage experts etc., to develop protections for the stream channel and fish, from installation – maintenance - to removal.

See California Salmonid Stream Habitat Restoration Manual (CDFW Chapter X, 4th Edition Ford and Armored Fill). See Handbook for Forest and Ranch Roads (Mendocino County Resource Conservation District).

ENVIRONMENTAL CONCERNS

- Discharge of sediment to streams or waterways, particularly washing of fine materials from crossing into stream.
- Harm to aquatic habitat.
- Harm to riparian areas.
- Water pollution from equipment operations and vehicle traffic.
- Impeding fish passage.
- Alteration of channel hydraulics and subsequent downstream effects.

BMP OBJECTIVES

- Minimize disturbance to the stream or waterway.
- Protect water quality by reducing erosion/sedimentation.
- Prevent potential water pollution from equipment operations.
- Eliminate fish barriers.

BEST MANAGEMENT PRACTICES

1) Consult with appropriate agencies to obtain permits for installation and removal of crossings *(*see *Permits* below*)*. During both installation and removal of crossings, dewater area as much as feasible and keep equipment out of active channel (see *Chapter 6.5 Dewatering*).

2) Schedule work to take into account the life cycles of salmon and steelhead and any other threatened or endangered species such as California red-legged frogs and fresh water shrimp.

3) Consult with County road engineers on the appropriate number and size of culverts incorporated into a crossing. Consult with County and Resource Agency fish passage engineers (NOAA, CDFW) on meeting fish passage criteria through these culverts. (See *Chapter 6.2 Culvert Cleaning, Repair and Replacement* and *Appendix A- Culvert Sizing and Appendix C- Guidelines for Salmonid Passage at Stream Crossings, NOAA, 2001).*

4) If dewatering is necessary during construction, consult a qualified fisheries biologist, apply for appropriate permits, and implement appropriate fish removal and dewatering BMPs. (See *Chapter 6.5 Dewatering.)*

5) Best Management Practices (BMPs) for sediment and turbidity control should be implemented and in place prior to, during, and after construction in order to ensure that no silt or sediment enters surface waters. Appropriate erosion and sediment control measures should be implemented immediately after removal is complete.

6) All project related construction work should incorporate appropriate BMPs, including stabilizing and seeding disturbed upland slopes and stockpiles situated landward and above of ordinary high water, to control and minimize bank erosion, sediment input and turbidity during the winter and spring months.

7) When a temporary culvert is installed, if needed, place appropriate geotextile or cellular confinement (honeycomb) fabric in the gravel bed at the downstream outlet to reduce erosion from the water flowing through the culvert. Do not use plastic netting.

8) Fill material placed in the stream to create the base for the crossings should be clean river gravel. Material placed above water level may be a road base allowing for compaction and a suitable driving surface. Clean river gravel may be left in the river to wash out during high winter flows. Road base or material containing a high level of fines above water level should be removed from the channel below the level of “ordinary high water.” This material may be stored above the level of “ordinary high water” to be used in subsequent years.

9) Upstream and downstream turbidity should be measured at each crossing before, during, and after installation and removal. Monitor the downstream area for sediment or fine material washing off the crossing.

10) Do not treat the crossing with oil or other material that may pollute the stream, or use chemically treated materials (e.g. creosote-treated wood) to construct the crossing unless the material or treatment is certified safe for use in aquatic habitat.

11) Following the removal of the crossing the constructed roadbeds should be largely removed to reestablish the approximate contour, elevation, and condition of the affected bar area that existed prior to the seasonal roadbed construction. All excavated material should be hauled and stockpiled landward and above ordinary high water. The effected bars should be fine-graded to remove any pits and depressions that could otherwise entrap salmonid fish species and to ensure positive drainage to the low-flow channel. Where roadbeds are constructed in flowing water, the dredged or fill material should be removed

only to an elevation of two feet above the water level to minimize turbidity and sedimentation. If gravel is used, skim it off as low as possible without entering the flowing water. Trenches may be dug in gravels to allow winter flows to break through the gravel.

BMP TOOLBOX

Culvert BMPs

- Culvert Hydraulics Diagram
- Energy Dissipator
- Culvert Inlet Sediment Trap

Water Management BMPs

- Aqua Barrier
- Coffer Dam
- Dewatering
- Diversion Berm
- Stream Bypass

Erosion / Sediment Control BMPs

- Silt Fence
- Turbidity Curtain
- Blankets/Geotextile Fabrics
- Coir Log/Roll
- Planting
- Seeding

PERMITS

Activity or Condition	**Required permit or limitation**
Installation or removal of temporary stream crossings, including dewatering.	• U.S. Army Corps of Engineers 404 Permit • Regional Water Quality Control Board 401 Water Quality Certification • California Department of Fish and Wildlife Streambed Alteration Agreement CDFW 1602 and 2081 incidental Take Permit with CESA/CEQA compliance. • NOAA Fisheries Service Consultation • Consult with county engineering or planning on appropriate size and design of structure.

6.7 FORD AND ARMORED FILL CROSSINGS

DESCRIPTION
Ford and Armored fill crossings work well on unpaved seasonal use roads at small to medium sized streams where there is a stable stream bottom and traffic is light. These crossing types may be needed if there is insufficient channel depth to install a culvert. In fact, a rock lined rolling dip with a rock apron face is generally desirable compared to permanent culverts on these swales and small waterways. These crossings have the advantage, over culverted crossings of: never plugging, not rusting out, not having diversion potential, and if designed properly being constructed for the 100-year peak flow event. However, construction of these types of crossings on well-traveled roads should be avoided where water is flowing because of their potential to impact water quality.

A Ford crossing is a crossing where no fill material has been put into the stream channel. Fords of live streams, called "wet fords," are typically composed of streambed gravels, or concrete structures built in contact with the streambed so that vehicles can cross the channel. See *Appendix A* for typical drawings and construction details.

Streams with high stream banks that would require the excavation of substantial ramps to get vehicles down to the streambed may be good candidates for the construction of an 'Armored Fill' crossing. The fill material that is imported into the streams crossing needs to be rock armored to prevent erosion during periods of runoff. The fill face on the downstream side of the fill should be protected with rock armor of a large enough size class that cannot be moved by stream flows. See *Appendix A* for typical drawings and construction details.

If possible, a stable, rocky (or bedrock) portion of the channel should be selected for crossings. These crossings could impede migrating fish and installation will require approval by California Department of Fish and Wildlife. See *California Salmonid Stream Habitat Restoration Manual* (CDFW Chapter X, 4th Edition Ford and Armored Fill), *Handbook for Forest and Ranch Roads* (Mendocino County Resource Conservation District), *Appendix A* BMP Ford & Armored Fill Steam Crossing.

ENVIRONMENTAL CONCERNS
These crossings can be vulnerable to erosion and can create pollution from several sources. High traffic levels and/or high water flows can cause erosion of both natural and artificial streambed materials. Material placed in the stream or moved about by vehicle traffic can create a barrier to fish migration. Deep water crossings can cause oil products to be released from vehicles as they pass through a wet ford. Streams with high stream banks require the excavation of substantial ramps to get vehicles down to the streambed. These through-cut ramps are often sites of substantial surface erosion and rilling that enters the stream during periods of winter rain. Additional environmental concerns include:
- Discharge of sediment or debris to streams or waterways.
- Harm to instream aquatic habitat or aquatic species.
- Harm to riparian areas and riparian species.
- Alteration of natural channel function or shape or destabilization of stream banks.

BMP OBJECTIVES

- Protect water quality by reducing erosion and sedimentation.
- Size stream crossing to 100-year storm capacity where feasible.
- Avoid negative impacts to aquatic and riparian habitat and species.
- Protect stream bank root habitat and riparian vegetation.
- Where applicable maintain or restore fish passage.

BEST MANAGEMENT PRACTICES

1) Schedule stream crossing maintenance during the dry season, avoid periods which may be more harmful to fish and aquatic species of concern, such as California red-legged frogs, and fresh water shrimp. Consult with a fisheries biologists to ensure compliance. See Seasonal Planning BMP.

<u>MEASURES TO MINIMIZE DISTURBANCE FROM INSTREAM CONSTRUCTION</u>

2) Construction should generally occur during the lowest flow period of the year.

3) Construction should occur during the dry period if the channel is seasonally dry.

4) Prevent construction debris from falling into the stream channel. Any material that does fall into stream should be immediately removed in a manner that has minimal impact to the streambed and water quality.

BMP TOOLBOX

<u>Streambank Protection - Biotechnical BMPs</u>

- Brush Mattress
- Joint Planting
- Large Woody Debris Revetment
- Willow Wall Revetment
- Live Fascine
- Live Stakes
- Fabric Reinforced Earth Fill with Brush Layering

<u>Streambank Protection - Hardscape BMPs</u>

- Boulder/Riprap
- Vegetated Concrete Cribwall
- Streambed Gravel

<u>Water Management BMPs</u>

- Aqua Barrier
- Coffer Dam
- Dewatering
- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside

- Stream Bypass

<u>Erosion / Sediment Control BMPs</u>
- Silt Fence
- Turbidity Curtain
- Branch Packing

<u>Planning and Prevention BMPs</u>
- Seasonal Planning

PERMITS

Activity or Condition	**Required permit or limitation**
Installation of stream crossings, including dewatering.	• U.S. Army Corps of Engineers 404 Permit • Regional Water Quality Control Board 401Water Quality Certification • California Department of Fish and Wildlife Streambed Alteration Agreement DFG1602 and 2081 incidental Take Permit with CESA/CEQA compliance. • NOAA Fisheries Service Consultation

CHAPTER 7: EROSION CONTROL AND SEDIMENT MANAGEMENT

TABLE OF CONTENTS

7.1 EROSION CONTROL – GENERAL PRINCIPLES

DESCRIPTION

Controlling erosion and managing the run-off of sediment is a "first line of defense" action in protecting water quality and salmonid habitat. Salmon lay their eggs in nests (redds) of streambed gravels, burying them deep in the substrate of the channel. The flow of water, and the oxygen it brings with it, are critical to the survival of the eggs and the young salmon that hatch from them. If the gravels are clogged or embedded with sediment, the eggs can smother from lack of oxygen or become toxic with metabolic waste that cannot be flushed from the gravels. Sediment can also negatively impact instream insect populations, causing further harm to aquatic wildlife further up the food chain.

This chapter emphasizes the importance of implementing erosion control to keep sediment on- site, and avoid run-off situations whenever possible. We also provide tools for controlling run-off, in order to keep mobile sediment out of our rivers and wetlands.

Erosion control is an integral part of all phases in the life of County maintenance projects, including:

a) planning
b) controlling run-off and sediment coming onto or leaving the site during construction; *(temporary BMPs),*
c) incorporating appropriate BMPs into constructed infrastructure *(permanent BMPs);* and
d) monitoring, maintaining or removing temporary BMPs after a project is complete.

ENVIRONMENTAL CONCERNS

- Discharge of sediment or debris to streams or waterways.
- Alteration of stream channel shape and function through erosion and/or sedimentation.
- Damage to or destruction of riparian and aquatic habitat through erosion and/or downstream sedimentation.
- Lethal and sublethal impacts to salmonids. Creation of a barrier to fish passage.
- Damage to or destruction of upslope vegetation and loss of topsoil.
- Creation of habitat favorable for noxious weeds or invasive plant species.
- Progression of erosion processes resulting in catastrophic slope or embankment failure.
- Damage to or destruction of public infrastructure or natural features.

BMP OBJECTIVES

- Protect water quality, aquatic habitat and riparian habitat by reducing erosion and sedimentation.
- Maintain proper functioning of stream channel and in-stream structures.
- Prevent the formation of fish passage barriers.
- Maintain healthy riparian and up slope vegetation.
- Retain topsoil.
- Avoid erosion before it creates chronic problems or future catastrophic hillslope or embankment failure.

BEST MANAGEMENT PRACTICES

1) Incorporate erosion control into the planning, construction and follow up phases for all maintenance activities. Review the guidance contained in this manual, select applicable BMPs for which materials are available and plan to have the necessary materials on hand for implementation before starting work.

2) If working during times when rain might be possible, always have erosion control measures onsite in case of a storm event. Have materials needed for erosion control BMPs available at the site before work is started.

3) Plan for projects involving disturbance of soil (earthwork) to occur during the dry season between April 15 and October 15, whenever possible. If work must be performed during the rainy season, work during dry weather conditions whenever possible. Guidelines for necessary unscheduled emergency earthwork conducted during the rainy season (October 15 through April 15) should comply with the County's Grading Ordinance and winter time grading guidelines.

4) Use the following hierarchy to select and prioritize the erosion control BMPs referenced below. Separate planning and prioritization may be required for BMPs implemented only during construction as opposed to BMPs left in place when the project is complete.

- I. Keep the disturbed area dry and keep water from flowing off-site when possible. Use Water Management BMPs to control or divert run off coming onto or leaving the site.
- II. Keep sediment in place to the extent possible. Use Erosion Control or Stream bank Protection BMPs to stabilize disturbed soil.
- III. If it is not practical to stop run-off from leaving the site, use Water Management and Sediment Control BMPs to minimize the amount of entrained sediment leaving the site.
- IV. If it is not possible to stop runoff with entrained sediment from leaving the site, use Sediment Control BMPs to capture the entrained sediment before it is delivered to a stream or waterway.

5) Set up the work and staging area to minimize the area of soil that will be disturbed and the tracking of soil out of the work area by vehicles and equipment. Avoid staging projects in areas where runoff will be concentrated. Do not stage equipment in riparian areas or adjacent to streams. Use the appropriate Erosion and Sediment Control BMPs to secure the staging area.

6) Protect storm drain inlets and waterways using Water Management and Sediment Control BMPs as referenced below.

7) Reuse (replace) excavated soil at the site to the extent possible.

8) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of the County right- of-way

without landowner's permission. In some instances, under the following guidelines (See Table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. The presence of vegetation helps to slow the travel of sediment downslope, so good judgment is needed to assess the situation. *Do not sidecast at all* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed at all*, however there may be rare instances on slopes greater than 2:1 where sidecasting is acceptable given very long distances from waterbodies and good vegetative cover. Seek advice from California Department of Fish and Wildlife staff when in doubt. Avoid concentrating sidecasting repeatedly in the same place.

Slope gradient	**Distance from waterway, stream crossing, riparian area, roadside ditch, storm drain**	**Sidecasting rule**
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope long distance from waterway	Allowed using good judgment
Greater than 5:1 (20%)	Sparsely vegetated slope and it appears that sediment will travel with rain into waterway	Not allowed

9) Temporarily stockpile excavated soil away from streams, waterways or areas where run off will concentrate, until reused or removed to a permanent disposal site. Implement erosion control BMPs on and around stockpiles to keep materials from eroding as outlined in *Chapter 7.3- Spoils Handling and Disposal*.

10) The performance of erosion control BMPs should be monitored daily during construction. Added attention should be given to monitoring of BMPs after storm events, and BMPs should be maintained, upgraded or augmented with additional BMPs as needed.

11) Projects should not be considered complete until the appropriate long-term erosion control BMPs are in place.

12) Use of biotechnical BMPs and native vegetation is preferable over hardscape techniques when appropriate for the site conditions.

13) For biotechnical BMPs that require the establishment of vegetative cover, plan and implement ongoing vegetation maintenance and irrigation as needed. Regularly evaluate the replanted area to ensure vegetation is establishing itself. Implement a follow-up revegetation program if the first attempt fails.

14) Implement adequate cover cropping or mulching; both are *quick and economic methods* to control or prevent surface erosion.

15) After completion of construction, monitor the performance of long-term BMPs periodically, particularly after significant storm events. Perform immediate repairs or upgrades as necessary.

BMP TOOLBOX

Culvert BMPs

- Energy Dissipater

Erosion Control BMPs

- Blankets/Geotextile Fabrics
- Coir Log/Roll
- Mulching
- Planting
- Plastic Covering
- Rock Breast Wall
- Seeding
- Stepped or Terraced Slope
- Surface Roughening & Soil Tracking

Sediment Management BMPs

- Sand Bag
- Sedimentation Sump
- Silt Fence
- Silt Mat
- Siltation Pond/Settling Pond
- Storm Drain Inlet Protection
- Sweeping
- Turbidity Curtain

Water Management BMPs

- Asphalt Berm
- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside
- Stream Bypass (Water Diversion)

PERMITS

Activity or Condition	Required permit or limitation
Instream work	U.S. Army COE 404 CWA
Instream work	California Department of Fish and Wildlife 1602
Bank stabilization	U.S. Army COE General Nationwide Permit No. 13
Sediment reduction measures at road and stream crossings	U.S. Army COE Regional General Permit

7.2 MINOR SLIDE REPAIR

DESCRIPTION

Minor slides, slipouts, and washouts are usually caused by the impact of heavy rainfall, concentrated runoff, subsurface water, loss of physical support, or freeze and thaw conditions on unstable or saturated soils. Slides and washouts may occur on the slope above or below roadways, private property, or sensitive areas. Minor slides, slipouts, and washouts are repaired to restore or prevent further damage to roadways and other structures, and prevent further sediment delivery to streams and waterways. Repair of minor slides and washouts includes: clearing materials (soil, rock, organic material and debris) deposited by wind, water, or minor landslides; excavating, recontouring and/or backfilling minor slides, washouts or eroded areas; revegetation and erosion control; repairing damage to roads and other structures; and constructing, repairing or improving drainage facilities. Repair of slides under emergency conditions is discussed in *Chapter 9.2 - Emergency Slide and Washout Repair*. Repair of road slipouts adjacent to streambanks is described in *Chapter 6.4 -Streambank Stabilization.*

ENVIRONMENTAL CONCERNS

- Delivery of sediment, organic debris, asphalt, and other potential pollutants into the streams, waterways or storm water drainage systems.
- Damage to stream or riparian habitat from the slide itself or from heavy equipment use instream or in the riparian zone.
- Damage to public infrastructure leading to further environmental damage.
- Water pollution from equipment operations.

BMP OBJECTIVES

- Protect water quality, aquatic habitat and riparian habitat by reducing erosion and sedimentation.
- Prevent potential water pollution from equipment operations.
- Restore and maintain healthy riparian and upslope vegetation. Retain topsoil.

BEST MANAGEMENT PRACTICES

1) When a slide impacts a stream system (for example, if the natural flow of a waterway is changed or habitat is damaged), seek the advice of appropriate experts prior to performing permanent repair work such as:

- Engineering, environmental, planning, and flood control staff
- Resource agency personnel (CDFW, NOAA Fisheries, RWQCB)
- Hydrologists or Hydraulic Engineers
- Geologists
- Geomorphologists
- Geotechnical Engineers
- Fisheries Biologists

2) Inspect equipment for leaks, damage and buildup of oils and grease prior to performing work, and perform maintenance at designated repair facilities.

3) To prevent water pollution from equipment operations, use non-organophosphate hydraulic fluid as part of standard operating procedures.

4) Set up the work and staging area to minimize the area of soil that will be disturbed and the tracking of soil out of the work area by vehicles and equipment. Keep equipment out of riparian areas, if possible. Do not stage equipment in riparian areas, adjacent to streams, or in areas where runoff may concentrate or may run into a waterway. Use the appropriate Erosion Control and Sediment Management BMPs to secure the staging area.

5) During the repair, protect storm drain inlets and waterways using the Sediment Control BMPs referenced below. Remove temporary BMPs when clean-up is completed.

6) Implement Water Management BMPs, as needed to divert runoff around the damaged area.

7) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of the County right- of-way without landowner's permission. In some instances, under the following guidelines (See Table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. The presence of vegetation helps to slow the travel of sediment downslope, so good judgment is needed to assess the situation. *Do not sidecast at all* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed*, however there may be rare instances on slopes greater than 2:1 where sidecasting is acceptable given very long distances from water bodies and good vegetative cover. Seek advice from California Department of Fish and Wildlife agency staff when in doubt. Avoid concentrating sidecasting repeatedly in the same place.

Slope gradient	**Distance from waterway, stream crossing, riparian area, roadside ditch, storm drain**	**Sidecasting rule**
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope long distance from waterway	Allowed using good judgment
Greater than 5:1 (20%)	Sparsely vegetated slope and it appears that sediment will travel with rain into waterway	Not allowed

8) Temporarily stockpile excavated soil away from streams, waterways, or areas where run off will concentrate, until reuse or removal to a permanent disposal site. Implement erosion control BMPs on and around stockpiles to keep materials from eroding as outlined in Chapter *7.2- Spoils Handling and Disposal*.

9) Use erosion control BMPs from the list below to repair and stabilize the slide area and the area disturbed during the repair. Use of biotechnical BMPs and native vegetation is preferable over hardscape techniques when appropriate for the site conditions. See *Chapter 7.1 - Erosion Control* for additional guidance about selection and implementation of appropriate BMPs, and consult with county engineering or planning as needed.

10) For biotechnical BMPs that require the establishment of vegetative cover, plan and implement ongoing vegetation maintenance and irrigation as needed.

11) After completion of construction, monitor the performance of long-term BMPs periodically, particularly after significant storm events. Perform immediate repairs or upgrades as necessary.

BMP TOOLBOX

<u>Erosion Control BMPs</u>

- Blankets/Geotextile Fabrics
- Broadcast Seeding
- Hydroseeding
- Mulching
- Planting
- Surface Roughening & Soil Tracking
- Stepped or Terraced Slope
- Plastic Covering
- Rock Breast Wall
- Vegetated Geoberm Toe Wall

<u>Sediment Control BMPs</u>

- Brush Packing
- Sandbag
- Silt Mat Inlet
- Silt Mat/Vegetated Grassy Swale
- Silt Fence
- Sedimentation Trap/Sump
- Siltation Pond
- Storm Drain Inlet Protection
- Sweeping
- Turbidity Curtain
- Asphalt Berm
- Diversion Berm
- Energy Dissipater

Stream bank Protection - Biotechnical BMPs

- Brush Mattress
- Joint Planting
- Large Woody Debris
- Live Fascine
- Live Stakes
- Fabric Reinforced Earth Fill with Brush Layering

Stream bank Protection - Hardscape BMPs

- Boulder/Riprap
- Streambed Gravel

Water Management BMPs

- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside
- Stream Bypass (Water Diversion)

PERMITS

Activity or Condition	**Required permit or limitation**
Instream work	See *Chapter 6.1 Working In and Or Near Stream Channels*
Bank stabilization	See *Chapter 6.4 Stream bank Stabilization*

7.3 SPOILS HANDLING AND DISPOSAL

DESCRIPTION
Excess soil, sediment, and debris are generated by a variety of County maintenance activities and must be handled and disposed of appropriately to keep these materials from eroding into streams and waterways and impacting water quality. Activities generating these materials include excavation; grading; culvert cleaning; ditching, slide removal; drainage system maintenance; pavement removal; concrete work, and other activities. Site selection and stockpile maintenance guidelines for handling and disposal of these materials are provided below.

Note: The following standards are for non-hazardous materials. For handling of wastes or hazardous materials see the Department of Transportation's 2012 Emergency Response Guidebook,
http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Hazmat/ERG2012.pdf .

ENVIRONMENTAL CONCERNS
- Discharge of sediment, debris, concrete, asphalt or organic material to streams or waterways.
- Surface or groundwater impacts from leachate formed in organic material disposal sites.
- Destruction or harm to aquatic, riparian or wetland habitat, or to endangered or threatened plant and animal species due to placement of fill material.
- Catastrophic fill or slope failure due to improper placement of material.

BMP OBJECTIVES
- Protect water quality, aquatic and riparian habitat by reducing erosion and sedimentation.
- Protect water quality by placing material that could generate leachate into properly permitted disposal facilities.
- Minimize impact to habitat and threatened or endangered species by selecting appropriate short term storage and disposal locations for spoils.

BEST MANAGEMENT PRACTICES

1) Identify and map existing permanent disposal sites that can be used for long-term disposal of materials from routine and emergency maintenance activities and provide this information to maintenance crews. These sites should be in upland areas, such as rock pits, ridges, and benches. Locations should be above the 100-year floodplain of the closest stream and away from any groundwater seeps or wetlands.

2) Temporary spoil stockpiles should be located in areas that are relatively level; relatively free of vegetation and outside the riparian zone; and away from streams, waterways, wetlands, or areas where run off will concentrate. Do not place temporary spoils piles at the top of unstable slopes or at the edges of slopes. Remove temporary stockpiles to permanent disposal locations before the rainy season, or if work is conducted during the rainy season, as soon as feasible and before the next rain storm. Implement Erosion Control BMPs as referenced

below on and/or around temporary spoil stockpiles to keep materials from eroding.

3) The performance of erosion control BMPs should be monitored routinely during construction, especially during and after storm events. BMPs should be maintained or upgraded as needed. Any materials not used at the site should be removed to a permanent disposal site at the end of the project.

4) Reuse materials from spoils piles when possible. For example, clean soil may be used as fill.

5) Segregate and reuse, or remove for recycling, asphalt materials, concrete, and other construction waste, when feasible. These materials may be reused as fill for projects when they are placed in upland areas where they will not enter the stream system.

6) For permanent disposal sites, develop a long-term erosion and sediment control plan incorporating the use of Erosion Control and Sediment Management BMPs and a monitoring program to verify the effectiveness and long term integrity of the BMPs.

7) Avoid sidecasting of soil in all cases where it could be delivered into a waterway, riparian area, roadside ditch or storm drain. Do not sidecast outside of the County right-of-way, without landowner's permission. In some instances, under the following guidelines (See Table below), sidecasting is allowable given remote distances from spoils storage sites. In these cases, the setback distance required depends on slope and vegetation. The presence of vegetation helps to slow the travel of sediment downslope, so good judgment is needed to assess the situation. *Do not sidecast at all* if the slope is sparsely vegetated and it appears that sediment will travel with rain runoff into a stream or estuary system, even if setback distances are applied. On slopes of 5:1 (20% gradient) or less, sidecasting is allowed beyond 150 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On 2:1 slopes (50%) or less, sidecasting is allowed beyond 300 feet of a waterway, stream crossing, riparian area, roadside ditch or storm drain. On slopes greater than 2:1, typically sidecasting is *not allowed at all*, however there may be rare instances on slopes greater than 2:1 where sidecasting is acceptable given very long distances from waterbodies and good vegetative cover. Seek advice from California Department of Fish and Wildlife agency staff when in doubt. Avoid concentrating sidecasting repeatedly in same place.

Slope gradient	**Distance from waterway, stream crossing, riparian area, roadside ditch,**	**Sidecasting rule**
Any slope	Appears that sediment will travel with rainwater into waterway.	Not allowed
5:1 (20%) or less	150 feet or more	Allowed using good judgment
2:1 (50%) or less	300 feet or more	Allowed using good judgment
Greater than 5:1 (20%)	Vegetated slope long distance from waterway	Allowed using good judgment
Greater than 5:1 (20%)	Sparsely vegetated slope and it appears that sediment will travel with rain into	Not allowed

8) Except as provided in #9 below, do not leave loose soil piled in berms alongside road or ditch. Loose or exposed soil berms are erodible and readily flushed into waterways and storm drains. Remove excess berm material before rainy season. If placed in emergency during rainy season, remove before the next rain. Dispose of all excess materials from shoulder maintenance activities in appropriate spoil disposal sites. See Chapter 7.3-: Spoils Handling and Disposal.

9) Berms are used in some places for traffic delineation or public safety (i.e. line of sight along soft shoulders with steep drop-offs). If any berm is left in place it must be kept to a minimum height and be compacted and stabilized with seeding or asphalt. Use Erosion Control BMPs to stabilize berms that are being left in place for road delineation.

10) Frequent, well placed breaks in the berms are necessary to allow water to drain from road and back into its original channel, preserving the natural drainage pattern of the slope. Check the areas breached to make sure they are stable. If erosion occurs at berm breaching areas, or the seeding is not in yet and rains are approaching, apply Erosion Control BMPs directly.

11) Dispose of concentrated amounts of vegetation that can generate leachate capable of affecting surface or groundwater quality only at permanent disposal sites that have Waste Discharge Requirements (WDRs) for this purpose from the RWQCB, or for which WDRs are waived.

12) Leave large woody debris in place if it does not increase the potential for flooding or damage to structures, create a public nuisance, create a fire hazard, or impact public safety. Large woody debris that is removed should be segregated and stored for future habitat improvement, when feasible.

13) Leave cut brush and branches remaining in riparian areas, adjacent to streams, when cut vegetation:

- Does not cause a safety concern or fire hazard;
- Does not contain noxious weeds (consult with experts about types, locations of noxious weeds);
- Is not stockpiled in concentrated areas that can release leachate to surface water; and
- Does not disturb existing drainage patterns.

14) When feasible, chip removed vegetation and reuse as mulch. Avoid mixing or burying organic materials in soil stockpiles as this limits the potential for future use.

BMP TOOLBOX

<u>Erosion Control BMPs</u>

- ➢ Blankets/Geotextile Fabrics
- ➢ Coir Log/Roll
- ➢ Mulching
- ➢ Planting

- Plastic Covering
- Seeding

<u>Sediment Management BMPs</u>
- Sand Bag
- Silt Fence
- Storm Drain Inlet Protection

PERMITS

Activity or Condition	**Required permit or limitation**
Grading	• County grading ordinance • County Noxious Weeds Ordinance • Conditional Use Permit -County Planning Department • Waste Discharge Requirements or Conditional Waiver issued by RWQCB
Dispose materials on USFS, BLM land	Special use permits may be required
Coastal Zone	Coastal development permit may be required
If spoils are placed above ordinary high water zone and away from wetlands. (See *Glossary of Terms*)	Permits are not required from other State or Federal agencies

CHAPTER 8: VEGETATION MANAGEMENT

DESCRIPTION

Roadside vegetation is managed to provide a safer roadway for the traveling public, maintain sight distance, remove hazard trees, manage non-native species, and prevent or repair slides or slip-outs. Vegetation growth can be managed manually, mechanically, or chemically. Activities include: mowing; trimming; pruning; spraying, removing brush; removing trees; chipping; and disposing of plant debris. Vegetation often needs to be planted after a maintenance project is completed (e.g., hydro-seeding after a culvert repair).

These guidelines apply to any vegetation management that is done for any reason, with the exception of instream channel maintenance. For the purposes of this manual, that is considered a flood control activity (not covered here). See Napa County Flood Control and Water Conservation District Stream Maintenance Manual (http://www.countyofnapa.org/FloodDistrict/).

ENVIRONMENTAL CONCERNS

- Discharge of sediment, plant material, or herbicides to streams or waterways.
- Harm to aquatic habitat, riparian areas or rare plant populations.
- Loss of trees as shade canopy and a future source of large woody debris in stream systems.
- Water pollution from equipment operations.
- Water pollution from leachate in vegetation disposal areas.
- Damage to vegetation beneficial to erosion control on slopes or sediment filtering.
- Introduction of exotic or invasive plant species or spreading of plant diseases.
- Increasing water temperature due to loss of shade from riparian zone.

BMP OBJECTIVES

- Reduce potential for water pollution from sediment delivery, herbicides or equipment operations.
- Encourage healthy and native vegetation to stabilize slopes, filter sediments entering streams or waterways and provide healthy riparian and aquatic habitat, including shade over streams.

BEST MANAGEMENT PRACTICES

1) Riparian vegetation is defined as "the vegetation growing in or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season". The riparian area, includes "stream channels, wetlands and those portions of floodplains and valley bottoms that support riparian vegetation" (CDFG 1998). These zones are of utmost value in protecting water quality and salmonid habitat. Therefore, it is extremely important that crews do not perform vegetation management in riparian areas unless under permit or in serious emergency conditions.

2) Vegetation management activities should be addressed by and comply with Napa County Flood Control and Water Conservation District vegetation management plans. These may include County vegetation management plans and chemical vegetation management guidelines issued by the Napa County Agricultural Commissioner.

3) Mechanical vegetation control and/or integrated pest management methods (IPM) are preferable to chemical methods when feasible.

4) Vegetation management and planting design should be conducted in a way that promotes native, rather than non-native, vegetation.

MOWING

5) Identify and protect drains and inlets from plant materials (e.g., grass clippings, branches, cuttings) that may clog the inlets or disturb drainage patterns.

6) Minimize disturbance of ground cover or grass on the shoulder, near ditches and outside of the road right-of-way. If the ground is bladed clean during mowing, the exposed soil will be vulnerable to erosion and could run-off into a creek. Vegetation can act as a pollution filter that traps sediment and other runoff before it gets into ditches or streams.

7) General guidelines for working within the road right-of-way:

- Minimize mowing, and the amount of vegetation that must be removed, to the extent necessary to maintain safety.
- Do not remove brush more than 20 feet on either side of the road at bridge structures, unless additional removal is required to address safety concerns or to control noxious weeds.
- Do not remove brush more than 10 feet on either side of a culvert, or 10 feet up and downstream from culverts, unless management is required to reduce plug potential of the culvert, for safety concerns, or to control noxious weeds.

8) County crews should receive specific training in vegetation management and proper cleaning of equipment to prevent passing contagious diseases to uninfected plant populations (e.g. Sudden Oak Death), and to prevent spreading seeds of invasive, non- native plant species.

9) When removing invasive plants and noxious weeds, use complete and thorough treatments. (Refer to County list of herbicides related to different plant species. The Napa County Agricultural Commissioner's Office and Napa County Flood Control and Water Conservation District may be able to provide guidance with noxious weed removal practices).

10) Small quantities of cut brush and trees may be left in riparian areas, adjacent to streams, when cut vegetation:

- Does not cause a safety concern or fire hazard;
- Does not disturb existing drainage patterns;
- Does not contain noxious weeds (consult with appropriate staff);
- Is not stockpiled in concentrated areas that can release leachate to surface water.

11) Dispose of larger amounts of vegetation and debris in approved upland disposal areas. Do not dispose of vegetation directly into water bodies such as streams or wetlands. Do not permanently dispose of concentrated amounts of vegetation that can generate leachate that could affect surface or groundwater quality, unless disposal is at a location permitted for this purpose. (See *Chapter 7.3 Spoils Handling and Disposal*).

12) When feasible, chip removed vegetation and reuse as mulch if it is not a noxious weed.

SPRAYING

13) County crews using herbicides for vegetation management should receive specific training in their proper application, safe work practices, and potential environmental hazards. Only personnel trained and certified in pesticide and herbicide use should be allowed to apply herbicides.

14) If using herbicides close to the "normal" start of the rainy season or in early springtime, use only aquatic approved formulations. Timing, rate, and volume of spraying should be included in a schedule for herbicide treatment. When in doubt, contact the Napa County Agricultural Commissioner's Office.

15) A Federal Court ruling (2004) prohibits the application of 38 listed pesticides/herbicides within 20 feet of salmon bearing streams, lagoons or estuaries (manual application) and within 100 ft (aerial spray). Crews should be aware if the County uses these chemicals in vegetation management and be knowledgeable as to which streams have salmon in them. Your Agricultural Commissioner's Office can give you advice on these rules and the use of these products. The Napa County Resource Conservation District can help you determine if there are salmon bearing streams in your work area. The Court's Order effectively applies to the following 38 pesticides. (February 2004 Federal Register)

1. 1,3-Dichloropropene	14. Diflubenzuron	27. Methyl parathion
2. 2,4-D	15. Dimethoate	28. Metolachlor
3. Acephate	16. Disulfoton	29. Metribuzin
4. Azinphos-methyl	17. Diuron	30. Naled
5. Bensulide	18. Ethoprop	31. Oxyfluorfen
6. Bromoxynil	19. Fenamiphos	32. Pendimethalin
7. Captan	20. Fenbutatin-oxide	33. Phorate
8. Carbaryl	21. Lindane (gamma-BHC and HCH)	34. Prometryn
9. Carbofuran	22. Linuron	35. Propargite
10. Chlorothalonil	23. Malathion	36. Tebuthiuron
11. Chlorpyrifos	24. Methamidophos	37. Triclopyr BEE
12. Coumaphos	25. Methidathion	38. Trifluralin
13. Diazinon	26. Methomyl	

BMP TOOLBOX

Planning and Prevention BMPs

- Seasonal Planning
- Small Spill Kit

Erosion Control BMPs

- Mulching
- Planting

Sediment Control BMPs

- Storm Drain Inlet Protection

Valuable References

- County Vegetation Management Plan (if available)
- County Weed Management Areas (if available)
- County Integrated Pest Management Plan (if available)

PERMITS

Activity or Condition	**Required permit or limitation**
Vegetation disposal sites that could impact surface or groundwater quality.	Waste Discharge Requirements from the California Regional Water Quality Control Board
Application of herbicides or pesticides.	Compliance with herbicide and pesticide restrictions and guidelines for application published by the County Agricultural Commissioner's office.
Removal of scenic resources, which may include large stands of trees; or healthy, mature, scenic trees.	Comply with County policies related to tree removal or County Vegetation Management Plan; possible CEQA
Working within the riparian zone.	CDFW 1602 agreement may be needed
•In Coastal Zone, •Vegetation maintenance, including trimming and cutting by hand and mechanical means.	Is exempt from a coastal development permit for maintenance treatment of all vegetative material growing native within the highway rights-of-way.

CHAPTER 9: EMERGENCY WORK

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9.1 EMERGENCY RESPONSE

DESCRIPTION
County roads and maintenance crews must respond quickly to fix damage to roadways and structures caused by storms, floods, and other events. Typical emergency response activities include: storm damage patrol; debris removal; emergency opening or closing of a road; and repairs to roads, slopes, and drainage facilities. County roads crews need to plan for emergency response scenarios to *protect the public* and to ensure that appropriate measures are employed to *protect the environment*.

Emergency is defined by regulatory agencies as:

> "A situation which would result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if corrective action requiring a permit is not undertaken within a time period less than the normal time needed to process the application under standard." (COE Regulations);
>
> "A situation involving an act of God, disasters, casualties, national defense or security emergencies, etc., and includes response activities that must be taken to prevent imminent loss of human life or property." (ESA rules, 50 CFR 402.05); and
>
> "A sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property or essential public services. Emergency includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage." (CEQA 15359).

ENVIRONMENTAL CONCERNS
- Discharge of sediment, organic material, and other potential pollutants to streams, waterways, or storm water drainage systems.
- Alteration of stream channels or destruction of riparian or aquatic habitat.
- Creation of a barrier to fish passage.
- Potential impacts to special status species.

BMP OBJECTIVES
- Prioritize maintenance for problematic areas to keep them from becoming an emergency.
- Reduce amount of road-related and hillslope materials entering storm drains and waterways.
- Decrease or prevent sediment delivery to storm drains inlets and waterways.
- Prevent the entry of spills into storm drains inlets and waterways.

BEST MANAGEMENT PRACTICES

1) Temporarily store materials (e.g., spoils) where they will not enter a stream or waterway, and permanently store or dispose of materials according to *Chapter 7.3- Spoils Handling and Disposal*.

2) Prepare emergency action plans and provide training for crews in various emergency scenarios that include steps to:

- inspect and assess site for potential hazards to workers, public safety and the environment,
- notify the appropriate public safety officials,
- notify appropriate agencies, and
- respond to emergencies in a safe manner.

DANGER: Notify the County Office of Emergency Services, or the State Office of Emergency Services (OES) at 800-852-7550, or the local fire department when a hazardous materials spill occurs.

3) When an emergency situation is significantly impacting, or could impact, a stream system (e.g., if the natural flow of a waterway is disrupted by a large flood or landslide), seek the advice of appropriate experts prior to performing permanent repair work, which may include:

- Engineering, environmental and planning staff
- County Flood Control and Water Conservation District staff
- Agency personnel (CDFW, NMFS, RWQCB)
- Hydrologists or Hydraulic Engineers
- Geologists, Geomorphologists, and Geotechnical Engineers
- Fisheries Biologists

4) When an emergency involves the discharge of hazardous substances or pollutants, implement Water Management BMPs and Water Quality Protection BMPs to contain pollutants and prevent them from entering drainage systems, streams, or waterways. Contact the local fire department or Cal Fire to respond to the hazardous substance.

5) During an emergency response that involves erosion, slope failure or embankment failure, implement Water Quality Protection/Sediment Control BMPs to control the discharge of sediment, and Upslope Erosion Control BMPs or Stream bank Protection BMPs to prevent further damage and, if possible, restore the damaged area. In addition, water management BMPs should be implemented as needed to keep runoff from entering or leaving the repair area. Refer to *Chapter 7.1-Erosion Control* and *Ch. 6.4-Streambank Stabilization* for additional information. Remedial actions should include biotechnical designs where practicable.

6) Use the following guidelines for modification or removal of large woody debris in emergency. If in doubt as to the best way to handle large woody debris in a stream, consult with Napa County Flood Control and Water Conservation District staff or CDFW personnel.

- Log jams on public property that are damaging or immediately threatening the integrity of roads, bridges, culverts and other public facilities or private developments during high flows may be modified to reduce or halt damage and direct flow toward a more desirable path.
- Consider opportunities to ***modify*** the debris jam to halt damage and direct flow toward a more desirable path. Only remove (as opposed to modify) logs and debris from streams as a “last resort” (e.g., failure to remove them will certainly cause damage to

an essential County facility or meets the definition of “emergency,” above).

- Take precautions to ensure that modifications of log or debris jams will not cause damage downstream to culverts and other structures.
- When modifying log jams, leave trees, logs and/or stumps in the longest lengths and diameters practicable for removal and hauling. If logs must be cut from fallen trees, leave as much as possible of the main trunk (12 feet plus is desirable) attached to the rootball and only cut branches obstructing flow.
- Limit modifications or removal to materials higher than approximately 2 feet above the streambed (above knee height) to preserve instream habitat features, unless the log or debris jam is immediately upstream of a culvert or bridge, or if permit conditions require otherwise.
- Incorporate large woody debris removed from water bodies into stream bank repairs or cribbing at a nearby location, or transport to an approved storage site for later use.
- Non-emergency debris maintenance can only be undertaken after the appropriate agency permits have been obtained. Refer to the permits section below for additional details.

7) Emergency repairs should be thoroughly inspected after the emergency is over, and final repairs should be made using the appropriate Upslope Erosion Control BMPs or Stream bank Protection BMPs. Remedial actions should include biotechnical designs where practicable.

8) Photo-document emergency actions for after-the-fact consultations.

BMP TOOLBOX

Culvert BMPs

- Culvert Hydraulics Diagram
- Culvert Plugging Diagram
- Energy Dissipater
- Single Post Trash Rack

Erosion Control BMPs

- Blankets/Geotextile Fabrics
- Coir Log/Roll
- Mulching
- Planting
- Plastic Covering
- Rock Breast Wall
- Seeding
- Silt Mat
- Surface Roughening & Soil Tracking
- Stepped or Terraced Slope
- Straw Log/Roll

Sediment Management BMPs

- Asphalt Berm
- Check Dam – Rock

- Check Dam – Straw Bale
- Concrete Containment
- Concrete Washout
- Sedimentation Sump
- Silt Fence
- Siltation Pond/Settling Pond
- Storm Drain Inlet Protection
- Sweeping
- Turbidity Curtain

<u>Stream bank Protection - Bioengineering BMPs</u>
- Brushmattress
- Fabric Reinforced Earth Fill with Brush Layering
- Large Woody Debris
- Live Fascine
- Live Stakes

<u>Stream bank Protection - Hardscape BMPs</u>
- Boulder/Riprap
- Streambed Gravel

<u>Water Management BMPs</u>
- Aqua Barrier
- Coffer Dam
- Dewatering
- Diversion Berm
- Fish Exclusion
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside
- Stream Bypass (Water Diversion)

PERMITS

Activity or Condition	Required permit or limitation
Project proponents are not required to notify CDFW or obtain a Streambed Alteration Agreement before commencing the following emergency work under the following conditions: 1. immediate emergency work necessary to protect life or property; 2. immediate emergency repairs to public service facilities under specified circumstances; and 3. emergency projects undertaken, or approved by a public agency to maintain, repair, or restore and existing highway, as defined, within the existing right-of-way of the highway, damaged as a results fire flood, storm, earthquake, land subsidence, gradual earth movement, or landslide, within one year of damage._Work needed in the vicinity of a highway may be conducted outside of the existing right-of-way, if it is needed to stop ongoing or recurring mudslides, landslides, or erosion to their pre-damage condition and functionality. This exception does not exempt any project undertaken, carried out, or approved by a public agency to expand or widen a highway damaged by fire, flood, storm, earthquake, land subsidence, gradual earth movement, or landslide.	CDFW regulations Fish & Wildlife Code Section 1602 (f)
Emergency work	CEQA (Sect. 15269) has similar conditions to CDFW conditions above
Emergency instream work	CDFW must be given written notification of emergency work within 14 days after work begins
Emergency work	COE requires a post-project 404 permit. Nationwide Permit #3 authorizes repair, rehabilitation, or replacement of structures destroyed by storms, floods, fire or discrete events, provided repair is begun (or under contract to begin) within 2 years of destruction or damage
Emergency work	RWQCB post-project 401 permit
Emergency work	Consult NOAA Fisheries

NOTE: Additional remedial work may be required by these agencies as a condition of post-project permits. If the work was implemented poorly, it may have to be replaced later.

9.2 EMERGENCY SLIDE AND WASHOUT REPAIR

DESCRIPTION
Slides and washouts or slip outs are typically caused by the impact of heavy rainfall, subsurface water, loss of support, loss of vegetation, concentrated runoff or freeze /thaw conditions on unstable or saturated soils. Slides and washouts can be caused by the events described, but those events are often only the trigger at improperly designed or constructed road features. Slides and washouts can be caused by cutbank failures, ditch diversion and over the bank runoff due to improper or infrequent maintenance of ditches, culverts, and road surface (slope and grading). Slides and washouts can often be prevented with proper design and construction maintenance BMPs. For example, frequent slides and washouts along a particular stretch of road may be helped by cleaning ditches, and culverts, or eliminated by installing additional road features such as improved road shaping, ditch relief culverts, or upgraded stream crossings.

Emergency slide or washout repair activities may include: removal of slide/washout material from the road right of way; backfilling or stabilizing the slope, reestablishing damaged roadway features; repairing and cleaning drainage system, and revegetating, and/or armoring with rock.

Slides and washouts are treated as emergencies if their impact could result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if corrective action is not immediately taken. Routine repair of minor slides under non-emergency conditions is discussed in *Chapter 7.2 -Minor Slide Repair*. Long term repair of major slides is generally a large project with an extensive planning and design component, and is not covered in this manual.

ENVIRONMENTAL CONCERNS
- Delivery of sediment, organic debris, asphalt, and other potential pollutants into the stream or storm water drainage system.
- Damage to stream or riparian habitat from the slide itself or from heavy equipment use instream or in the riparian zone.

BMP OBJECTIVES
- Reduce delivery of sediment into streams, storm drains and waterways.
- Protect water quality and stream habitat by removing slide material and restoring stream flow.

BEST MANAGEMENT PRACTICES

1) Comply with general emergency response standards (*Chapter 10.1- Emergency Response*).

2) Set up the work area in such a way that vehicles will not track mud and debris in and out to the maximum extent practicable.

3) Protect storm drain inlets and waterways using Water Quality Protection/ and Sediment Control BMPs.

4) During the emergency response, concentrate on controlling runoff flowing into and out of the repair area to the extent feasible using Water Management BMPs. Decrease sediment leaving the repair area using Water Quality Protection / Sediment Control BMPs. Stabilize the slide or washout using Upslope Erosion Control BMPs or Stream bank Protection BMPs to prevent further damage and, if possible, restore the damaged area. See *Chapter 7.1- Erosion Control* or *Chapter 6.4- Stream bank Stabilization,* for additional information. Remedial actions should include bioengineering designs where practicable.

5) Implement erosion and sediment control BMPs on or around stockpiles to keep materials from eroding into a stream or waterway. Remove debris for proper long-term storage or disposal once the emergency is under control (*Chapter 7.3- Spoils Handling and Disposal).*

6) If fish-bearing streams are impacted, follow Water Management BMPs for water diversion and fish exclusion to the maximum extent practicable during the emergency slide repair. Consult a hydrologist or fish biologist with CDFW or NOAA Fisheries prior to performing the work. (See *Permits* below for notification requirements.)

7) Temporarily store materials where they will not enter a stream or waterway, and permanently store or dispose of materials according to *Chapter 7.3 - Spoils Handling and Disposal.*

8) Emergency repairs should be thoroughly inspected after the emergency is over, and final repairs should be made using the appropriate Upslope Erosion Control BMPs or Stream bank Protection BMPs. Remedial actions should include biotechnical designs where practicable.

BMP TOOLBOX

Culvert BMPs

- Culvert Hydraulics Diagram
- Culvert Plugging Diagram
- Energy Dissipater
- Trash rack

Erosion Control BMPs

- Blankets/Geotextile Fabrics
- Coir Log/Roll
- Mulching
- Planting
- Plastic Covering
- Rock Breast Wall
- Seeding
- Silt Mat
- Surface Roughening & Soil Tracking
- Stepped or Terraced Slope

- Straw Log/Roll

Streambank Protection - Bioengineering BMPs
- Branchpacking
- Brushmattress
- Joint Planting
- Large Woody Debris
- Live Fascine
- Live Stakes
- Fabric Reinforced Earth Fill with Brush Layering

Stream bank Protection - Hardscape BMPs
- Boulder/Riprap
- Streambed Gravel

Water Management BMPs
- Aqua Barrier
- Coffer Dam
- Dewatering
- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside
- Stream Bypass (Water Diversion)
- Fish Exclusion

Sediment Management BMPs
- Storm Drain Inlet Protection
- Sand Bag
- Sedimentation Sump
- Silt Fence
- Siltation Pond/Settling Pond
- Sweeping
- Turbidity Curtain

PERMITS

Activity or Condition	Required Permits or Limitation
Emergency instream work	CDFW must be given written notification of emergency work within 14 days after work begins, according to the Fish and Wildlife Code. COE post-project 404 permit RWQCB post-project 401 permit Consult CDFW and NOAA biologists before performing work on fish bearing streams

9.3 ACCIDENT CLEAN UP

DESCRIPTION
County road and maintenance crews may have to respond to accidents on County roads involving spills of debris or hazardous materials. The accident may be due to: a) County activity, or b) activity by a non–County entity or individual, which the County is assisting in cleaning up. Activities include: hazard assessment, traffic control, isolation, containment, identification, and proper removal and disposal of spilled substances on the road right-of-way.

ENVIRONMENTAL CONCERNS
- Discharge of spilled materials into streams or waterways.
- Damage to aquatic habitat at the site of the spill and downstream.
- Lethal impact to fish and aquatic organisms.
- Damage to riparian areas during clean up.
- Pollutants from equipment entering the streams or waterways.

BMP OBJECTIVES
- Prevent spilled materials from entering streams or waterways
- Reduce sediments entering storm drain inlets and waterways.

BEST MANAGEMENT PRACTICES

1) Response to accidents should be addressed by and comply with a local spill contingency plan and emergency operations plan. County personnel responding to accidents should be periodically trained in accident response and automotive fluid spill clean-up. Work should comply with the general emergency response standards in *Chapter 9.1 - Emergency Response*.

2) Only specially trained and equipped response teams should respond to hazardous materials or hazardous waste spills. County maintenance personnel should be trained in the appropriate notification requirements if they suspect that a hazardous material or hazardous waste spill has occurred, and they should stay clear of the area pending further instructions from responding agency personnel.

3) County maintenance crews can assist emergency response personnel (e.g., the CHP, Sheriff or fire department) with vehicle accident cleanup or traffic control, and should take direction from these agencies for their work. In the event that County personnel are the first to have knowledge of the accident, appropriate authorities must be immediately notified and consulted. (See *Permits* below.)

4) County staff should have available, and be trained to use, emergency spill response equipment such as absorbent spill kits, river booms, and oil skimmers ,at all maintenance yards and other strategic spill response sites. Sufficient equipment should be available to cleanup or contain at least a moderate petroleum product or non-hazardous spill (1-50 gallons).

5) Contain spilled material and prevent it from entering drain inlets and waterways using Walter Quality Protection / Sediment Control BMPs. Containerize absorbent and spilled material for removal from the site as soon as possible.

BMP TOOLBOX

Planning and Prevention BMPs
- Small Spill Kit
- Large Spill Kit

Erosion and Sediment Control BMPs
- Asphalt Berm
- Diversion Berm
- Silt Fence
- Siltation Pond/Settling Pond
- Storm Drain Inlet Protection
- Sand Bag
- Sweeping
- Turbidity Curtain

Valuable References
- County or State Spill Contingency Plan
- County Emergency Operations Plan
- DFG Pollution Response Manual (1998), Sacramento
- Spill Responses Training Manual, DFG – Office of Spill Prevention and Response (OSPR), Sacramento
- Upper Sacramento Spill Contingency Plan (Resources Agency & DFG) – based on experience of the toxic "Cantara Spill": by Southern Pacific Railroad

PERMITS

Activity or Condition	Required permit or limitation
Accident Clean-up	Follow notification protocols established by Napa County Office of Emergency Services.

9.4 EMERGENCY UTILITY REPAIRS

DESCRIPTION

County maintenance crews may be called upon to repair irrigation lines, sprinklers or valves, as well as broken waterlines, sewer lines or storm drain lines that are damaged, could pollute streams or cause flooding or erosion. In some cases, significant work beyond the repair of sewer, water or storm drain lines may be needed just to stabilize the emergency – for example, a failing bank that threatens a pump station. Such emergency repairs may require significant excavation, construction of temporary access, bank stabilization, dewatering, and so on. Please refer to other sections of this manual for environmental protection BMPs associated with ancillary activities.

Note: Regular permit requirements always apply for *non*-emergency work. Carefully distinguish emergency work according to emergency permit requirements. (See Permit sections in this chapter.)

ENVIRONMENTAL CONCERNS

- Flooding or pollution of streams from discharges associated with broken utilities.
- Excessive erosion caused by discharges associated with broken utilities.
- Sedimentation or pollution caused by repair work during emergencies.
- Lethal impact to fish and aquatic organisms.

ENVIRONMENTAL BMP OBJECTIVES

- Prevent accidents, damage to infrastructure or harm to public health that may be caused by discharges flowing from broken utilities.
- Prevent pollution caused by discharges from broken sanitary sewer utilities.
- Prevent erosion and sediment delivery to streams caused by discharges from broken water and sanitary sewer utilities, non-functional drainage systems or soil disturbance during utility repair.
- Contain any spill associated with broken pipe.
- Restore proper drainage.

BEST MANAGEMENT PRACTICES

1) Shut off utility or drainage system to prevent further damage to roadway or structure. Contact utility company, City or local utility district to do this if necessary.

2) Notify proper authorities immediately. Effluent from sewer lines is considered a health hazard. The local fire department or Hazardous Material Response Team (HMRT) and the County Department of Environmental Health should be notified immediately to determine the proper protocol for management of sewage leaks.

3) Identify and protect drain inlets and waterways using appropriate Water Management, Erosion Control and Sediment Management BMPs. County engineering staff may be able to help you locate drain inlets or determine their drainage configuration so the spill can be stopped before it reaches water.

4) Set up work area so vehicles will not track mud and debris to the maximum extent practicable.

5) Implement Erosion Control and Sediment Management BMPs on or around excavation areas and stockpiles to keep materials from eroding into a stream or waterway. Reuse soil as backfill or remove for proper long-term storage or disposal once the emergency is under control (*Chapter 7.3 - Spoils Handling and Disposal).*

6) When containing a spill associated with a broken pipe, it may be necessary to implement Large Spill Kit BMPs, which include use of absorptive materials and provisions for containment to prevent the spill from reaching nearby water bodies (use of temporary bladders in stream to limit spill)

7) Once the utility is repaired, identify any damage caused by erosion to slopes or impacts to streams and apply appropriate Erosion Control BMPs or Streambank Protection BMPs to prevent further erosion and repair the damage. See *Chapter 7.1 -1 Erosion Control* and *Chapter 9.2 – Emergency Slide and Washout Repair* for additional guidance.

8) Monitor the repaired utility periodically until you are confident the repair was effective.

BMP TOOLBOX

Water Management BMPs
- Diversion Berm
- Sandbag
- Slope Drain – Temporary
- Slope Drain – Overside

Sediment Management BMPs
- Storm Drain Inlet Protection
- Sandbag
- Silt Fence

Planning and Prevention
- Large Spill Kit
- Small Spill Kit

Useful Information
- Storm Drain System Maps or GIS

Valuable References
- County or State Spill Contingency Plan
- County Emergency Operations Plan
- DFG Pollution Response Manual (1998), Sacramento
- Spill Responses Training Manual, DFG – Office of Spill Prevention and Response(OSPR)

PERMITS

Activity or Condition	Required permit or limitation
Releases from sewer pipes	Follow protocols of County Office of Emergency Services.
Emergency instream work	DFG must be given written notification of emergency work within 14 days after work begins.
Emergency instream work	COE post-project CWA Section 404 permit. Corps Emergency Permit defines "emergency" consistent with CEQA and NEPA definitions. The COE limits remediation allowed under the emergency permit to the minimum necessary to stabilize the situation. Otherwise, you *must* follow normal permit routes.
Emergency instream work	RWQCB post-project CWA Section 401 permit

CHAPTER 10 MAINTENANCE FACILITIES

TABLE OF CONTENTS

10.1 BUILDING AND GROUNDS MAINTENANCE

DESCRIPTION

Permanent maintenance facilities require building and grounds maintenance, including care of landscaped areas around the facility; cleaning of parking areas and driveways; and maintenance of the storm water drainage system. Proper handling and disposal of waste and wash water generated during building and grounds maintenance; minimization of water use, and immediate clean-up of spills are key elements in the protection of storm water quality.

ENVIRONMENTAL CONCERNS

- Discharge of the following materials into the storm water drainage system or waterways:
  - Litter and debris
  - Plant material
  - Fertilizer
  - Pesticides
  - Herbicides
  - Sediments
  - Petroleum products

BMP OBJECTIVES

- Minimize the likelihood of water pollution.

BEST MANAGEMENT PRACTICES

1) County maintenance yards are subject to the General Municipal Storm Water Discharge NPDES Permit and, depending upon activities conducted at the maintenance yard, the General Industrial Storm Water Discharge NPDES Permit. These facilities must notify the RWQCB and prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) and, again depending upon activities, a Storm Water Monitoring Program (SWMP). Facilities with above-ground petroleum product storage exceeding planning thresholds (see Permits section below) must also prepare and implement a Spill Prevention, Control and Countermeasures (SPCC) Plan, and facilities that handle more than 55 gallons of hazardous materials must prepare and implement a Hazardous Materials Business Plan (HMBP) and file it with the local Certified Unified Program Agency (CUPA). These plans require periodic evaluations and updates. County maintenance personnel should be familiar with and implement the provisions of these plans at their yard facilities.

2) Perform annual employee education about storm water management, procedures for emergency response, proper handling of hazardous materials, and spill cleanup.

3) Periodically inspect, clean, and maintain the storm water drainage system. At a minimum, the system should be checked in the fall, prior to the rainy season, and in conjunction with scheduled visual inspections performed as part of a monitoring program

4) Properly label all containers.

5) Cover all dumpsters during rainy season; inspect for fluids leaking from dumpsters and patch holes if leaks are identified.

6) Sweep or vacuum maintenance facility floors and pavement to prevent tracking of materials outdoors. Use mopping as an alternative to hosing down work areas when possible.

7) When mopping is used to clean maintenance area floors or pavement, do not dispose of mop water into the parking lot, street, gutters, or drain inlets. Contain and dispose of the mop water to the sanitary sewer system following these guidelines:

- Remove any spilled oil or other hazardous liquid using dry sweep or rags to absorb the spill before mopping.
- If an oil/water separator is available, pour the mop water into a separator inlet so that the wastewater is treated before being discharged to the sanitary sewer system.
- If a sanitary sewer connection is not available, provide dead-end sump or storage tank to collect mopping wash water. Periodically clean out sump or tank and haul to sewer system. Do not dispose hazardous liquids into the sump or tank.

8) Use drip pans or absorbent material under leaking vehicles and equipment to capture fluids. Recycle or dispose of fluids and absorbent materials as appropriate.

9) Recycle or properly dispose of used oil, antifreeze, solvents, asphaltic emulsion, and any other hazardous or toxic materials.

10) Use street sweeper frequently at the motor pool.

11) Monitor runoff from the area to determine BMP performance. Determine if a swirl separator type device with an oil-water separator feature is needed.

12) Install a grassy swale where runoff leaves the motor pool if sufficient space is available.

13) Properly dispose of used rags, contaminated materials, and sweeping and cleaning wastes as solid waste.

14) Minimize water use when washing equipment and vehicles.

15) For facilities with sanitary/industrial sewer connections, drain or dispose of wash water to the oil water separator (if available) or to the sewer if acceptable under the facilities discharge permit. Under no circumstances discharge wash water to storm drains, the site surface, or to sewers connected to a septic system.

16) Avoid excessive irrigation of landscaped areas. Program the amount and timing of automatic controllers to minimize runoff and encourage deep rooting of vegetation.

17) When flushing water lines, reuse the rinse water for landscaping purposes as long as excess water does not negatively impact any receiving waters or cause erosion. Avoid large volumes of water running off the site into storm drains or waterways.

18) Apply fertilizer and pesticides in accordance with the label instructions and County regulations and guidelines. Use of integrated pest management (IPM) is always preferable where applicable.

19) Use the least toxic housekeeping products that can effectively do the job.

BMP TOOL BOX

Planning and Prevention BMPs

- Hazardous Materials Site Planning
- Small Spill Kit
- Large Spill Kit

PERMITS

Activity or Condition	Required permit or limitation
Total above ground petroleum product storage at the facility exceeds 1,320 gallons in aggregate or 660 gallons in any individual container, or underground petroleum product storage exceeds 42,000 gallons	Prepare and comply with a Spill Prevention, Control and Countermeasures Plan
County maintenance facilities	Must apply with the RWQCB to be covered under the General Municipal Storm Water Discharge Permit (and under certain conditions a General Industrial Storm Water Discharge Permit), and prepare and implement a Storm Water Pollution Prevention Plan and, depending upon activities, a Storm Water Monitoring Program.
County maintenance facilities handling 55 gallons or more of hazardous materials	Must file a Hazardous Materials Business Plan with their Certified Unified Program Agency (CUPA)
Hazardous material (e.g. fuel or waste oil) underground storage tanks	Register with the CUPA and comply with storage tank construction and leak detection monitoring regulations of the SWRCB
Above-ground hazardous material storage tanks	File an inventory statement for any with the SWRCB
Vehicle fueling systems	Permits to construct and permits to operate must be obtained from the local Air Quality Management District. Compliance requirements vary by District.
Discharges of vehicle or equipment wash water to the sewer system	Industrial waste water discharge permits are typically required from the local sewage treatment facility. Compliance requirements may include pollutant discharge limits, discharge volume restrictions and discharge volume and pollutant monitoring and reporting.

10.2 VEHICLE AND EQUIPMENT MAINTENANCE

DESCRIPTION
Vehicles and equipment are stored and maintained at County maintenance yards. Maintenance activities performed at the yard include fueling, cleaning, painting, maintenance and repair of vehicles and equipment.

ENVIRONMENTAL CONCERNS
- Discharge of the following materials into the storm water drainage system or waterways:
  - Automotive vehicle fluids, including fuel, ATF, oil and antifreeze
  - Automobile maintenance chemicals such as solvents and carburetor cleaner
  - Cleaning products
  - Sediment
  - Paint products
  - Soil or groundwater contamination.

BMP OBJECTIVES
- Reduce the likelihood of water pollution.
- Protect aquatic species.

BEST MANAGEMENT PRACTICES

1) Employees should be trained in and familiar with provisions of the Storm Water Pollution Prevention Plan, Hazardous Materials Business Plan, Hazard Communications Program and (if planning thresholds are exceeded) the Spill Prevention, Control and Countermeasures Plan for the facility. Training should include procedures for emergency response, proper handling of hazardous materials, and spill cleanup. Update the plans for the facility at the required intervals.

2) Keep an ample supply of spill clean-up materials near fueling, vehicle maintenance and hazardous materials/hazardous waste storage areas. Inventory clean-up materials monthly and restock as needed. Restock immediately following significant spills.

3) Post proper fueling and spill clean-up instructions at fueling areas. Never leave the area while equipment is being fueled.

4) If a spill does occur, contain and clean up the spill immediately using dry absorbent (e.g., “clean sweep”), absorbent pads, and/or absorbent pillows. Handle and dispose of used spill pillows and other absorbents as hazardous waste.

5) Use a “dry shop” principle for cleaning areas used for maintenance, materials storage and fueling. Use absorbents such as “clean sweep,” pads or pillows to clean up free liquids; a damp cloth for wiping fuel dispensers and other equipment; and a damp mop on the floor for final cleaning.

6) Install automatic shut off (“break away”) valves at each fueling pump, and manual shut off valves inside and outside of shop buildings.

7) Pave the ground where fueling takes place with concrete or chip seal.

8) Periodically inspect hazardous materials and hazardous waste storage areas, maintenance areas, above ground tanks and fuel dispensers for leaks.

9) Perform vehicle and equipment maintenance in a designated covered facility, where feasible.

10) For vehicle fluid removal, transfer contents to designated vehicle waste fluid storage drums or tanks. Use drip pans under vehicles when draining or filling fluids.

11) When cleaning engines or parts:
- If using solvents to clean parts, perform the work in self-contained solvent sinks or tanks.
- After cleaning, allow parts to drain over the solvent sink or tank. Prevent dripping of solvent, onto the floor.
- Allow parts to dry over the hot tank, if available. If rinsing is required, rinse over the hot tank.
- Steam clean or pressure wash parts only over containments designed for this purpose.

12) Perform vehicle and mobile equipment steam cleaning, pressure washing or degreasing only over a containment designed to collect any generated wash water. Collect wash water and discharge to sewer via an oil water separator as discussed in *Building and Grounds Maintenance*. Do not pour wash water down storm drains, ditches, or sewers connected to septic systems.

13) Perform vehicle washing in a building or structure designed for this purpose. Use a closed-loop system to recycle wash water or discharge wash water to the sewer. Washing areas without a closed loop system or a connection to the sewer should be designed to contain wash water for later removal. Wash water should not be allowed to run off onto adjacent areas or discharged to storm drains, soil or surface water.

14) Designate an area for pre-wash of vehicles and equipment to capture solid materials, where feasible. Wash water from this area should be handled as indicated above.

15) Vehicle washing areas should be equipped with sediment traps. Sediment traps should be inspected and cleaned periodically, and the sediment removed from the site for disposal at an appropriately licensed facility.

BMP TOOL BOX

<u>Planning and Prevention BMPs</u>
- ➢ Small Spill Kit
- ➢ Large Spill Kit

PERMITS

Activity or Condition	Required permit or limitation
Total above-ground petroleum product storage at the facility exceeds 1,320 gallons in aggregate or 660 gallons in any individual container or underground petroleum product storage exceeds 42,000 gallons	Prepare and comply with a Spill Prevention, Control, and Countermeasures Plan
County maintenance facilities	Must apply with the RWQCB to be covered under the General Municipal Storm Water Discharge Permit (and under certain conditions a General Industrial Storm Water Discharge Permit), and prepare and implement a Storm Water Pollution Prevention Plan and, depending upon activities, a Storm Water Monitoring Program.
County maintenance facilities handling 55 gallons or more of hazardous materials	Must file a Hazardous Materials Business Plan with their Certified Unified Program Agency (CUPA).
Hazardous material (e.g. fuel or waste oil) underground storage tanks	Register with the CUPA and comply storage tank construction and leak detection monitoring regulations of the SWRCB
Above-ground hazardous material storage tanks	File an inventory statement for any with SWRCB
Vehicle fueling systems	Permits to construct and permits to operate must be obtained from the local Air Quality Management District.

10.3 OIL/WATER SEPARATOR MAINTENANCE

DESCRIPTION

Many maintenance facilities have portable or permanent oil water separators. Oil water separators are often used in vehicle and equipment washing areas or steam cleaning containments to separate oil and other products from the wash water before it drains to the sanitary sewer. Oil water separators may be used to similarly pre-treat mop water or other wash water before it drains to the sanitary sewer. Oil water separators must be maintained to be effective at separating oil and other products from wash water. (Refer to sanitation district pretreatment program regulations and permit requirements.)

ENVIRONMENTAL CONCERNS

- Discharge of oil, grease, or other hydrocarbons into storm water drains, waterways, ditches, or groundwater.
- Discharge of soluble oils and hydrocarbons into soil and groundwater via leach fields.

BMP OBJECTIVES

- Reduce the likelihood of water pollution.

BEST MANAGEMENT PRACTICES

1) Water discharges from maintenance areas, steam cleaning or pressure washing containments, and (as required in some jurisdictions) vehicle wash areas should be directed to an oil/water separator prior to discharge to a sewer system. Discharge of water from these sources to a septic system is not permitted under any circumstances, even if an oil water separator has been installed.

2) Remove accumulated oil and grit frequently to maintain effective performance of the separator. Designate frequency of cleaning oil/water separators based on size and use of the facility.

3) Recycle oil or dispose of oil according to hazardous waste disposal standards (See *Chapter10.5-Hazardous Materials*).

4) Dispose of grit from separator appropriately. If the grit is contaminated with oil or heavy metals it must be disposed at an appropriately permitted facility and handled according to applicable standards for those materials, and cannot simply be placed into the trash (See *Chapter 10.5 Hazardous Materials*). Consult your supervisor for proper disposal procedures for each separator/facility.

5) Record maintenance dates of oil/water separators in order to track upkeep and to prolong the life of the device.

6) Do not discharge hazardous liquids such as oil and automotive fluids to the sewer system, even if an oil/water separator is in place.

BMP TOOL BOX

Planning and Prevention BMPs

- Hazardous Materials Site Planning
- Small Spill Kit
- Large Spill Kit

PERMITS

Activity or Condition	**Required permit or limitation**
Discharges from maintenance and steam cleaning containments, and is often also required for discharges from vehicle washing areas.	Industrial waste water discharge permit from the local sewage treatment facility, if applicable. Use of oil water separators is typically required under these permits Contact your local sewage treatment facility for additional information. Comply with the Storm Water Pollution Prevention Plan for the facility

10.4 WASTE HANDLING, STORAGE, AND DISPOSAL

DESCRIPTION
Some wastes generated by maintenance activities are stored at the maintenance yard prior to disposal. Care must be taken when handling these materials and standards must be followed to assure these materials are properly stored and disposed. Hazardous wastes have stricter storage and documentation requirements and are discussed in *10.5 – Storage of Hazardous Materials).* There is economic and environmental benefits to preventing spills of toxic materials.

WARNING: Always consult supervisor if unclear of proper procedures, containers, or storage locations for the type of waste you are handling.

ENVIRONMENTAL CONCERNS
- Discharge of the following materials into the storm water drainage system or waterways:
  - waste products;
  - litter and debris;
  - sediment;
  - waste fluids from auto maintenance; oil/water separator grits; or other organic or inorganic waste materials.

BMP OBJECTIVES
- Prevent pollutants from entering drainage systems or waterways at or near the facility.
- Prevent ground water or soil contamination at or near the facility.
- Prevent soil, surface water, and groundwater contamination through disposal of waste materials at appropriate off-site facilities.
- Use proper secondary containment for wastes.

BEST MANAGEMENT PRACTICES

1) Maintain an inventory of the types of waste streams handled at the facility, containers used for storage, facilities designated for off-site disposal, and any special handling or storage requirements.

2) Minimize the amount of waste that is generated to the extent possible. Conduct an inventory of supplies, and order in smaller quantities as appropriate to reduce the amount of excess and unused materials stored on site.

3) Use the least toxic products available that will do the job.

4) Reuse or recycle materials when feasible. Segregate materials designated for recycling.

5) Place waste into appropriate containers. For example, put liquid or flammable waste in drums or tanks designed to contain such materials. Place oily rags into metal waste cans designed for storage of flammable rags.

6) Close waste containers when waste is not being actively added or removed.

7) Set up a routine inspection schedule to check for leaking or deteriorated containers and repair or replace as appropriate. At a minimum, conduct inspections as part of the facility's monitoring program. Inspections should be more frequent during the rainy season.

8) Use extra caution when handling wastes outside during rainfall events. If possible, postpone activities that could lead to spills of waste due to weather.

9) Ensure that all wastes such as residual paints, batteries, spent fuels, chemicals, and other wastes that can cause pollution are stored in properly designed and constructed secondary containment and are protected from the rain.

10) Materials should be stored on paved surfaces. The pad should be able to capture or contain possible spills through the use of an underground container to capture spilled materials or sufficiently sized curbing to hold the spill on the pavement.

BMP TOOLBOX

Planning and Prevention BMPs

- Hazardous Materials Site Planning
- Small Spill Kit
- Large Spill Kit

PERMITS

Activity or Condition	**Require permit or limitation**
Waste handling and storage disposal	Comply with the Storm Water Pollution Prevention Plan for the site

10.5 STORAGE OF HAZARDOUS MATERIALS

DESCRIPTION
Maintenance facilities may store a variety of materials that are classified as Hazardous Material or Hazardous Waste based on flammability, toxicity or corrosivity. These products may be harmful to the environment if they come in contact with surface waters or soil.

WARNING: Always consult your supervisor if you are unclear of the proper handling procedures, containers, or storage locations for the type of material or waste you are handling.

DANGER: Notify the State Office of Emergency Services (OES) at 800-852-7550 when a hazardous material spill occurs.

ENVIRONMENTAL CONCERNS
- Discharge of the following materials into the storm water drainage system or waterways:
  - Automotive vehicle fluids, including fuel, ATF, oil, and antifreeze
  - Automobile maintenance chemicals such as solvents and carburetor cleaner
  - Cleaning products
  - Sediment
  - Paint products
  - Corrosives
  - Pesticides, fertilizers and herbicides.
- Soil or groundwater contamination.
- Fire and related air and surface water discharges.
- Harm to aquatic life or other wildlife.
- Harm to human health and safety.

BMP OBJECTIVES
- Protect groundwater quality and potential beneficial uses.
- Prevent pollutants from entering drainage systems or waterways.

BEST MANAGEMENT PRACTICES

1) Employees should be trained in and familiar with provisions of the Storm Water Pollution Prevention Plan, Hazardous Materials Business Plan (including Emergency Response and Contingency Plan if the facility generates hazardous waste), Hazard Communications Program and (if planning thresholds are exceeded) the Spill Prevention, Control and Countermeasures Plan for the facility. Training should include procedures for emergency response, proper handling of hazardous materials, selection and use of personal protective equipment and spill cleanup. Update the plans for the facility at the required intervals.

FOR HAZARDOUS MATERIALS STORAGE (GENERAL):
2) Train personnel on proper handling procedures and familiarize them with the procedures in the emergency response portion of the above plans. Post proper handling instructions and Material Safety Data Sheets in a conspicuous location.

3) Limit access to storage areas to authorized persons only.

4) Keep labels on containers and ensure that covers or caps are secure when containers are not in use.

5) Maintain an ample inventory of appropriate spill clean-up materials near all storage areas and attend to all spills immediately. Keep absorbent and baking soda on hand to soak up spilled fluids and to neutralize spilled acid from cracked batteries. Use appropriate personal protective equipment (e.g., rubber boots, gloves and safety glasses).

6) Maintain fire extinguishers near hazardous materials and waste storage areas.

7) Mark storage areas with the appropriate NFPA placards.

8) Store materials on paved surfaces, minimize moving stored materials, and periodically inspect storage facilities.

9) Store hazardous materials in a designated area containing similar and chemically compatible materials.

10) Do not store incompatible products in the same storage area without some type of physical barrier separating the containers. For example, do not store oxidizers, such as hydrogen peroxide, with organics or flammable materials such as oil.

11) Store small (consumer) containers of flammable materials in flammable materials storage cabinets when not in use.

12) Store hazardous materials under cover and away from areas that might drain into the storm water drainage system or waterways. Store granular hazardous materials under cover well away from waterways, storm drains, curbs, and gutters.

13) Store hazardous liquid materials; including lead acid batteries, in secondary containment (Uniform Fire Code Article 80, Section 8003.1.3.3).

14) Install safeguards to prevent accidental releases such as: overflow protection devices; automatic shutdown interlocks on transfer pumps; and traffic protection guards (bollards) around tanks and piping to prevent vehicle or forklift damage.

FOR OUTDOOR CONTAINER STORAGE AREAS

15) Inspect storage areas weekly and before and after rainfall events. Ensure all containers are properly labeled, covered, securely fastened and in good condition. Check for external corrosion or other signs of wear of material containers (CCR Title 22 Section 66265.174).

16) If a container is corroded or leaking, have trained and qualified personnel or the local Hazmat Manager transfer wastes to a new clean container. Label the new container appropriately and properly clean (if equipped to do so) and dispose of the old container. Note that the old container may be classified as hazardous waste if not cleaned.

17) Repair and/or replace perimeter controls, containment structures, and covers as necessary to ensure their proper functioning.

18) Cover treated wood post storage areas during the rainy season.

FOR PAINT STORAGE AREA

19) Inspect all pallets of paint to ensure that they are securely fastened before moving.

20) Load and off-load paint on level ground when using a forklift to minimize possible spills and ruptures of paint containers.

21) Where feasible, store paint materials in an area with a canopy or roof designed to direct runoff away from the area. Paint is hazardous to aquatic systems.

WHEN STORING AND DISPOSING HAZARDOUS WASTES

22) Hazardous waste should be handled and managed only by personnel trained to do so.

23) Place appropriate placards on all hazardous waste storage and satellite accumulation areas. Hazardous waste storage areas should be locked and only authorized personnel with hazardous waste training should be allowed to enter.

24) Inspect hazardous waste storage areas weekly and maintain a record of inspections.
Store all hazardous waste in secondary containment.

25) Place hazardous waste in appropriate containers. Containers must be DOT-approved if used for off site shipment. Do not store liquid waste materials in buckets.

26) Place hazardous waste labels on all hazardous waste containers as soon as they are used.
Label empty containers as empty.

27) Containers should be kept closed unless they are actively being filled or emptied.

28) Dispose of hazardous waste only at authorized treatment, storage and disposal facilities. Illegal dumping of hazardous waste is a violation subject to fine and/or time in jail under several state and federal regulations.

29) Use licensed hazardous waste haulers for threshold quantities as required by state and federal regulations.

30) Cover containers carrying hazardous materials during transit. Illegal transit of hazardous waste is a violation subject to fine and/or jail time.

BMP TOOL BOX

Planning and Prevention BMPs

- Hazardous Materials Site Planning
- Large Spill Kit
- Small Spill Kit

PERMITS

Activity or Condition	**Required Permit or Limitation**
Total above-ground petroleum product storage at the facility exceeds 1,320 gallons	Prepare and comply with a Spill Prevention, Control and Countermeasures Plan
County maintenance facilities	Must apply with the RWQCB to be covered under the General Municipal Storm Water Discharge Permit (and under certain conditions a General Industrial Storm Water Discharge Permit), and prepare and implement a Storm Water Pollution Prevention Plan and, depending upon activities, a Storm Water Monitoring Program.
County maintenance facilities handling 55 gallons or more of hazardous materials	Must file a Hazardous Materials Business Plan with their Certified Unified Program Agency (CUPA).
Above-ground hazardous material storage tanks	File an inventory statement for any with the SWRCB.
Hazardous material (e.g., fuel or waste oil) underground storage tanks	Register with the CUPA and comply with storage tank construction and leak detection monitoring regulations of the SWRCB
Facilities generating hazardous waste	Must obtain a Generator Identification Number from U.S. EPA or the California Department of Toxic Substances Control
Transport and disposal of contaminated material and hazardous waste	Must be in accordance with the rules and regulations of the following agencies: • U.S. Department. of Transportation • U.S. Environmental Protection Agency • California Environmental Protection Agency (CAL-EPA). • California Department of Toxic Substances Control (DTSC). • California Division of Occupational Safety and Health Administration (CAL-OSHA). • Local Regulatory Agencies (e.g., County Department of Public Health).

10.6 SPILL PREVENTION AND CONTROL

DESCRIPTION
Maintenance facilities may utilize above ground storage tanks for storage of bulk quantities of liquids. Often the liquids stored are potentially harmful to human health or the environment. Safeguards must be in place at the maintenance yard and spill prevention and control standards must be followed to prevent the discharge of potential pollutants to the storm water drainage system or waterways from above ground storage tanks and accidental spills.

DANGER: If a large spill or rupture occurs: (1) call 911; (2) contact the Road Supervisor; and (3) contact the local Hazmat Manager. Your supervisor and Hazmat Manager will determine if a Hazmat team or private clean-up company is required. Notify the State Office of Emergency Services (OES) at 800-852-7550. See the Permits section below for additional agency notification requirements.

ENVIRONMENTAL CONCERNS
- Discharge of the following materials into the storm water drainage system or waterways:
  - Automotive vehicle fluids, including fuel, ATF, oil and antifreeze
  - Automobile maintenance chemicals such as solvents and carburetor cleaner
  - Cleaning products
  - Sediment
  - Paint products
  - Corrosives
  - Pesticides, fertilizers and herbicides.
- Soil or groundwater contamination.
- Fire and related air and surface water discharges.
- Harm to aquatic life or other wildlife.
- Harm to human health and safety

BMP OBJECTIVES
- Protect groundwater quality and potential beneficial uses.
- Prevent pollutants from entering drainage systems or waterways.

BEST MANAGEMENT PRACTICES
1) Prepare and comply with a Spill Prevention, Control and Countermeasures Plan if total above-ground petroleum product storage at the facility exceeds 1,320 gallons in aggregate or 660 gallons in any individual container, or if underground petroleum product storage exceeds 42,000 gallons. Employees should be trained in and familiar with the provisions of this plan. Training should include procedures for emergency response, proper handling of hazardous materials, selection and use of personal protective equipment and spill cleanup. Evaluate the plan every two years and update as needed.

2) Employees should be trained in and familiar with the provisions of the Storm Water Pollution Prevention Plan, Hazardous Materials Business Plan and the Hazard Communications Program. Update these plans for the facility at the required intervals.

3) All above-ground hazardous materials storage tanks should be provided with secondary containment, protected from potential vehicle or mobile equipment impacts using bollards or similar devices and, if possible, placed under cover to protect them from rainfall.

4) If above-ground storage tanks are not sheltered and the secondary containment fills with rainwater, the rainwater must be inspected and may need to be tested prior to releasing it from the containment to make sure it does not contain contaminants. If the rainwater contains contaminants, it must be containerized pending discharge to the sewer system or off-site disposal at a licensed facility, as appropriate.

5) After releasing rainwater from secondary containment, ensure that drain valve is closed.

6) Inspect existing above ground storage tanks, secondary containment, and associated valves and piping for signs of leakage, external corrosion, structural failure, and loose connections at least monthly.

7) Keep a spill kit near above-ground storage tanks. Such a kit includes an ample supply of clean-up materials (absorbent materials, shovel, rags, and plastic bags). Inventory cleanup materials monthly and restock as needed. Restock immediately following significant spills.

8) Contain and clean-up small spills immediately.
- Assess the type of material spilled and use appropriate personal protective equipment (e.g., rubber boots, gloves and safety glasses).
- Block all storm drain inlets and contain the spill using spill “pigs” and absorbent pillows.
- Soak up wet spills using an absorbent material or dry mop.
- Place wastes and absorbents in a waste container and dispose of the contents according to approved waste disposal procedures (see *Chapter 10.4-Waste Handling, Storage, and Disposal*; and *Chapter 10.5-Hazardous Material Storage*).

BMP TOOLBOX

<u>Planning and Prevention BMPs</u>
- Hazardous Materials Site Planning
- Small Spill Kit
- Large Spill Kit

PERMITS

Activity or Condition	Required Permit or Limitation
Total above-ground petroleum product storage at the facility exceeds 1,320 gallons in aggregate or 660 gallons in any individual container, or if underground petroleum product storage exceeds 42,000 gallons.	Prepare and comply with a Spill Prevention, Control and Countermeasures Plan

County maintenance facilities	Must apply with the RWQCB to be covered under the General Municipal Storm Water Discharge Permit (and under certain conditions a General Industrial Storm Water Discharge Permit), and prepare and implement a Storm Water Pollution Prevention Plan and, depending upon activities, a Storm Water Monitoring Program.
County maintenance facilities handling 55 gallons or more of hazardous materials	Must file a Hazardous Materials Business Plan with their Certified Unified Program Agency (CUPA).
Hazardous material (e.g., fuel or waste oil) underground storage tanks	Register with the CUPA and comply with storage tank construction and leak detection monitoring regulations of the SWRCB
Above-ground hazardous material storage tanks	File an inventory statement with the SWRCB.
In the case of a hazardous spill	Ensure the following agencies are contacted related to the listed conditions: • County Sheriff – for dispatch and if substance is off-highway in unincorporated area. • County Environmental Services – for all incidents. • CDFW – if substance is near waterway or affects wildlife. • RWQCB – if substance is in or near a waterway (County Environmental Services is responsible for notifying). • Local Hazardous Material Response Team (HMRT) – in the event of a significant hazardous material incident, Level II or greater, the HMRT shall be requested immediately by on-scene personnel. • State Office of Emergency Services Warning Center – for all incidents – (800) 852-7550. • California Highway Patrol – if substance is on a road way or State Highway. • Coast Guard Marine Safety Office – if spill is near coast, offshore, or in a bay. • US EPA, if substance is in other than navigable waters and response is beyond capabilities of local and state resources – (800) 424-8802 National Response Center. • Landowners where spill occurred if adjacent to county road

APPENDIX A: BMP TOOLBOX

TABLE OF CONTENTS

ROAD DRAINAGE BMPs

BMP- ROLLING DIPS (Unpaved roads)

DESCRIPTION

Rolling dips along unpaved road surfaces are probably the most effective way to disperse runoff. While an insloped, outsloped, or crowned road surface can disperse runoff, their function can be reduced by wheel rutting. Frequently installed rolling dips ensure the most reliable form of road drainage with the least amount of maintenance in the future. Also, rolling dips can be constructed to drain the cutbank and inboard ditch as well as the road surface. *See BMP-Ditch Relief Culvert* which may be used in conjunction with rolling dips.

Rolling Dips are smooth, angled depressions constructed in the roadbed where the road grade reverses for a short distance and surface runoff is directed in the dip to the outside or inside of the road. The dip causes storm water runoff to exit the road surface while allowing for passage of motor vehicles at reduced road speeds. On average, no more than 150' of road surface or ditch should be connected to a rolling dip. See Typical drawings 11, 19a, 19b, 19c.

APPLICATIONS

Appropriate for road surface drainage on any low-speed ranch or forest road. Rolling dips may be traveled on in winter if the road surface has sufficient rock and otherwise good drainage.

LIMITATIONS

- Never outlet rolling dips onto unstable fillslopes.
- Take into consideration the rate of speed the user is permitted to travel.
- Must be deep enough that it is not obliterated by normal grading or driving, but not so deep that it is difficult to negotiate or a hazard to normal traffic.
- Along sections of 'thru-cut' road where the outboard berm is significant construct a Type 2 rolling dip. See Typical drawing 19b.
- As road grades exceed 12% gradient it can be difficult to construct the reverse grade of the rolling dip. In these instances consider constructing a Type 3 rolling dip. See typical drawing 19c

CONSTRUCTION GUIDELINES

1) Begin the cut portion of the rolling dip about 50 to 80 feet up the road from where you would like the trough of the dip to outlet. This cut portion should increase in its outslope as it approaches the trough. The trough portion of the rolling dip should be oriented at a 30 degree skew to the road. At the trough the reverse grade or fill portion of the dip should begin, running for about 15 to 20 feet in length. The fill portion should then gradually return to the original road grade. See Typical drawings 11, 19a, 19b, 19c.
2) Angle the axis of the dip no less than 30 degrees and up to 60 degrees to the road alignment. A steeper angle is required for steeper road grades.
3) The lowest portion of the dip should be 11 to 18 inches deep into the roadbed with the cross-slope of the dip axis at least 1% greater than that of the original roadbed cross-slope.
4) If rolling dips are constructed along rocked roads than rolling dip needs to be rocked.
5) The outlet must be on stable ground or armored or otherwise stabilized.

6) On average, no more than 150’ of road surface or ditch should be connected to a rolling dip. See Table 1 for road grade specific spacing guidelines.

BMP MAINTENANCE

- Instruct road maintenance personnel as to the function and design of rolling dips.
- Check outlet for erosion and repair as needed.
- Periodically inspect before and during rainy season. Remove sediment buildup, repair ruts.

BMP REMOVAL

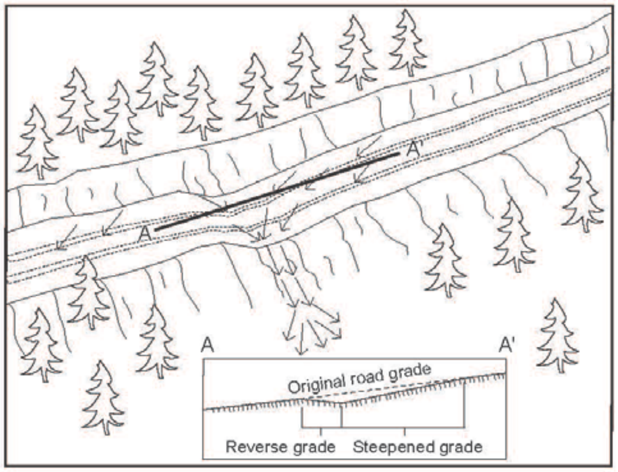
- N/A

Table 1. Maximum distance between waterbreaks on roads and trails (feet)[1]

Erosion Hazard Rating (for surface erosion)	Road or Trail Gradient (%)			
	10% or less	**11-25%**	**26-50%**	**over 50%**
Extremely high	100'	75'	50'	50'
High	150'	100'	75'	50'
Moderate	200'	150'	100'	75'
Low	300'	200'	150'	100'

1 From California Forest Practice Rules. This is the maximum distance between waterbreaks: when in doubt, reduce the spacing. Soils are non- renewable and waterbreaks are inexpensive.

Typical Road Surface Drainage by Rolling Dips



Rolling dip installation:

1. Rolling dips will be installed in the roadbed as needed to drain the road surface.
2. Rolling dips will be sloped either into the ditch or to the outside of the road edge as required to properly drain the road.
3. Rolling dips are usually built at 30 to 45 degree angles to the road alignment with cross road grade of at least 1% greater than the grade of the road.
4. Excavation for the dips will be done with a medium-size bulldozer or similar equipment.
5. Excavation of the dips will begin 50 to 100 feet up road from where the axis of the dip is planned as per guidelines established in the rolling dip dimensions table.
6. Material will be progressively excavated from the roadbed, steepening the grade unitl the axis is reached.
7. The depth of the dip will be determined by the grade of the road (see table below).
8. On the down road side of the rolling dip axis, a grade change will be installed to prevent the runoff from continuing down the road (see figure above).
9. The rise in the reverse grade will be carried for about 10 to 20 feet and then return to the original slope.
10. The transition from axis to bottom, through rising grade to falling grade, will be in a road distance of at least 15 to 30 feet.

Table of rolling dip dimensions by road grade

Road grade %	**Upslope approach distance** (from up road start to trough) ft	**Reverse grade distance** (from trough to crest) ft	**Depth at trough outlet** (below average road grade) ft	**Depth at trough inlet** (below average road grade) ft
<6	55	15 - 20	0.9	0.3
8	65	15 - 20	1.0	0.2
10	75	15 - 20	1.1	0.01
12	85	20 - 25	1.2	0.01
>12	100	20 - 25	1.3	0.01

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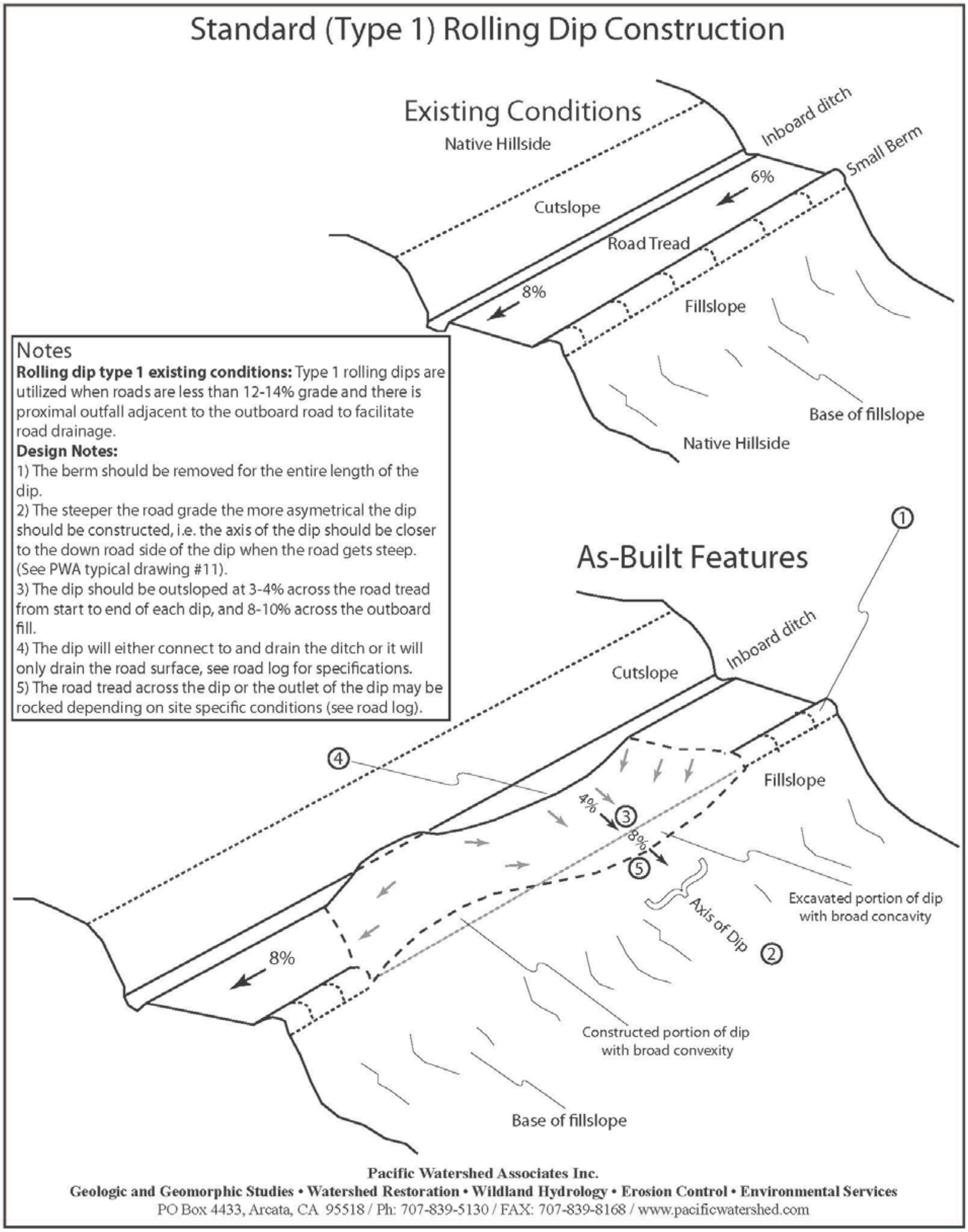
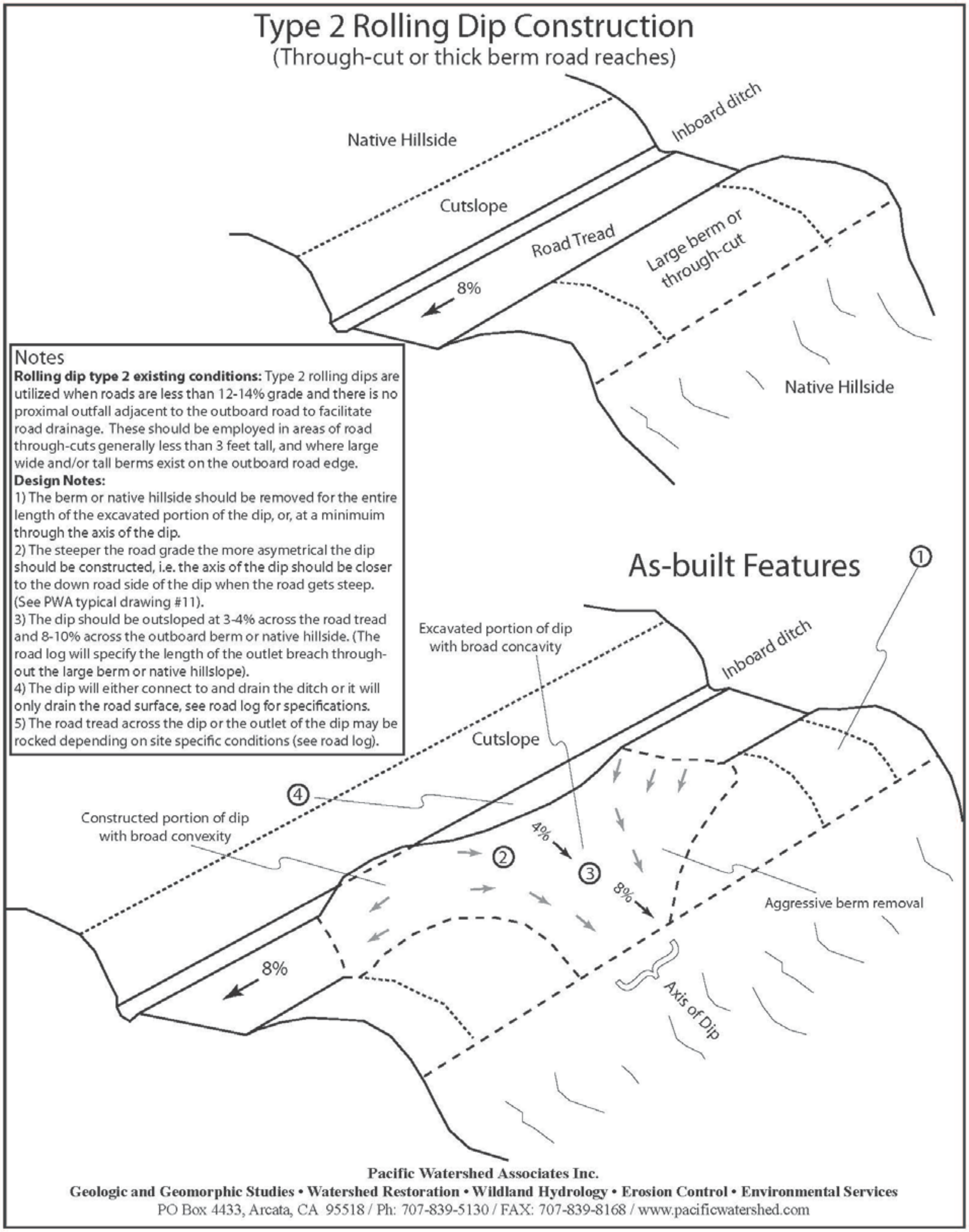
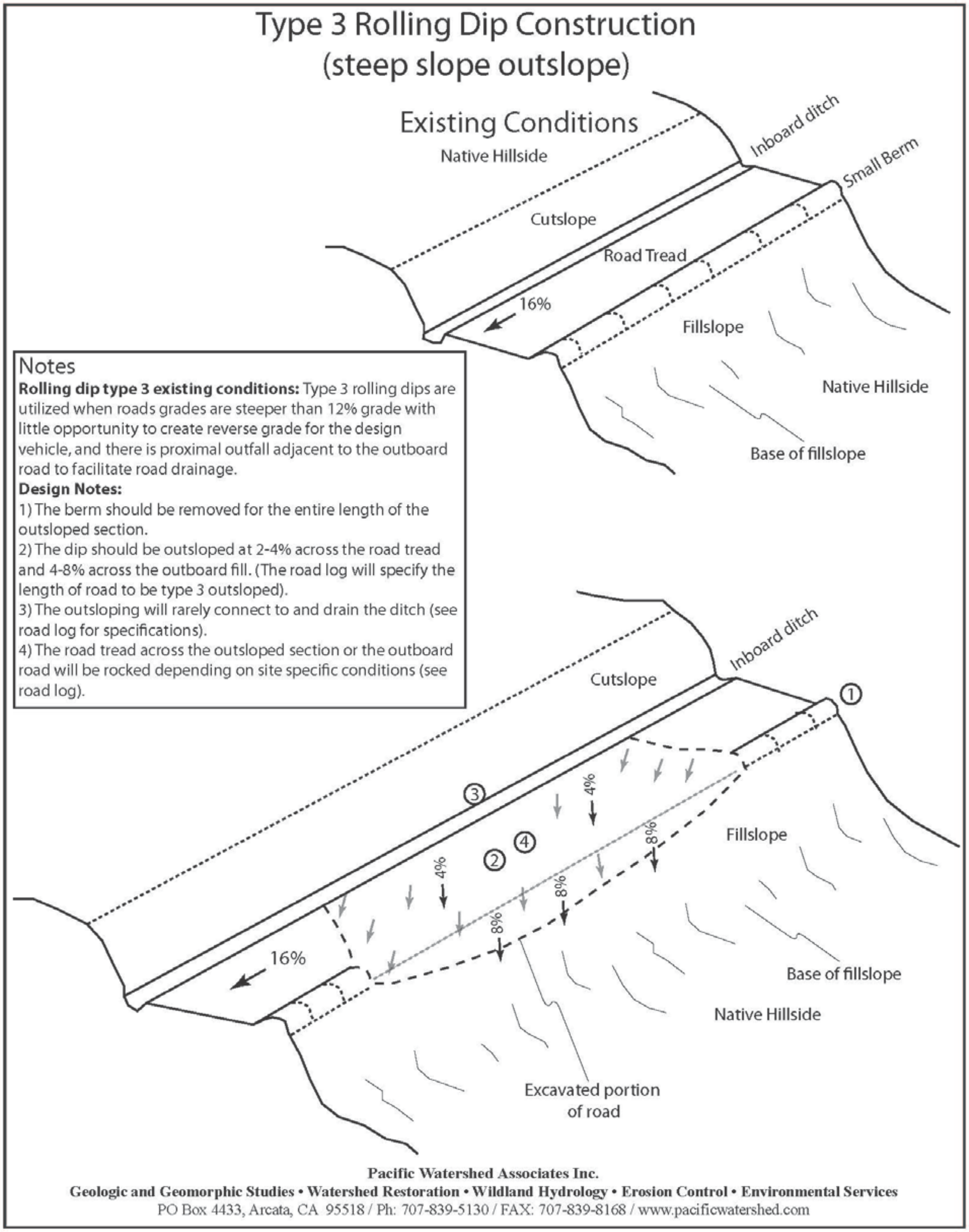
Typical Drawing #11



PWA Typical Drawing #19a



PWA Typical Drawing #19b



PWA Typical Drawing #19c

BMP- ROAD SURFACE SHAPING

DESCRIPTION

Roads constructed with an insloped, outsloped, or crowned shape allows runoff to disperse along the entire road's edge instead of concentrating flow on the road surface. The purpose of these road shapes is to minimize water concentration along roads, and maximize water dispersal. On unpaved roads all of these road shaping techniques should be incorporated with adequately spaced rolling dips to ensure the greatest water dispersal and minimize future maintenance needs. If you are designing an outsloped road and retaining the inboard ditch, or insloped, or crowned road shape then ditch relief culverts or rolling dips need to be installed frequently to drain the cutbank and inboard ditch. See Typical drawing 9.

APPLICATIONS

Used on roads where fillslopes are stable.

LIMITATIONS

- On unpaved roads outsloping should not be employed on road that experience traffic during snow or icy conditions.
- On unpaved roads rolling dips are required at intervals in conjunction with various shaping techniques to disperse water off the road surface
- On unpaved roads it may be necessary to implement annual grading to maintain an outsloped road.
- Outsloping may not be appropriate on curves or other areas where vehicles may slip off the outside edge. A crowned road or insloped road may be required in such cases.

CONSTRUCTION GUIDELINES

1) On unpaved roads frequency of rolling dips and the amount of outboard pitch required to maintain a good road varies with grade (see details).
2) When fillslopes are stable, the road should be designed with a minimum width and a gentle (4-6%) outslope.
3) On unpaved roads rolling dips are preferred to waterbars, which should be used only where winter use of the road is limited. Waterbars will break down or breach with extended traffic and create the need for higher maintenance.

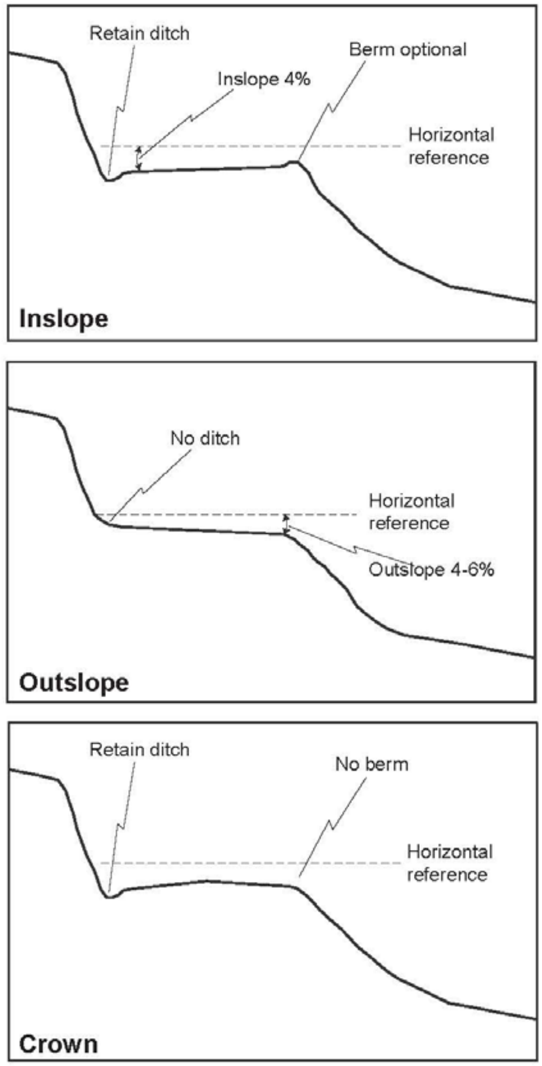
BMP MAINTENANCE

- Unpaved roads should be inspected frequently to repair signs of erosion or wear on the surface and in the rolling dips or waterbars.

BMP REMOVAL

- N/A

Typical Designs for Using Road Shape to Control Road Runoff



Outsloping Pitch for Roads Up to 8% Grade		
Road grade	**Unsurfaced roads**	**Surfaced roads**
4% or less	3/8" per foot	1/2" per foot
5%	1/2" per foot	5/8" per foot
6%	5/8" per foot	3/4" per foot
7%	3/4" per foot	7/8" per foot
8% or more	1" per foot	1 1/4" per foot

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Typical Drawing #9

BMP- DITCH RELIEF CULVERTS

DESCRIPTION

Ditch relief culverts (DRCs) divert water from an inside road ditch to an outside area beyond the outer edge of the road fill. See also unpaved road BMP-Rolling Dip which may be used in conjunction with DRCs. Ditch relief culverts may also be used to filter water in a buffer zone prior to entering a waterway. On average, no more than 150’ of road surface or ditch should be connected to a DRC. See Table 1 for general guidelines on spacing. See Typical drawing 8.

LIMITATIONS

- Regular culverts should be designed and installed at intervals that are close enough to prevent erosion of the ditch and at the culvert outfall, and at locations where collected water and sediment is not discharged directly into waterways.
- Ditches should neither be discharged directly into the inlet of a waterway crossing culvert, nor should ditch relief culverts discharge into a waterway without first directing flow through an adequate filter strip.
- In addition to installing ditch relief culverts on either approach to waterway crossings, it is also advisable to consider installing ditch drains before curves, above and below through-cut road sections, and before and after steep sections of the road.
- DRCs should not be used on erosive slopes without rock armor, or downspout, or T spreader.

CONSTRUCTION GUIDELINES

1) In areas of high erosion and/or storm runoff, minimum ditch relief culvert sizes should be 18 inches in diameter, and never less than 12 inches in other areas.
2) A 10% grade to the culvert will usually be self-cleaning. The culvert grade should also be at least 2% greater than the ditch which feeds it. The culvert should be placed at a 30 degree skew to the ditch to improve inlet efficiency and prevent plugging and erosion at the inlet.
3) Culvert outlets should be installed to drain on original ground slope beyond base of fill. If not, the fill below the culvert outlet should be armored with rock *or* culvert should be fitted with an anchored downspout to carry erosive flow past the base of the fill. Outlet of downspout could be fitted with a T spreader to dissipate or slow flows.
4) Backfill shall be compacted from the bed to a depth of 1 ft or 1/3 of culvert diameter, whichever is greater, over the top of the culvert.
5) Build up berm on downhill side of inlet to reduce diversion potential. Inlet protection, such as rock armoring or drop structures, can be used to help minimize erosion.
6) On new roads, ditch flow should be culverted and discharged into buffer areas and filter strips before it reaches a waterway crossing.
7) DRCs must be spaced frequently enough to carry ditch and road surface waters without creating erosive concentrated flows. See attached table for spacing guidelines.

BMP MAINTENANCE

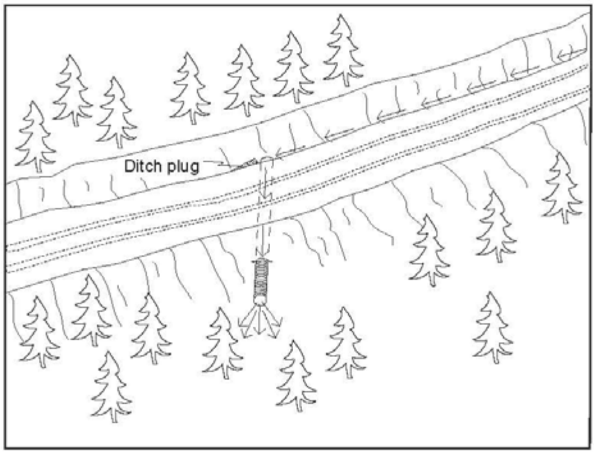
- Regular inspection and maintenance to remove debris.
- Ensure proper working condition, culverts need to be inspected and maintained for any signs of erosion after storms.

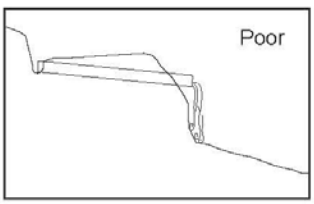
Table 1. Maximum distance between waterbreaks on roads and trails (feet)[1]

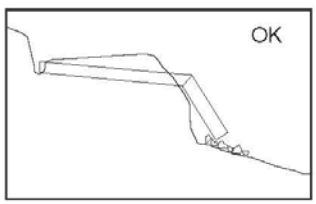
Erosion Hazard Rating (for surface erosion)	Road or Trail Gradient (%)			
	10% or less	**11-25%**	**26-50%**	**over 50%**
Extremely high	100'	75'	50'	50'
High	150'	100'	75'	50'
Moderate	200'	150'	100'	75'
Low	300'	200'	150'	100'

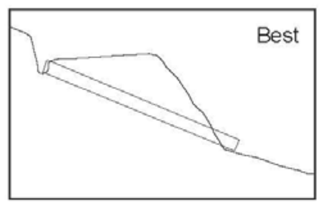
[1] *From California Forest Practice Rules. This is the <u>maximum distance between waterbreaks:</u> when in doubt, reduce the spacing. Soils are non- renewable and waterbreaks are inexpensive.*

Typical Ditch Relief Culvert Installation









Ditch relief culvert installation

1) The same basic steps followed for stream crossing installation shall be employed.
2) Culverts shall be installed at a 30 degree angle to the ditch to lessen the chance of inlet erosion and plugging.
3) Culverts shall be seated on the natural slope or at a minimum depth of 5 feet at the outside edge of the road, whichever is less.
4) At a minimum, culverts shall be installed at a slope of 2 to 4 percent steeper than the approaching ditch grade, or at least 5 inches every 10 feet.
5) Backfill shall be compacted from the bed to a depth of 1 foot or 1/3 of the culvert diameter, which ever is greater, over the top of the culvert.
6) Culvert outlets shall extend beyond the base of the road fill (or a flume downspout will be used). Culverts will be seated on the natural slope or at a depth of 5 feet at the outside edge of the road, whichever is less.

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Typical Drawing #8

BMP- CRITICAL DIP/CULVERT

DESCRIPTION

Serious erosion problems may occur at stream crossings that have *diversion potential*. This is usually associated with stream crossings whose void space is smaller than the area of the stream channel (culverted stream crossings). Stream diversion can occur at stream crossings when if flooded, the stream spills onto the road surface and flows down the road outside the natural hingelines of the stream valley. When this occurs the roadbed, hillslope, and/or stream channel that receive the diverted flow may be deeply gullied or destabilized.

A relief outlet or drainage feature in the roadbed which captures overflow from culverted crossings and redirects the overflow back into the original channel. Construction of Critical Dips on unpaved roads may be similar to BMP – Rolling Dip (Road Surface BMPs). On paved roads a broad dip can be constructed through the crossing to capture flood flows or a Critical Culvert should be installed on the lower hingeline of the crossing to capture the flood flows. Also if a road is outsloped or banked steeper than the road grade through the crossing may be the best way to redirect flood flows back into the original channel downstream of the road. See Figure1 and Typical drawing 1c.

APPLICATIONS

For stream crossings with diversion potential. The Critical Dip/Culvert will prevent stream diversion down the road if the culvert plugs.

LIMITATIONS

- On some paved roads the road can be dipped through the crossing to reduce diversion potential. But these dips need to be broad to account for higher speeds of vehicle traffic and paving limitations.
- Some roads may be too steep to construct the reverse grade needed for a critical dip to function. Therefore a Critical Culvert should be installed.
- On unpaved roads Critical Dip must be deep enough that it is not obliterated by normal grading, but not so deep that it is difficult to negotiate or a hazard to normal traffic.
- On paved roads, some crossing there may not be enough room to install a critical culvert higher than the primary culvert. In these instances the Critical Culvert may need to be installed further down the road

CONSTRUCTION GUIDELINES

1) Stream crossings should be constructed to prevent diversion of flood overflow if the culvert were to become plugged. On both paved and unpaved roads this can be done by designing the road to dip into and out of the stream crossing site or by constructing a broad dip on the down-road side of the crossing. This will allow the overflow to be directed back into the natural stream channel.
2) Ensure that the critical dip extends from the cutbank to the outside edge of the road.
3) Road surface and fill slopes at the critical dip should be rocked or otherwise stabilized.
4) See BMP-Rolling Dip for more details.

BMP MAINTENANCE

- Instruct road maintenance personnel as to the function and design of critical dips.
- Inspect inlet, outlet, and bottom of culvert to ensure that they are open and in sound condition.
- Check outlet for erosion and repair as needed.
- Periodically inspect before and during rainy season. Remove sediment buildup, repair ruts on unpaved roads.

BMP REMOVAL

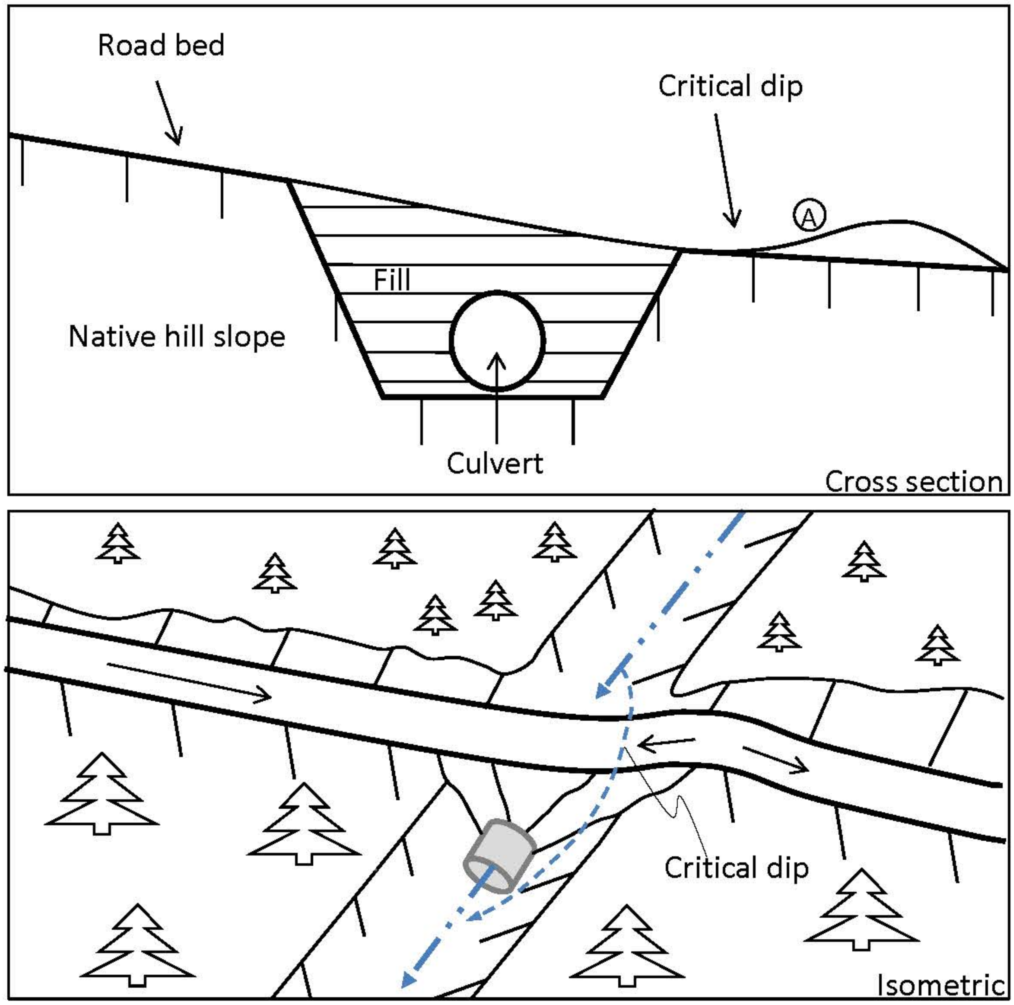
- N/A

SOURCE

Weaver, William E. PhD and Danny Hagans, Pacific Watershed Associates. Handbook for Forest and Ranch Roads. Prepared for the Mendocino County Resource Conservation District, June 1994.

Figure 1. Example of a critical culvert installed at a stream crossing with diversion potential (Pacific Watershed Associates Inc. 2003).

Typical Critical Dip Design for Stream Crossings with Diversion Potential



Critical Dip Construction:

1. Critical dip will be constructed on the lower side of crossing.
2. Critical dip will extend from the cutbank to the outside edge of the road surface. Be sure to fill inboard ditch, if present.
3. Critical dip will have a reverse grade (A) from cutbank to outside edge of road to ensure flow will not divert outside of crossing.
4. The rise in the reverse grade will be carried for about 10 to 20 feet and then return to original slope.
5. The transition from axis of bottom, through rising grade, to falling grade, will be in the road distance of at least 15 to 30 feet.
6. Critical dips are usually built perpendicular to the road surface to ensure that flow is directed back into the stream channel.

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Typical Drawing # 1c

BMP - BERM REMOVAL

DESCRIPTION

This BMP refers to removal of specific berms along roadsides that have been created either as side-cast from road grading operations, constructed as roadside safety bumpers, or as water diversion barriers. These types of berms are typically made of soil or road base materials. Berms on the downslope side or outside of an outsloped road can allow water to concentrate on road surfaces for long distances. See Typical drawing 12.

APPLICATIONS

Removal or frequent breaching of berms in many cases is recommended to prevent water from concentrating and forming rills and gullies. ***Frequent dispersal*** of water off road surfaces is the key to road-related erosion control.

LIMITATIONS

- Care must be taken so that spoils from berm removal are not deposited into a waterway.
- Some berms must be left in place where it is necessary to keep water from flowing onto sensitive areas.
- Some berms may keep vehicles from sliding off the road – there are alternatives, however such as coarse road base with good traction on unpaved roads, less road outslope, insloped or crowned road surfaces, or guard rails.

CONSTRUCTION GUIDELINES

1) Mark the specific areas for berm removal before grading begins.
2) Consider whether the berm or an alternative device is needed where slippery road surfaces are present, especially where roads outslope on steep embankments.
3) Wherever possible on unpaved roads, pull the berm material back into the road and incorporate into the road surface. Care must be taken not to interrupt other drainage facilities such as **rolling dips** or **critical dips.**
4) In some cases, specifically gentle slopes away from waterways, pushing the material off the side of the road may be warranted. All areas of bare soil greater than 100 square feet should be seeded and mulched before the end of October.
5) The final surface grade where berms have been removed must be outsloped to allow water to run off the road surface to the downhill side.

BMP MAINTENANCE

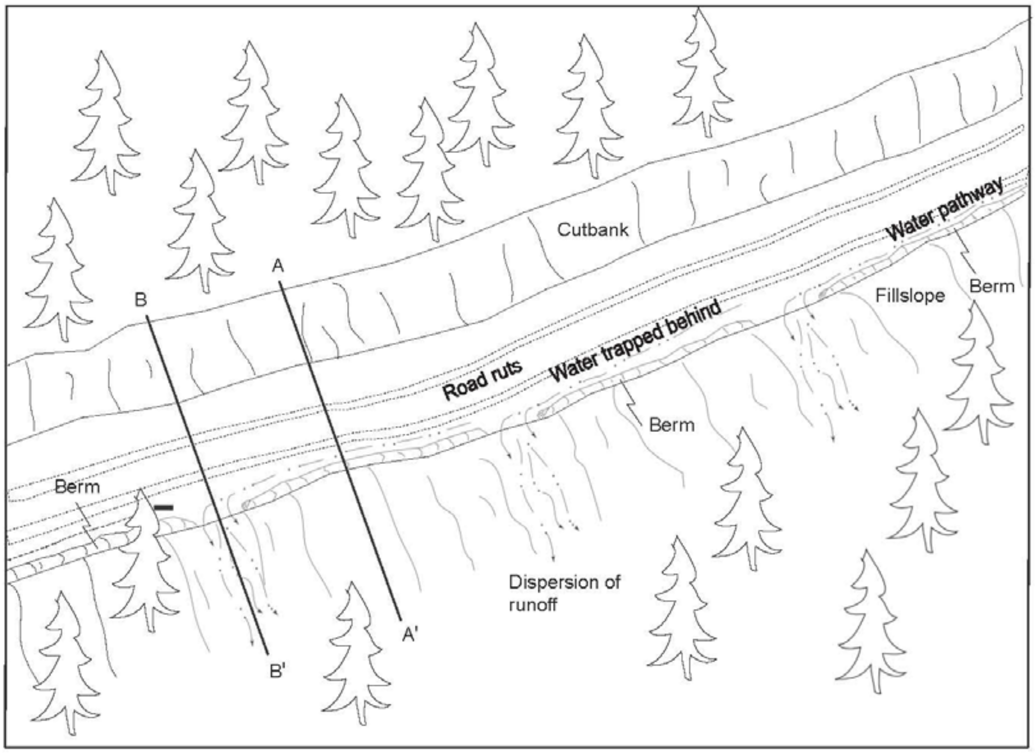
- Where berm breaches plug, they must be unplugged. Winter monitoring before and/or after major storm events may be required.
- Where berms re-form, they must be removed.
- Tire tracks and ruts in dirt road surfaces may short-circuit the benefits of berm removal. Re-grading or digging ditch outlets by hand may be required.

BMP REMOVAL

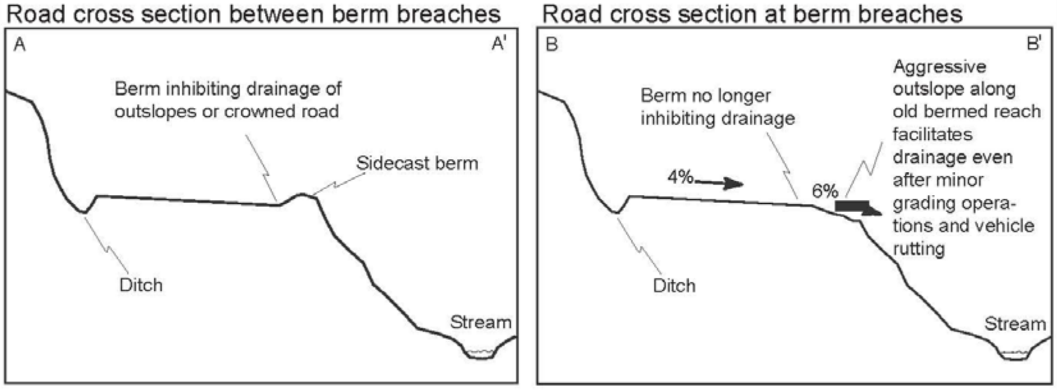
- **N/A**

Typical Sidecast or Excavation Methods for Removing Outboard Berms on a Maintained Road

1. On gentle road segments berms can be removed continuously (see B-B').
2. On steep road segments, where safety is a concern, the berm can be frequently breached (see A-A' & B-B') Berm breaches should be spaced every 30 to 100 feet to provide adequate drainage of the road system while maintaining a semi-continuous berm for vehicle safety.



Road cross section between berm breaches | Road cross section at berm breaches



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Typical Drawing #12

ROAD DECOMMISSIONING BMPS

DESCRIPTION

There are many reasons for closing or proactively "decommissioning" a road, most of which involve excessive maintenance costs, lack of continued need or continuing water quality problems. Not all roads need to be part of the permanent or seasonal road system. For example, temporary roads are used once, and then decommissioned until they are needed again. In addition, there may be many miles of existing roads that may no longer be needed, and older abandoned roads that are now overgrown. The techniques described below can be used to decommission or "storm-proof" roads to prevent future sediment delivery to the steam system, restricting access to unauthorized users, and as an added benefit or incentive, save on expenses of continued maintenance.

APPLICATIONS

- **Inactive roads** are those needed infrequently for fire control other intermittent activities. These roads remain unused for most of the year, or for several years in succession. There is a tendency to not maintain these routes because they may only be used intermittently for administrative purposes. However, all drainage structures on inactive road <u>must</u> still be inspected and maintained because they are just as likely to cause water quality issues as those on more actively travelled routes.
- **Temporary roads** are constructed for a single entry access to an area. Forest practice regulations for state and private lands require such preventive practices to stabilize temporary roads when they are closed.
- **Abandoned roads** were previously a part of the active road network, but are no longer used. Many are now overgrown. They may have been abandoned because they were no longer needed, or because they cross unstable areas, require excessive maintenance or cause persistent environmental damage. Most have drainage structures which are in disrepair and are no longer being maintained. These abandoned roads can represent one of the greatest future threats of non-point source pollution because erosional process are going on without being inspected. Landowners and resource managers should work aggressively to inventory and proactively treat these potential sources of erosion and sedimentation.

LIMITATIONS

Care must be taken so that spoils from excavations are not deposited into a waterway.

CONSTRUCTION

1) All stream crossings on temporary or decommissioned roads need to be completely removed *before* the first winter period following their installation or closure (if not, they should be capable of passing the 50-year flood flow for that channel).
2) Removing a stream crossing involves excavating and removing all materials placed in the stream channel when the crossing was built. Fill material should be excavated to recreate the original channel grade (slope) and orientation, with a channel bed that is as wide or slightly wider than the original waterway. Channel sideslopes should be graded ("pulled" or excavated) back to a stable angle (generally less than 50%) to prevent slumping and soil movement. The bare soils should then be mulched, seeded and/or armored to minimize erosion until vegetation can protect the surface, and the approaching road segments should be decompacted with frequently installed cross-road drained to prevent road runoff from discharging into the stream channel. See Typical

drawing 14 for construction details.

3) Any unstable or potentially unstable road fills (or sidecast should be excavated and stabilized so material does not fail and enter a waterway or destroy down-slope vegetation. Such areas include sidecast and fill materials which show recently developed scarps or cracks. These sites occur most often 1) on sidecast constructed roads built on steep slopes, 2) where roads have been built on steep slopes over springs or seeps, or 3) where roads have been cut into steep headwater swales or "dips" in the hillside. Cribbed fills which were installed at unstable areas during road construction or reconstruction should also be removed and outsloped if they could fail into a downslope stream channel. All spoil material should be placed in a stable location and revegetated. Spoil disposal sites can include the cut portion of closed roads and the inside portion of landings or turnouts. Wet, spring-fed cutbanks along closed roads should not be covered with spoil materials. See Appendix A (Road Decommissioning). See Typical drawing 16 for construction details.
4) Cutbank failure materials are often completely caught and stored on the adjacent road prism. For this reason, cutbank instabilities often do not need the same amount of "storm-proofing" and stabilizing as is needed on fillslopes and stream crossings. Some buttressing, revegetation and upslope drainage control may be required to prevent larger failures and erosion that could affect water quality. No active ditches or diversions should be left at the base of an unstable or ravelling cutbank on a decommissioned road. In fact, ditches should not be left open and functioning because all ditches are likely to eventually become plugged with sediment or vegetation and cause water to be diverted onto the road surface.
5) Roads that are to be decommissioned should have adequate, self-maintaining surface drainage so that the road surface is stable and will not erode and deliver sediment to a stream. Road surfaces should be decompacted (ripped to a depth of 15-24 inches. Any ditched segments of roads should be filled so that water is not diverted and gullies do not form. Outside road berms should be removed to encourage continuous drainage off the road surface. All road lengths should be drained with frequently spaced cross-road drains that are constructed from the cutbank to the outside edge of the road. Cross-road drains should be made deeper than standard waterbars in order to not only to intercept all road surface flow but to prevent any unauthorized use of the road. See Typical Drawings 15 & 17 for construction details.
6) On steep sections of road (>10%) cross drains should be skewed at 45% to the road alignment (instead of the usual 30%) to reduce the threat of erosion at the inlet. Since inside ditches will be breached and no longer carry runoff, ditch relief culverts are no longer needed on closed roads and can be either removed and salvaged or left in-place.
7) Cross-road drains should be placed frequently enough such that flow through individual drains will not require the use of rock armor energy dissipators to prevent erosion at the outlet. However, cross drains that carry spring flow or flow from small upslope gullies may require armoring at their outlet and should be discharged into vegetation to filter water and sediment before runoff reaches a stream.

GUIDELINES

- Planned, systematic road closure can be an inexpensive and effective technique for minimizing long-term resource damage caused by roads built in steep areas and can prevent large scale damage to road alignments that require costly repairs if the road is to be reopened for future use. It also provides land managers with an opportunity to permanently prevent or control the majority of post-construction road-related erosion and its associated on-site and downstream impacts.

BMP MAINTENANCE

- Decommissioned road should be inspected after the first winter’s storms to ensure no excessive erosion has occurred at all stream crossings and fill slope excavations.

BMP REMOVAL

N/A

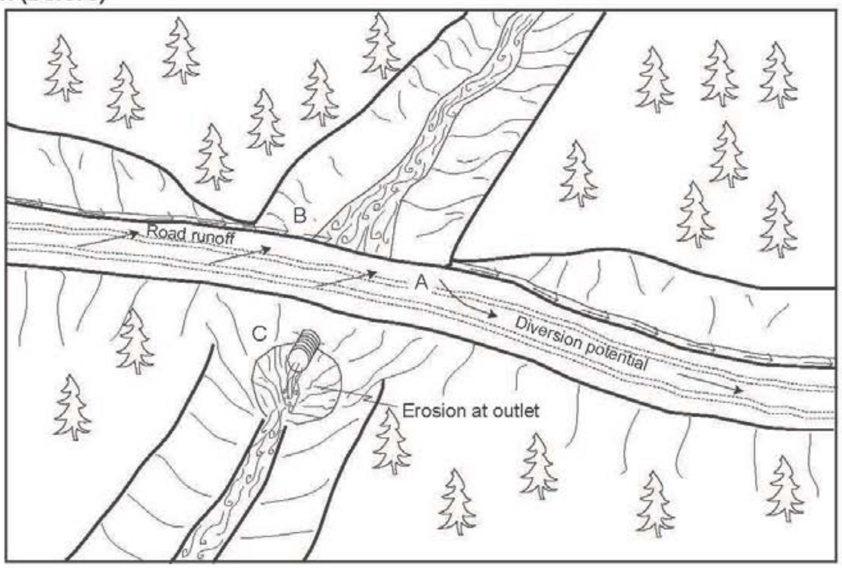
Typical Problems and Applied Treatments for a Decommissioned Stream Crossing

Problem condition (before)

A - Diversion potential

B - Road surface and ditch drain to stream

C - Undersized culvert high in fill with outlet erosion

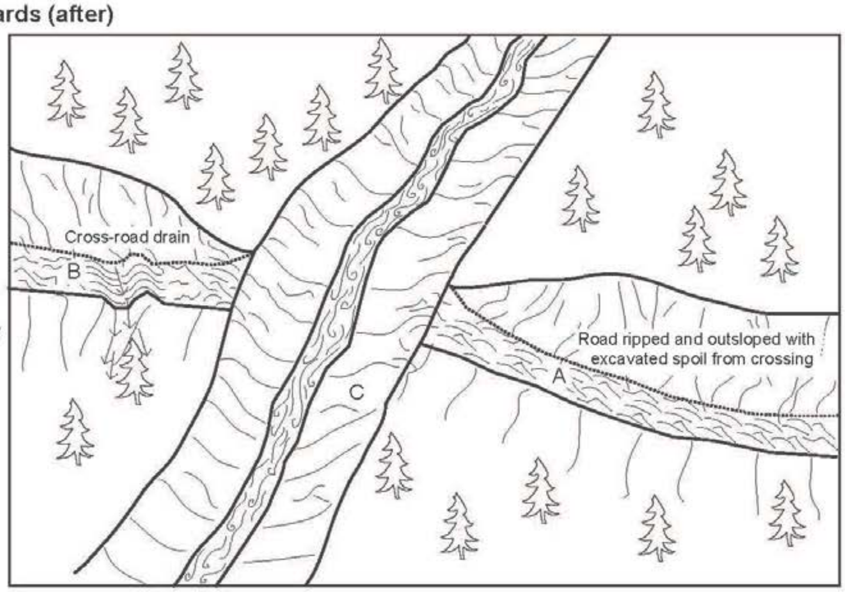


Treatment standards (after)

A - Diversion prevented by road surface ripping and outsloping using excavated spoils

B - Road surface and ditch disconnected from stream by road surface decompaction and cross-road drains

C - Stream crossing fill completely excavated



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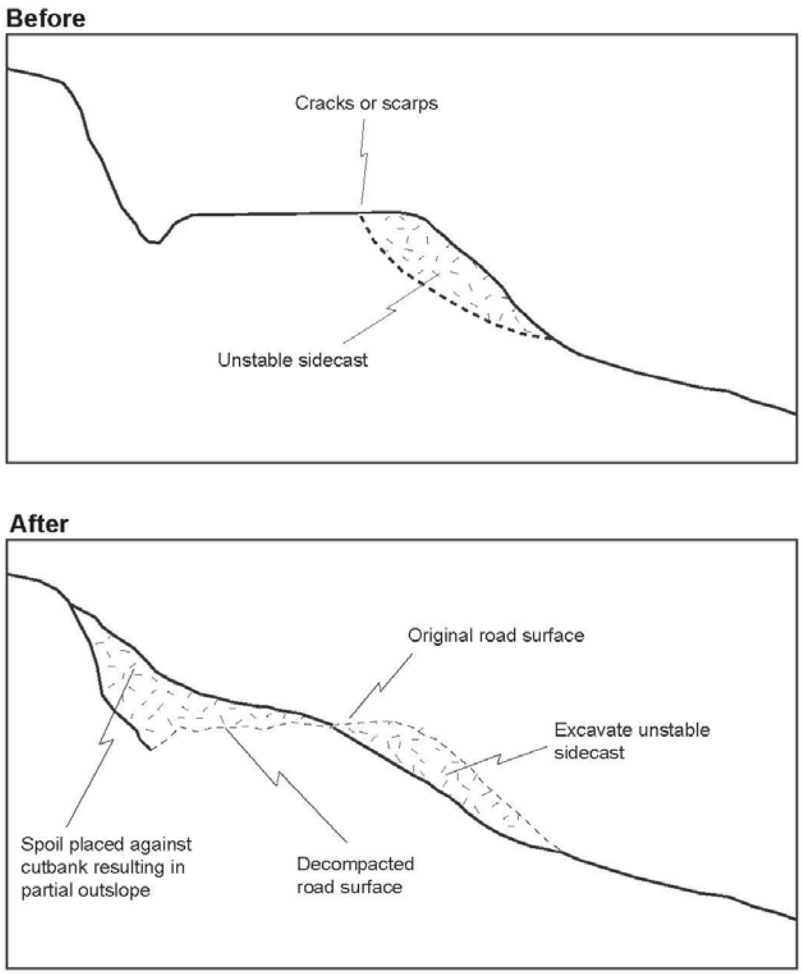
Typical Drawing #14

Typical Excavation of Unstable Fillslope on a Decommissioned Road



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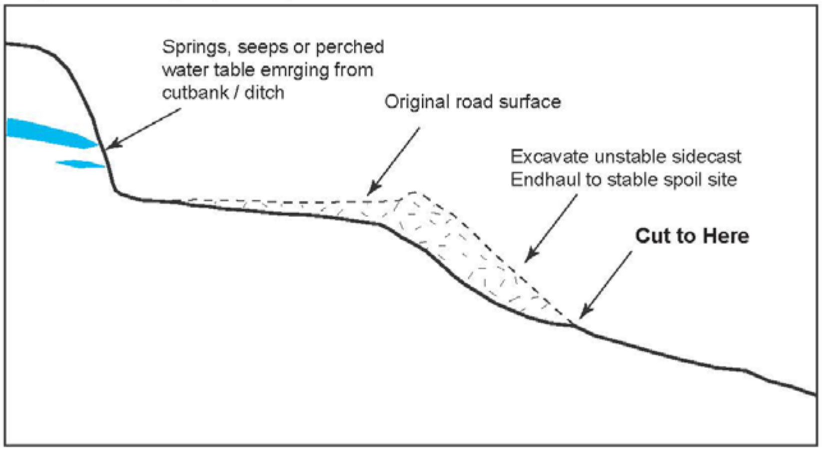
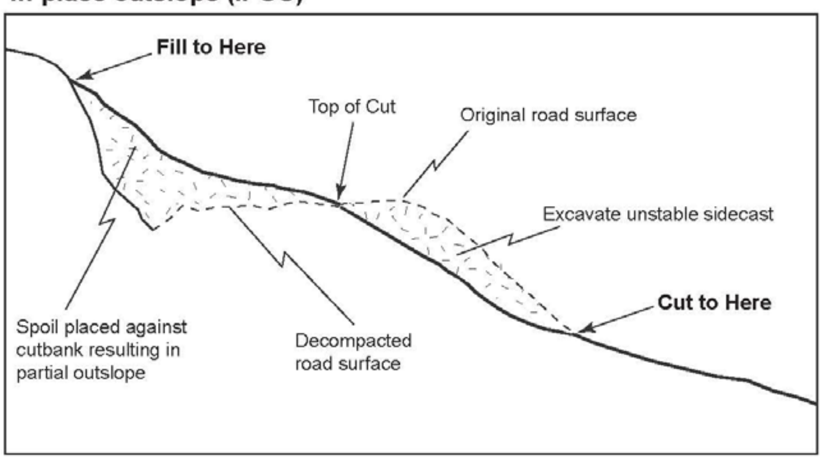
Typical Drawing #16

Typical Design for Road Decommisioning Treatments Employing Export and In-Place Outsloping Techniques

Export outslope (EPOS)



In-place outslope (IPOS)



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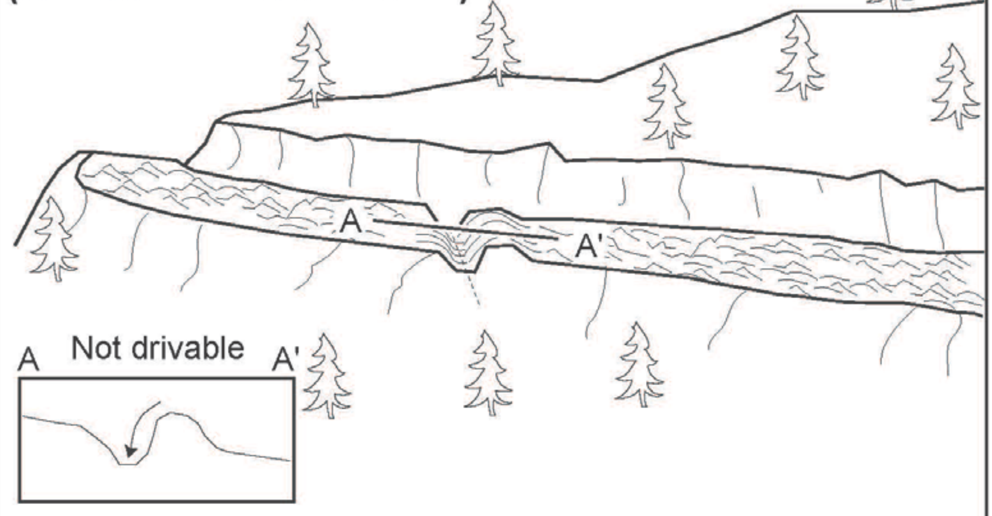
Typical Drawing #15

Cross-road drain and decompaction (decommissioned roads)



Cross road drain construction will ensure gullies, springs, road runoff and other concentrated flow will no longer collect over long lengths of road causing gully erosion and sediment delivery to streams. Cross road drains will be constructed at approximately 75 ft spacing intervals and these cross road drains will direct road surface runoff off the road onto stable hillslope locations.

Ripping the road surface 16 to 24 inches deep will increase road surface infiltration rates, decompact the road surface, and prevent concentrated runoff. Road ripping will also pulverize the compacted road surface or hardpan and allow for vegetation to establish and recover naturally.

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PWA Typical Drawing #17

STREAM CROSSING BMPs

BMP- FORD & ARMORED FILL CROSSINGS

DESCRIPTION

These crossing types have the advantage, over culverted fills, of never plugging, they don't rust out, they do not have diversion potential, and if constructed properly they are designed for the 100-year peak flow event. See Typical drawings 5a, 5b, 6, 7 for construction details.

APPLICATIONS

These crossings work well on unpaved seasonal use roads at small to medium sized streams where there is a stable stream bottom and traffic is light.

LIMITATIONS

- Use of these types of crossings on well-traveled roads should be avoided where water is flowing because of their potential to impact water quality.
- If possible, a stable, rocky (or bedrock) portion of the channel should be selected for these crossings.
- These crossings could be a barrier to migrating fish and installation will require approval by the Department of Fish and Wildlife.
- Deep water crossings can cause oil products to be released from vehicles as they pass through a wet ford.
- Streams with high stream banks require the excavation of substantial ramps to get vehicles down to the streambed. These through-cut ramps are often sites of substantial surface erosion and rilling that enters the stream during periods of winter rain.

CONSTRUCTION GUIDELINES

1) If applicable, remove existing drainage structure.
2) Dip out crossing wide enough to accommodate 100-year peak flow event.
3) Construct rolling dips along road lengths draining into crossing to minimize road drainage to crossing.
4) Rock road lengths draining into crossing with 'drain rock' to protect against erosion of the road surface.
5) When constructing an Armored Fill stream crossing the downstream side of fill should be armored with a size class of rock that will not be transported by stream flow.

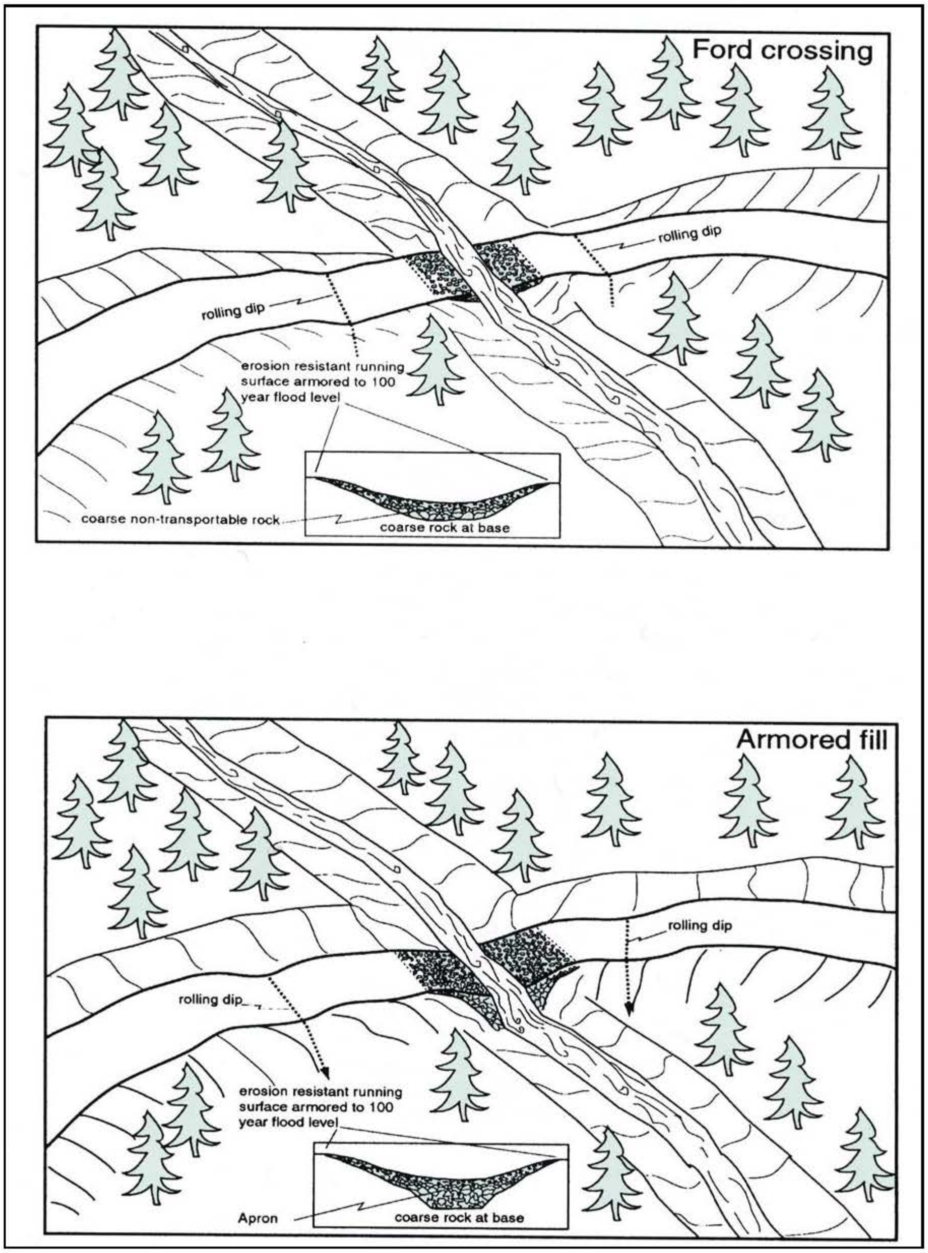
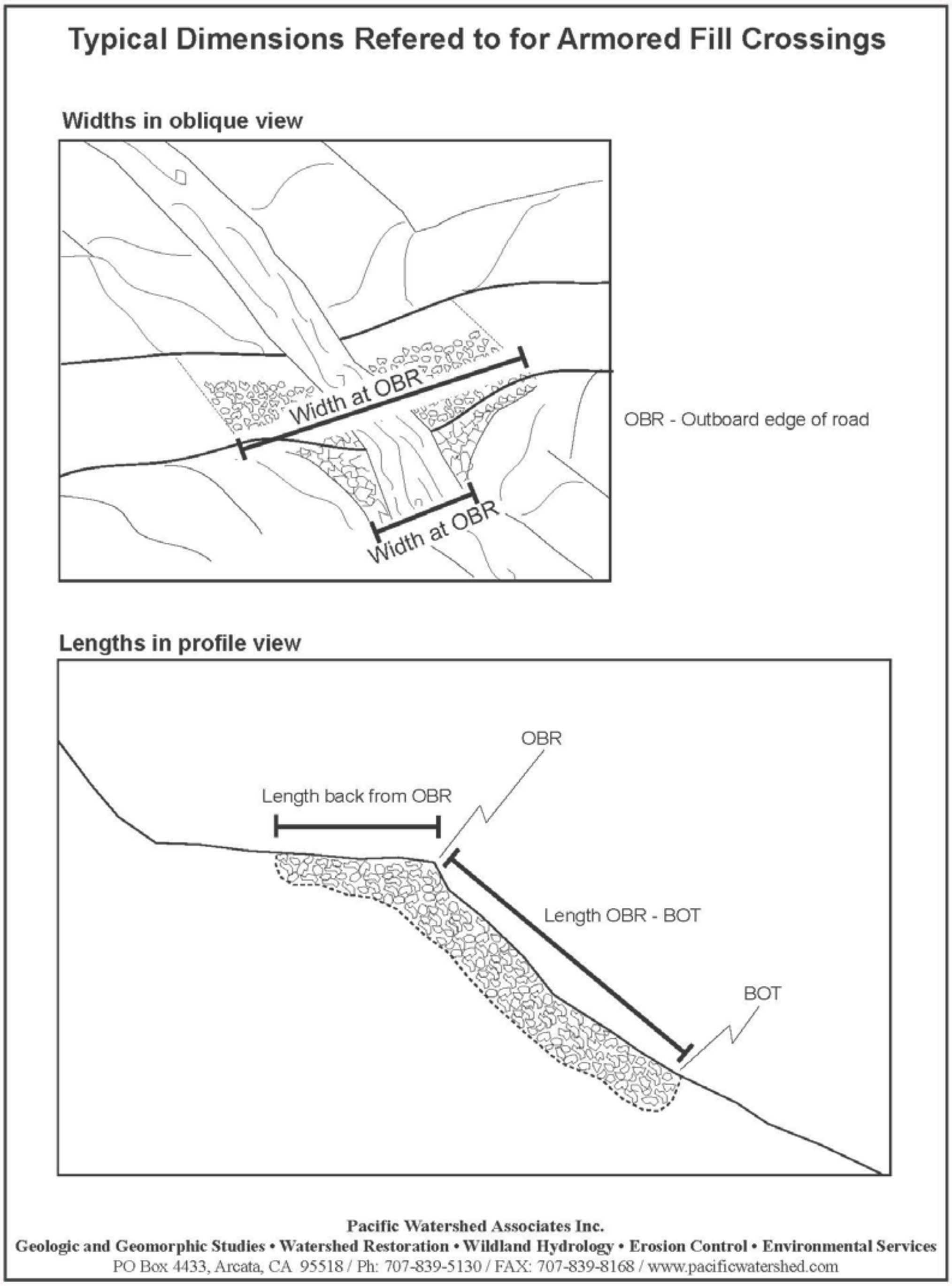
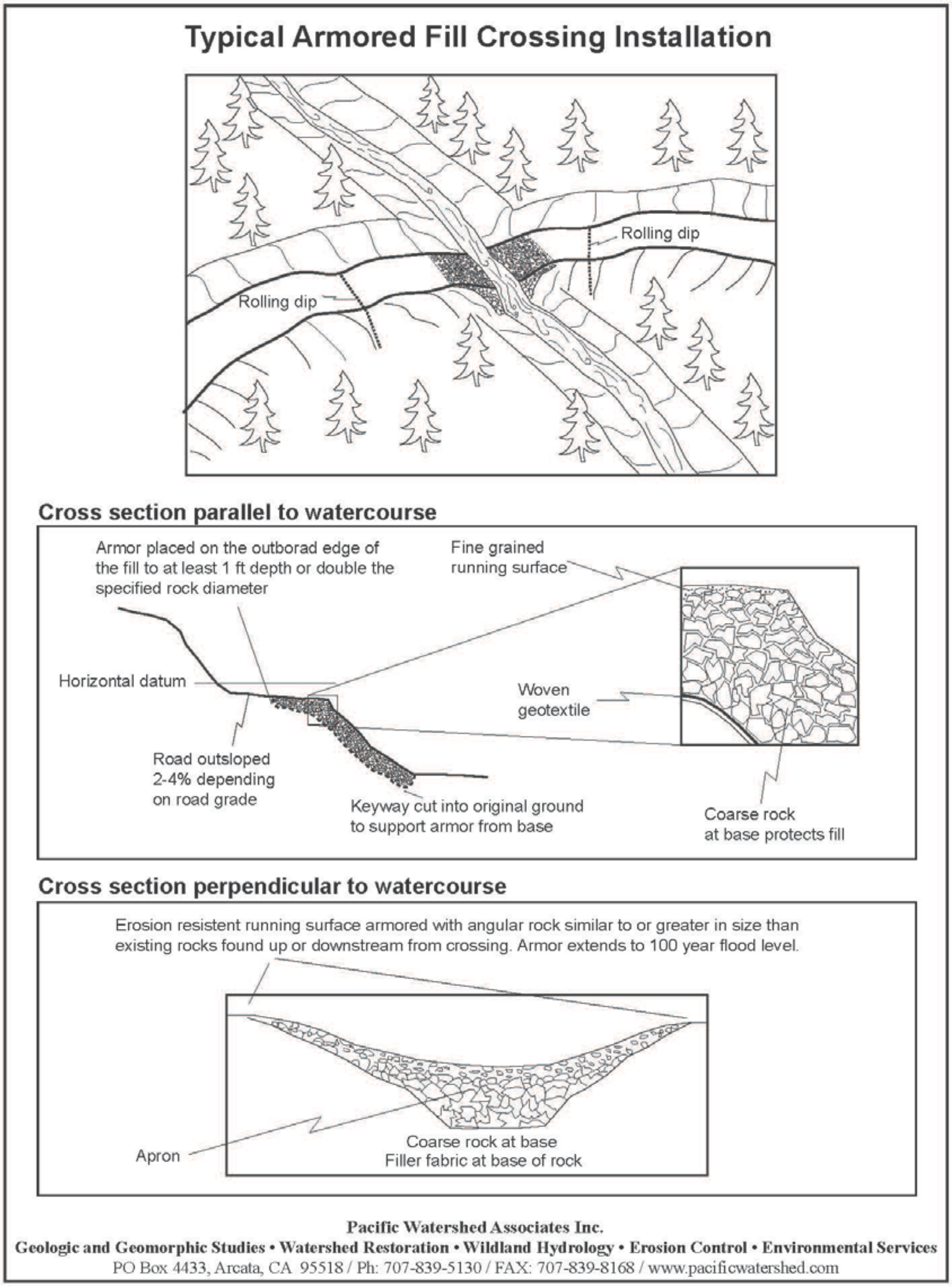


Figure X-15. Typical ford and armored fill stream crossings.

Typical Drawing #5a

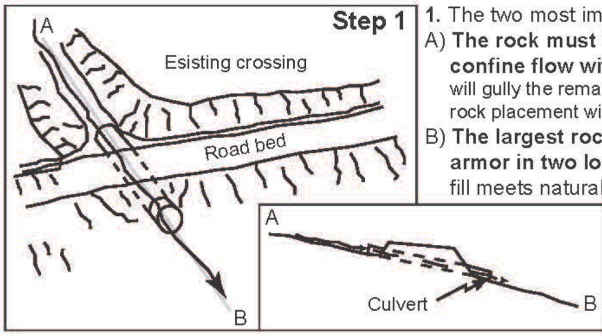


Typical Drawing #5b

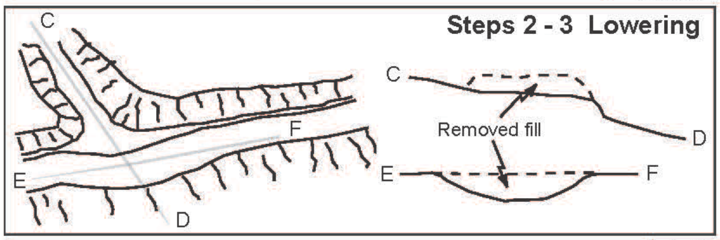


Typical Drawing #6

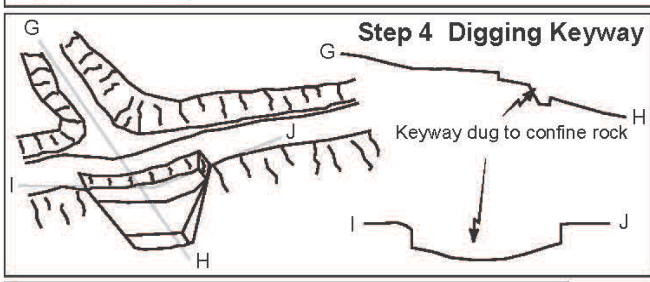
Ten Steps for Constructing a Typical Armored Fill Stream Crossing



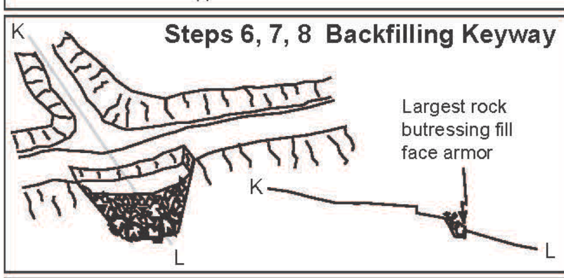
1. The two most important points are:
A) **The rock must be placed in a "U" shape across the channel to confine flow within the armored area.** (Flow around the rock armor will gully the remaining fill. Proper shape of surrounding road fill and good rock placement will reduce the likelihood of crossing failure).
B) **The largest rocks must be used to buttress the rest of the armor in two locations:** (i) The base of the armored fill where the fill meets natural channel. (This will butress the armor placed on the outboard fill face and reduce the likelihood of it washing downslope). (ii) The break in slope from the road tread to the outer fill face. (This will butress the fill placed on the outer road tread and will determine the "base level" of the creek as it crosses the road surface).



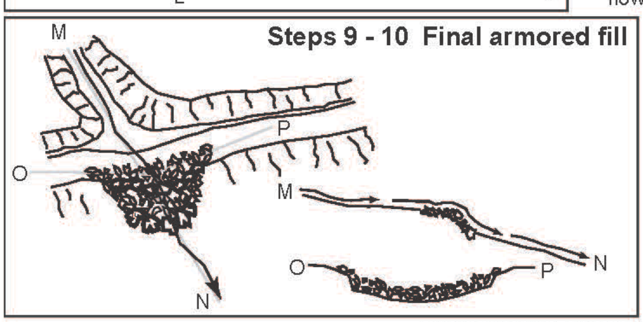
2. **Remove any existing drainage structures** including culverts and Humboldt logs.
3. **Construct a dip** centered at the crossing that is large enough to accomodate the 100-year peak storm flow and prevent diversion (C-D, E-F).



4. **Dig a keyway** (to place rock in) that extends from the outer 1/3 of the road tread down the outboard road fill to the point where outbaord fill meets natural channel (up to 3 feet into the channel bed depending on site specifics) (G-H, I-J).
5. **Install geofabric (optional)** within keyway to support rock in wet areas and to prevent winnowing of the crossing at low flows.



6. **Put aside the largest rock** armoring to create 2 buttresses in the next step.
7. **Create a buttress using the largest rock** (as described in the site treatments specifications) at the base of fill. (This should have a "U" shape to it and will define the outlet of the armored fill.)
8. **Backfill the fill face** with remaining rock armor making sure the final armored area has "U" shape that will accomodate the largest expected flow (K-L).



9. **Install a second buttress** at the break in slope between the outboard road and the outboard fill face. (This should define the base level of the stream and determine how deep the stream will backfill after construction). (M-N)
10. **Back fill the rest of the keyway** with the unsorted rock armor making sure the final armored area has a "U" shape that will accommodate the largest expected flow (O-P).

Typical Drawing #7

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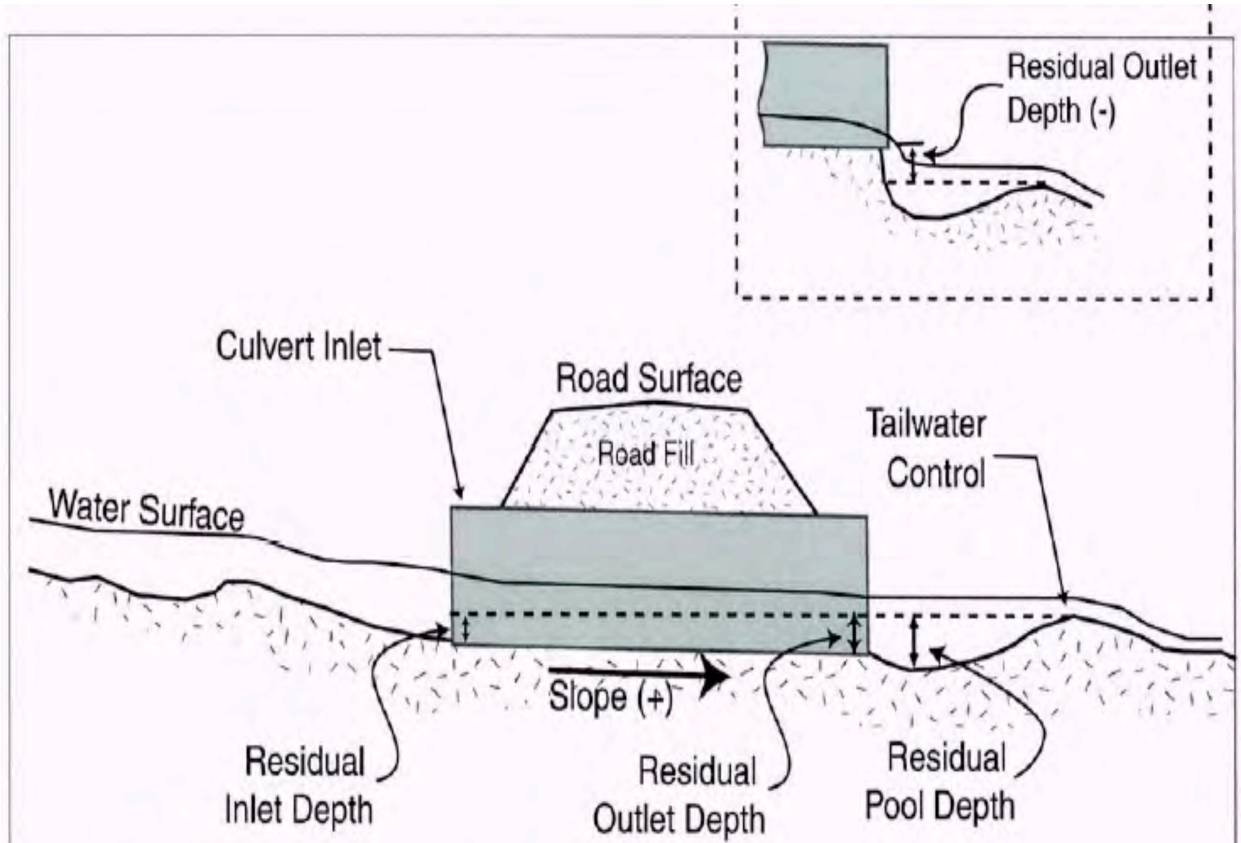
DIAGRAM - CULVERT HYDRAULICS

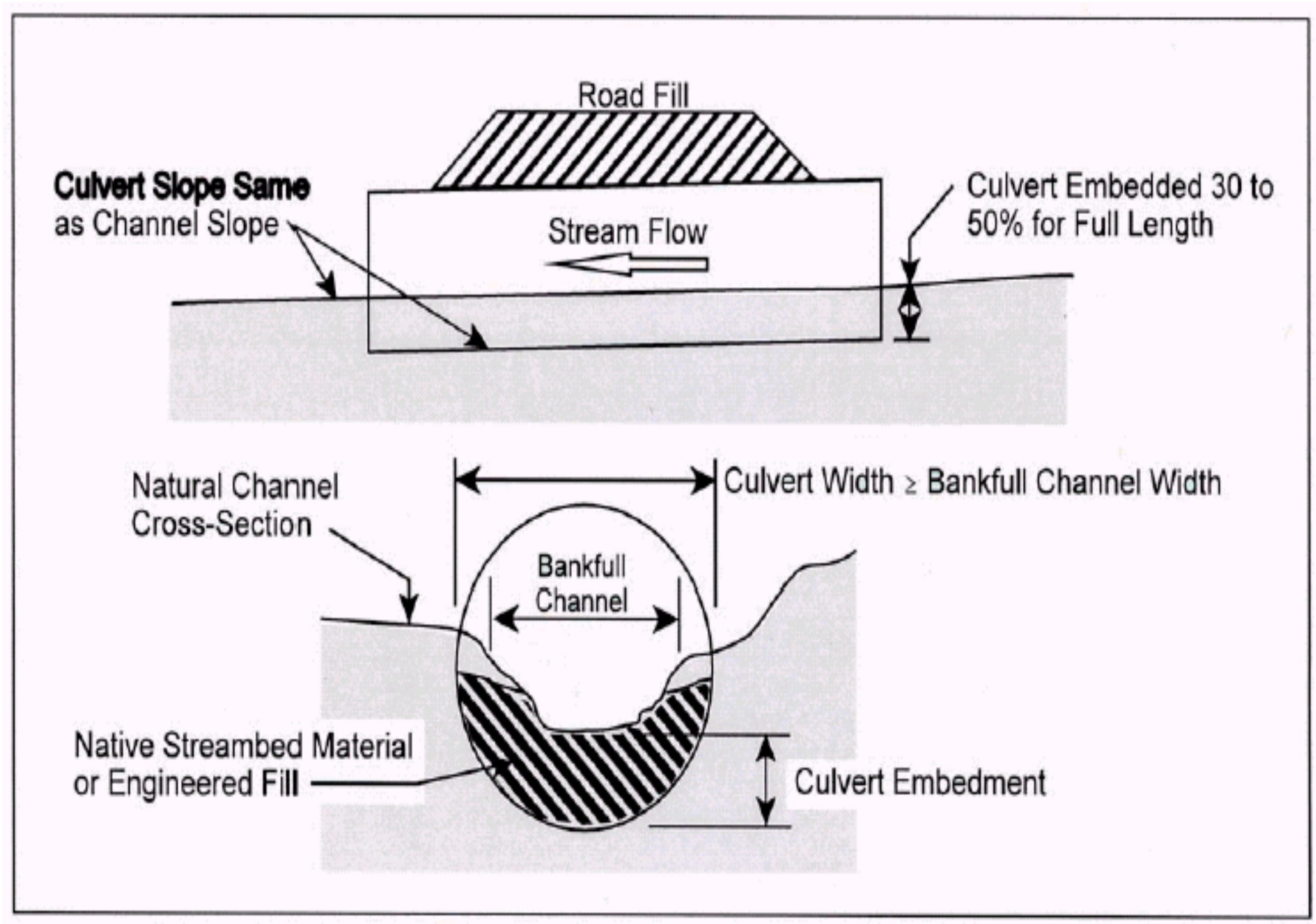


Residual Pool Depth = (Elev $_{\text{Tailwater Control}}$ - Elev $_{\text{Pool Bottom}}$)

Residual Outlet Depth = (Elev $_{\text{Tailwater Control}}$ - Elev $_{\text{Culvert Outlet}}$) (If Residual Outlet Depth is less than zero it is referred to as the Residual Outlet Drop)

Residual Inlet Depth = (Elev $_{\text{Tailwater Control}}$ - Elev $_{\text{Culvert Inlet}}$)

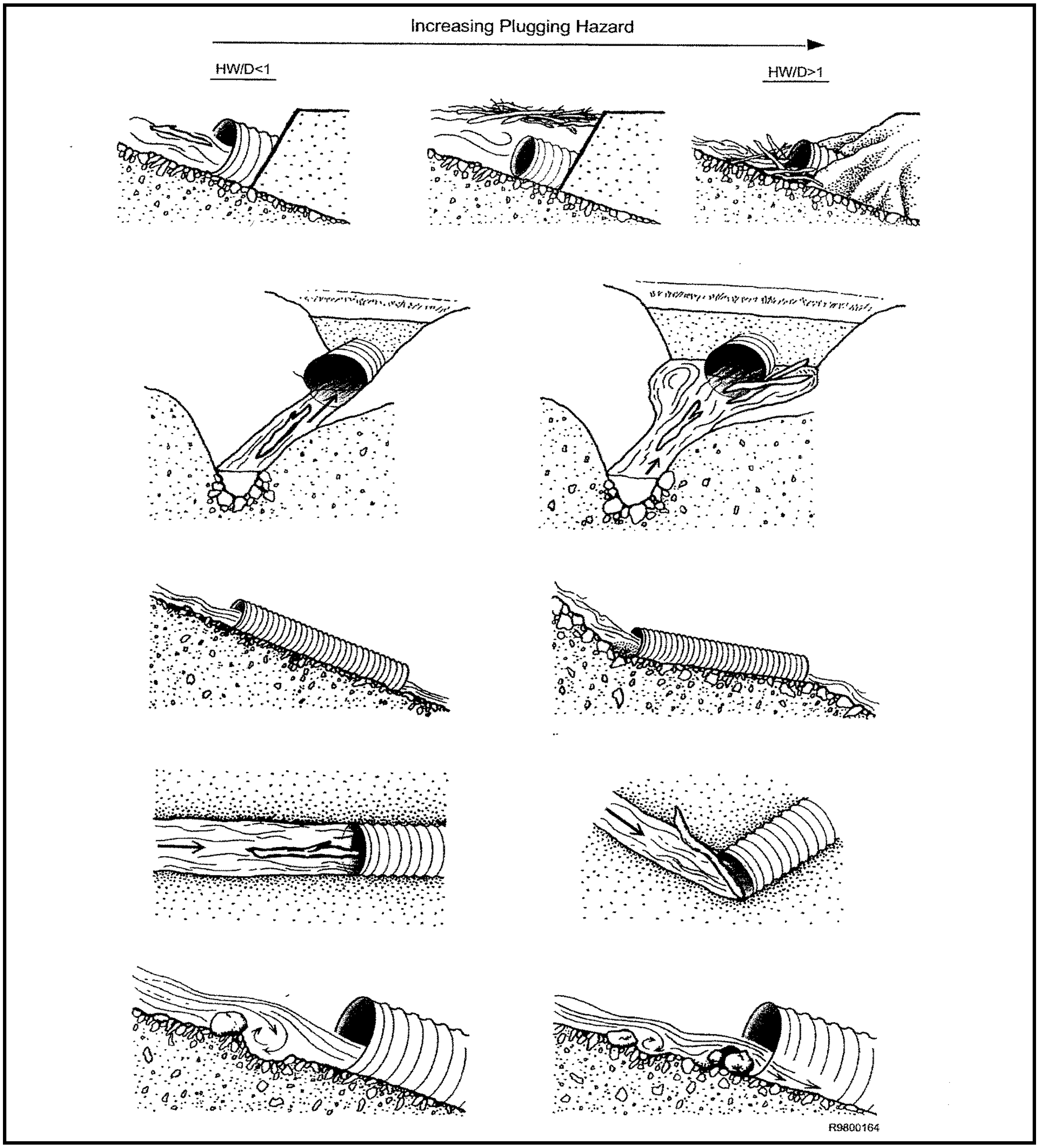
Source: FishNet4C



Stream simulation strategy option for installing culverts for fish passage. (DFG CA Salmonid Stream Habitat Restoration Manual. CH IX, 2002)

Source: FishNet4C

DIAGRAM - CULVERT PLUGGING



Source: USDA Forest Service (USFS). 2000. Water/Road Interaction Technology Series: "Diversion Potential at Road-Stream Crossings", By M. Furniss et al., Technology and Development Program. San Dimas, CA.

Stream Diversion due to plugged culvert on abandoned road.
Source: U.S.D.A Forest Service.

BMP - CULVERT SIZING

DESCRIPTION

Current state and federal guidelines for new crossing installation aim to provide unimpeded passage for both adult and juvenile salmonids. Guidelines have also been developed for sizing culverts on non-fish bearing streams. For detailed specifications see Appendix C: NOAA Fisheries Guidelines for Salmonid Passage at Stream Crossings and Fish and Game Passage Criteria for All Aquatic Life Forms Chapter IX of the California Salmonid Stream Habitat Restoration Manual CDFG, 2002.

APPLICATIONS

Three design guidelines have been created by state and federal agencies for designing new and replacement culverts. The three methods are:

1. The Active Channel Design Method is a simplified design that is intended to size a culvert sufficiently large and embedded enough into the channel to allow for natural movement of bedload and formation of a stable bed inside the culvert. Used for streams under 3% natural slope and for culverts less than 100 feet in length.
2. The Stream Simulation Design Method is a design process that is intended to mimic the natural stream processes within a culvert. Fish passage, sediment transport, flood and debris conveyance with the culvert are intended to function as they would in a natural channel. Stream simulation culverts require a greater level of information on hydrology and geomorphology (topography of the stream channel) and a higher level of engineering expertise than Active Channel Design Method.
3. The Hydraulic Design Method is a design process that matches the hydraulic performance of a culvert with swimming abilities of a target species and age class of fish. Determination of high and low flow fish passage design flows, water velocity, and water depth are required for this method.

LIMITATIONS

- ✓ It is the responsibility of the project sponsor to obtain the most current version of the culvert criteria for fish passage. Copies of the current criteria are available from the California Department of Fish and Game through the appropriate regional office.
- ✓ Obtain all applicable permits for modification of the bed or bank of a stream.
- ✓ Culvert installation can generate sediment so erosion and sediment control measures need to be implemented.
- ✓ All culverts are prone to failure. Examine alternatives to culverts such as bridges and wet crossings.

Source: FishNet4C

CONSTRUCTION GUIDELINES

1) Choose the appropriate method from the three sketches presented.

3) All culverts should be designed to pass the 100-year storm at less than 100% of the culverts height. This allows for passage of woody debris during extreme high flows. The size of the culvert as determined by methods 1, 2, or 3 should be checked to pass the 100-year storm. The 100-year storm flow can be determined by using the rational method, local stream gage data, or regional flood estimation equations. The culvert size should then be checked using a simple hydraulic program such as Culvert Master or Fish-Xing now available on-line.

4) Culvert width should be at least as wide as the active channel. This reduces constriction of flows at the inlet.

5) The culvert bottom should be buried below the streambed allowing for a natural bottom, creating a smooth entrance at the upstream and downstream end without excessive drops.

6) Minimize stream diversion potential by providing an outslope (see BMP - Outsloping) or dip (see BMP - Critical Dip) in the road grade at the crossing so that when the culvert plugs, water passes over the road and returns to its original course without being diverted down the road or road ditch.

7) Place the culvert parallel to the natural channel so that the inlet will not plug, and flow from the outlet will not erode either of the channel banks.

8) Whenever possible, the road should cross at right angles to the stream channel.

9) Prevent discharge of soil and other pollutants into the watercourse. Prevention methods include: construction when there is no water in the stream (see BMP – Seasonal Planning), diverting the water around the construction site or installing a temporary dam (see BMP - Aqua Barrier), and installing other silt barrier and control BMPs.

10) Debris-free fill soil, preferably with some clay content, must be properly compacted in layers along the length of the pipe to prevent water piping on the outside of the culvert. See also BMP - Ditch Relief Culvert for installation details.

11) Fill slopes at the inlet and outlet should be armored with the appropriate size rock or well- vegetated with perennial vegetation. Fill slopes should be no steeper than 2:1 (H:V).

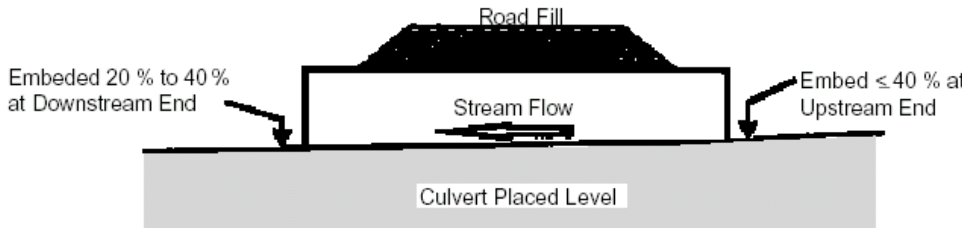
12) Maintain copies of permits on-site during construction.

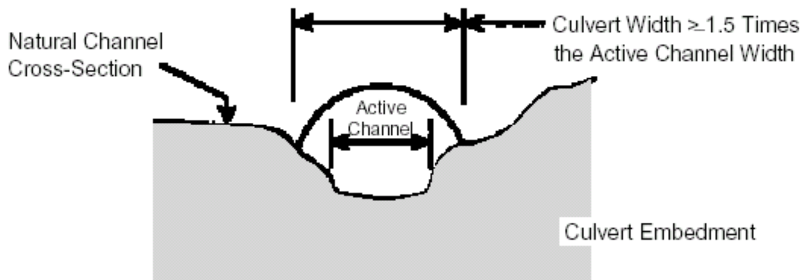
BMP MAINTENANCE

- ✓ Culverts require a high degree of maintenance to prevent plugging. Trash racks for small culverts such as the Single-Post Trash Rack BMP may help to reduce plugging but still must be checked and cleaned before and during the rainy season.
- ✓ Check around the culvert for piping or by-passing. Plug any gaps.
- ✓ Maintain the integrity of fill-slope protection of both the inlet and outlet sides.
- ✓ Check culverts for rusted bottoms or joint separation.

BMP REMOVAL

- ✓ If the crossing is to be abandoned or cannot receive annual maintenance, remove the culvert and slope back the banks to the original grade. Seed and mulch all bare soil areas with the appropriate weed free seed and mulch. Dispose of fill in an upland stable location, and stabilize with seed and mulch.





Active Channel Design Option :

- New and replacement culvert installations
- Simple installations on very small streams with channel slopes less than 3 %
- Short culvert length (less than 100 feet)
- Passage required for all fish

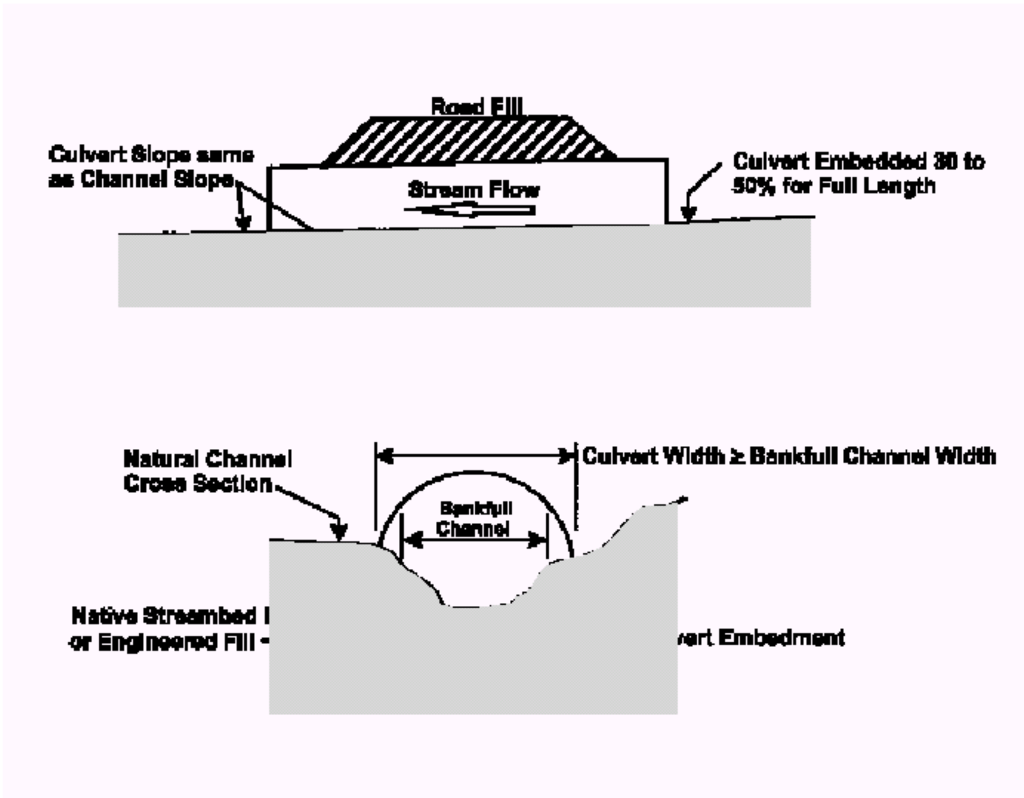
Choose a culvert size 1.5 times the width of the active channel. The active channel is that width indicated by the end of perennial vegetation and bed materials scoured a several storm events per year. Install the culvert at 0% or less slope. Embed the culvert so that the downstream end is 20 % to 40% embedded, and the upstream end is equal to or less than 40 % embedded.

Source:
California Fish Passage Workshop 2001

CULVERT SIZING

OPTION #1

Source: FishNet4C



Stream Simulation Design Option:

- New and replacement culvert installations
- Minimum Culvert width = 6 feet
- Simple installations with channel slopes less than 6 %
- Moderate to long culvert length (greater than 100 feet)
- Passage required for all fish
- Ecological connectivity required

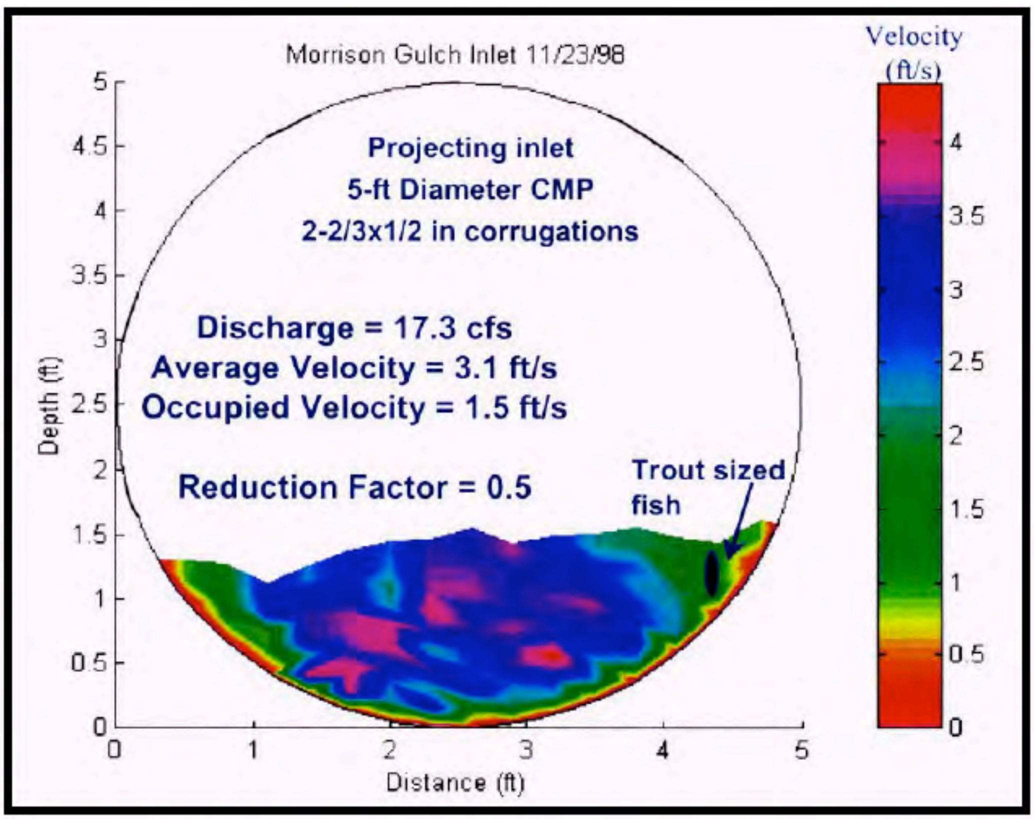
Need topographic survey, hydrology, channel forming discharge geometry. See Sept. 2000 Army Corps waterways experiment station report "Channel Forming Discharge"
See California Deptartment of Fish & Game, 2002. California Salmonid Stream Habitat Restoration Manual, chapter IX.

Source:
California Fish Passage Workshop 2001

CULVERT SIZING

OPTION #2

Fish passage can be computed by Roads Engineers by using Fish Xing Software for culvert design and assessment, found at http://www.fs.fed.us.fishxing/



On Quarry Road at Morrison Gulch, tributary to Jacoby Creek, Humboldt Bay watershed.

Hydraulic Design Option :

- New, replacement, and retrofit culvert installations
- Minimum Culvert width = 3 feet
- Low to moderate channel slopes less than 3 %
- Active Channel Design or Stream Simulation Option is not physically feasible
- Swimming ability and behavior of target species of fish is known
- Ecological connectivity not required
- Evaluation of proposed improvements to existing culverts

Detailed design matching hydraulic performance of culvert with swimming ability of target species and age class of fish. High level of engineering expertise, hydrologic data analysis needed. Fish passage software for culvert design and assessment is available on the net at www.stream.fs.fed.us/fishxing/

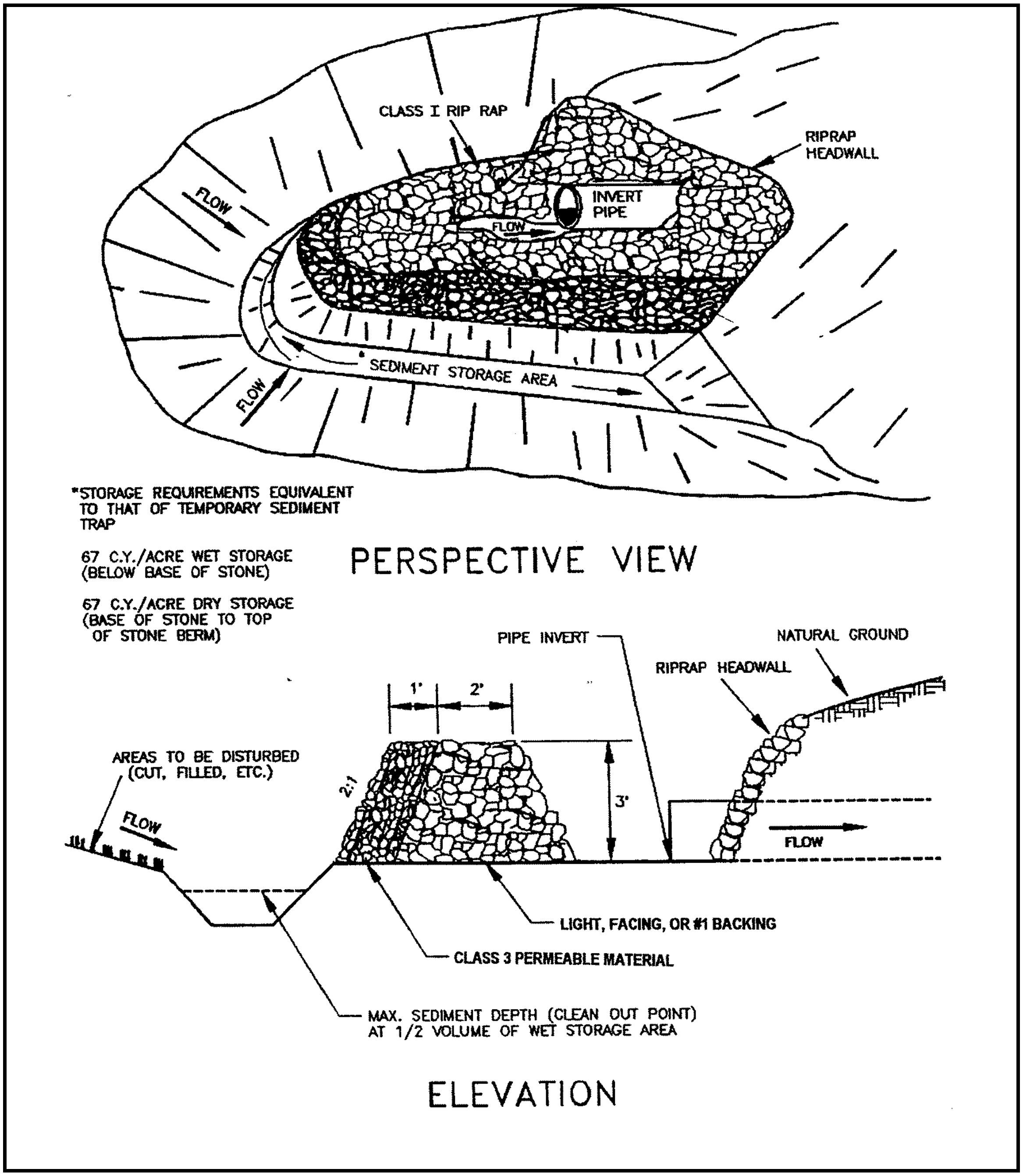
Source:
California Fish Passage Workshop 2001

CULVERT SIZING

OPTION #3

Source: FishNet4C

BMP - CULVERT INLET SEDIMENT TRAP



Source: Association of Bay Area Governments (ABAG). 1995. Manual of Standards for Erosion & Sediment Control Measures. 2nd edition. Oakland CA.

BMP- TRASH RACK- SINGLE POST

DESCRIPTION
A single-post trash rack is placed upstream of a culvert in small streams to turn floating branches and debris along the direction of flow so that they will pass through the culvert. See Typical Drawing 3.

APPLICATIONS
A trash rack can be used in small drainages when woody debris may contribute to the failure of a culvert by hanging up across the culvert opening.

LIMITATIONS
- Trash racks require frequent maintenance to remain effective.
- Larger debris may hang up on the post and create an upstream blockage. Depending on channel entrenchment, debris could cause water to bypass the culvert.
- Culverts must be sized for the 100-year storm or larger when using the single post trash rack in order to pass debris.
- Culverts and trash racks must be constructed with other fall-back measures such as a critical dip in the road (see BMP-Critical Dip) to take overflow and fill slope protection with rock armoring.

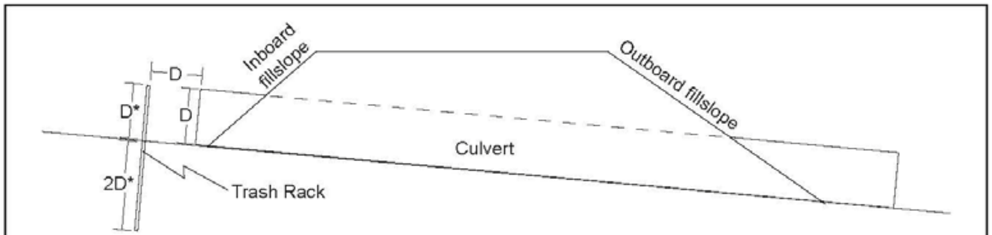
CONSTRUCTION GUIDELINES
1) A galvanized steel post is installed upstream of the culvert.
2) The post is driven into the ground centered at a distance upstream equal to the diameter of the culvert. Example: a 3 foot diameter culvert would have a post placed 3 feet upstream from the culvert inlet in the center of the channel.
3) 2/3 of the post length must be secured into the ground to be kept in place. Top of the post should be at least as high as the top of the culvert.

BMP MAINTENANCE
- Trash racks must be checked on a regular basis and cleared after storm events to prevent the complete failure of the culvert.

BMP REMOVAL
- **N/A**

Typical Design of a Single-post Culvert Inlet Trash Rack

Cross section view



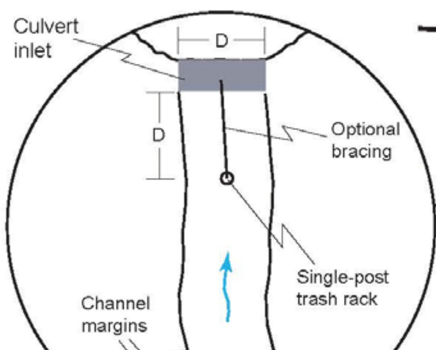
D - Culvert diameter

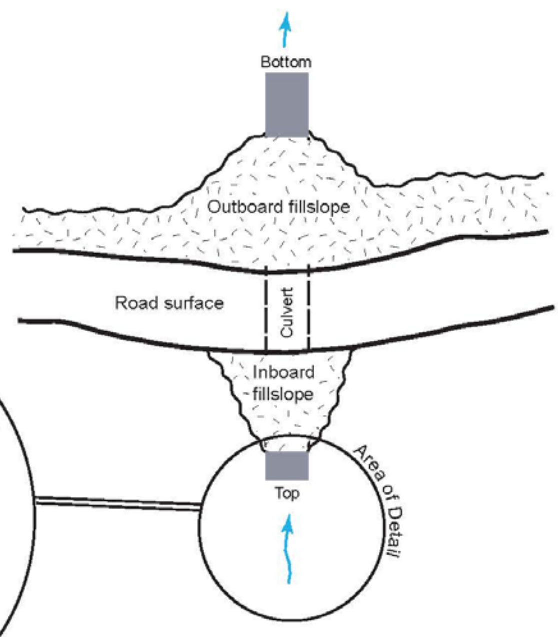
D* - If the culvert is designed for the 100-year peak storm flow, the trash rack height above the streambed should equal D.
If the culvert is undersized, then the trash rack needs to be extended vertically above the streambed to match or exceed the expected headwall height.

Plan view

Notes:

1. Many materials can be used for a single-post trash rack including old railroad track, galvanized pipe, and fence posts.
2. The diameter of single-post trash racks should be sized based on the size of expected woody debris. As a basic rule of thumb, the diameter of the trash rack should be equal to the diameter of the expected woody debris up to 4 inches.





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Typical Drawing #3

BMP - ENERGY DISSIPATER

DESCRIPTION

An energy dissipater is a structure designed to control erosion at the outlet of a culvert or conduit by reducing the velocity of flow and dissipating the energy.

APPLICATIONS

This BMP is required at the outlet of any new or replacement drainage culvert. The outlets of channels, conduits, and other structures are points of high erosion potential. To prevent scour and undermining, an outlet stabilization structure is needed to absorb the impact of the flow and reduce the velocity to non-erosive levels. Evaluate existing culverts and schedule upgrades of energy dissipater installations as appropriate.

A riprap-lined apron is a commonly used practice for this purpose because of its relatively low cost and ease of installation. Extend the riprap apron downstream until stable conditions are reached, even though this may exceed the length calculated for design velocity control. Down drains may also be used as energy dissipaters. Rock aprons may also be required below down drains depending on slope steepness and soil conditions.

LIMITATIONS

- ✓ Do not use this BMP below the mean high water line of any water body before obtaining appropriate permits. Due to issues relative to Corps 404 jurisdiction sometimes energy dissipaters are not placed below the ordinary high water mark which results in increased erosion
- ✓ Consider other energy dissipaters such as concrete impact basins, paved outlet structures, or a half culvert where site conditions warrant.
- ✓ Rock/riprap dissipaters may require containment in mattresses to maintain their effectiveness.

CONSTRUCTION GUIDELINES

1) Adequately compact berm material to prevent failure.

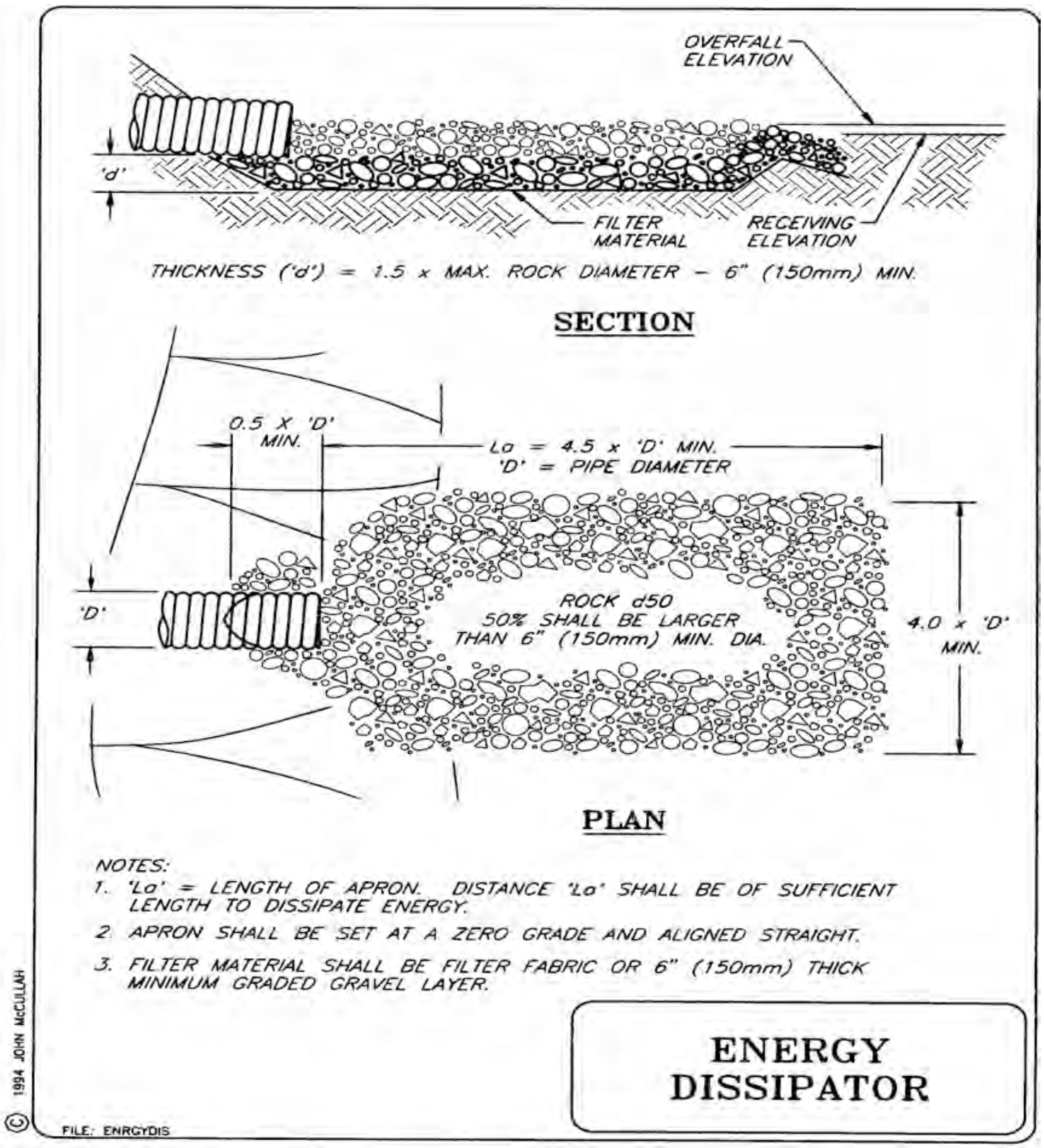
2) Apply temporary seeding and mulch to all surfaces of a soil diversion berm according to the BMP-Seasonal Planning.

BMP MAINTENANCE

- ✓ After heavy rains, inspect outlet structures for erosion or dislodged stones. Immediately make all needed repairs to prevent further damage.

BMP REMOVAL

- ✓ BMP removal should not be necessary.

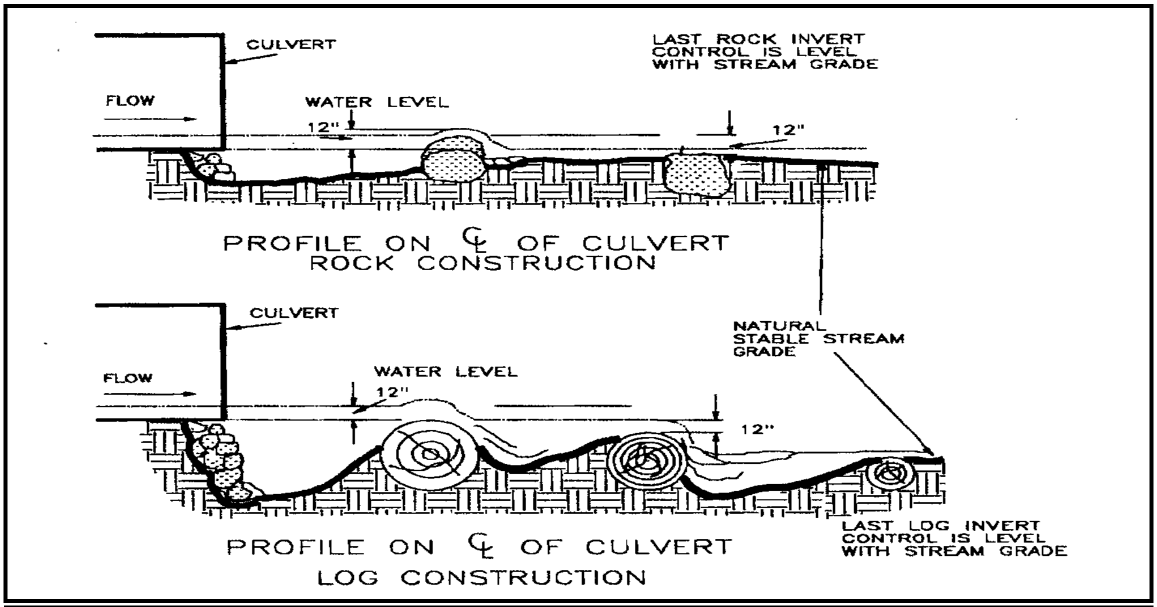


Source: FishNet4C

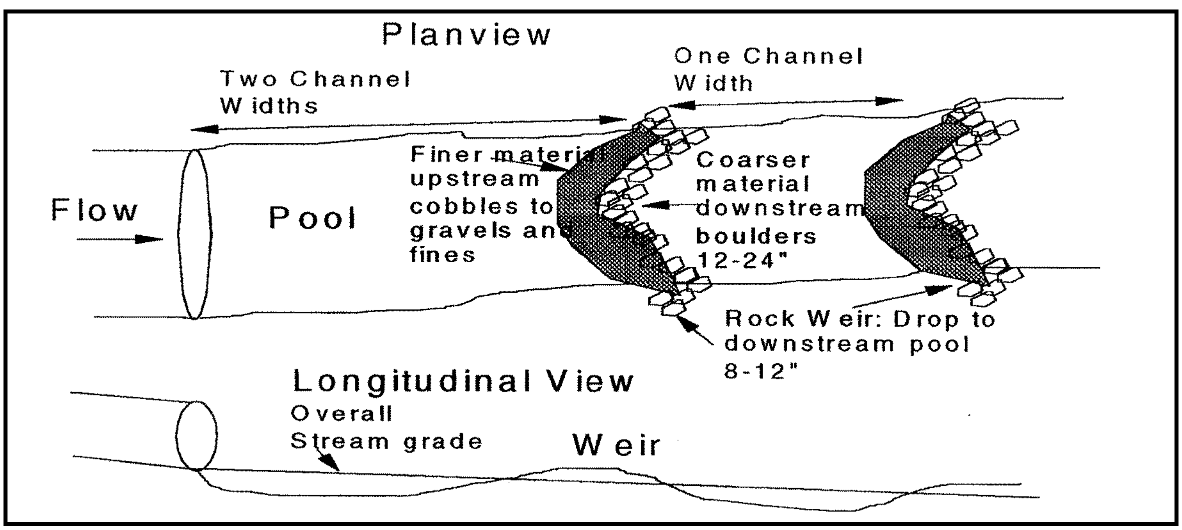
BMP - BACK-FLOODING WEIRS

APPLICATIONS

This BMP should be used when a culvert is *not* installed with at least 1/4 of its diameter at or below stream grade. The purpose is to help pass adult and juvenile fish where a jump barrier was created by scour at the downstream end of culverts.



Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat Restoration Manual. By Gary Flosi, et al. Inland Fisheries Div., 3rd edition.



Source: Robison, E., A. Mirati, and M. Allen. 1999. Oregon Road/Stream Crossing Restoration Guide. Advanced Fish Passage Training Version. Salem OR.

BMP- BAFFLES FOR FISH PASSAGE

DESCRIPTION

Baffles are added to a culvert to increase the hydraulic roughness of the culvert and therefore reduce the average cross-section velocity. The purpose is to improve fish passage, mainly for adults.

Note: In general, we *do not* recommend baffled culverts except as a last resort. In many cases the culvert should simply be removed.

APPLICATIONS

To provide for adult fish passage in an existing culvert in a low gradient stream with good habitat upstream, and where funding is not available to replace with a bridge or open bottomed culvert. Cost and maintenance usually make this choice a last resort.

LIMITATIONS

Again, this BMP is usually a last resort, for reasons including:

- ✓ Baffles within a culvert are not a desired solution to meeting velocity criteria and are not appropriate for new culvert installations.
- ✓ Baffles should not be installed in culverts with less than 5 feet of headroom or in high gradient streams (>3.5% slope) with large bedload and debris moving through.
- ✓ Culverts with baffles are more prone to clog with debris and sediment. Baffles can rip out and damage the culvert or cause it to fail.
- ✓ Cost of maintenance is high.
- ✓ Permit process is longer and more difficult than for other solutions, thereby requiring more advance planning

CONSTRUCTION GUIDELINES

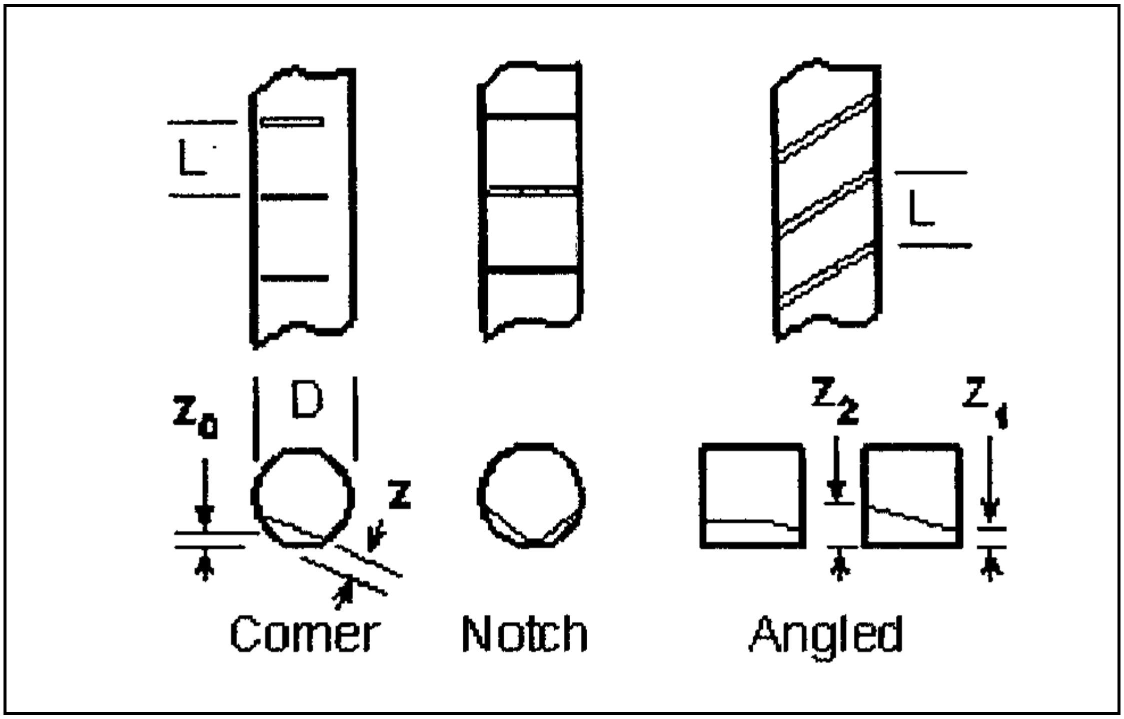
13) The figure below depicts two baffle styles for round culverts and one for box culverts. They are all designed with a continuous alignment of notches along one wall rather than alternating back and forth. This design allows less resistance to high flows and an uninterrupted line of fish passage along one or both sides. This feature is particularly important for weak fish which would be forced to cross the high velocity zone at every baffle in an alternating baffle design.

14) Two details of angled baffles are shown for box culverts; the continuously sloped baffle is generally used for juvenile passage situations and in culverts 6 feet wide and less. The notch baffle style is especially useful in large culverts and can be

applied to slopes of 2.5-3.5%. Corner baffles generally apply to culverts with slopes from 1.0-2.5%.

15) To avoid reducing the culvert capacity, the upstream baffle should be placed at least one culvert diameter downstream of the inlet and should be high enough to ensure subcritical flow at the inlet at the high design flow. A modification of the culvert, such as a mitered end or wingwalls, may also be required to improve its hydraulic efficiency.

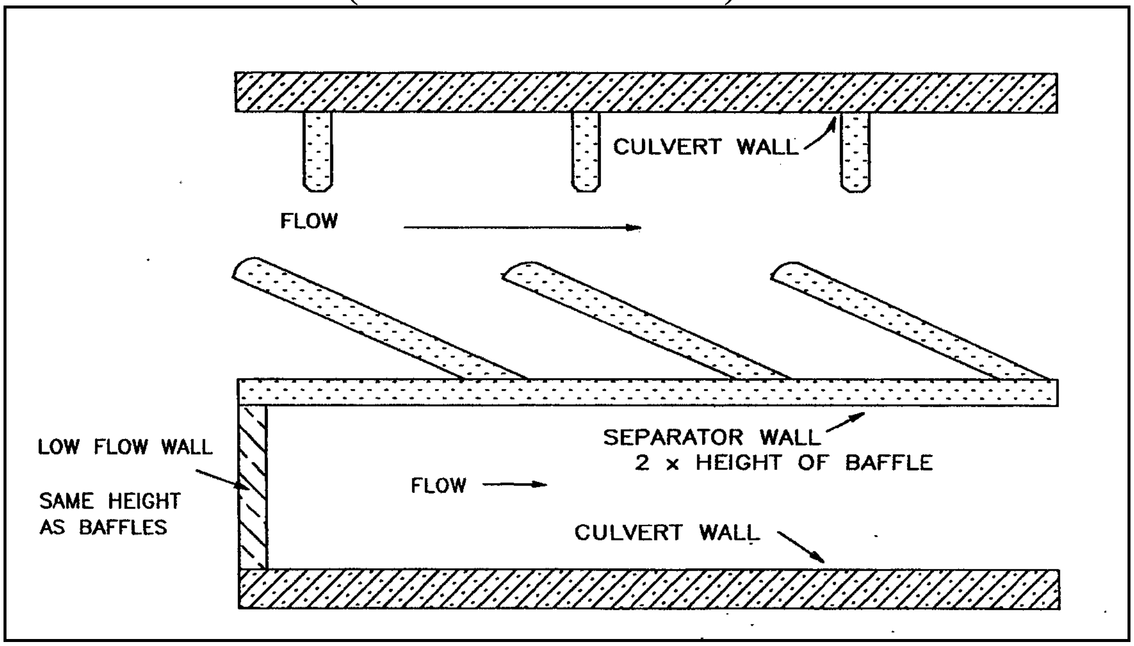
Baffles for Round and Box Culverts



Source: Washington Dept. of Fish and Wildlife. 1999. Fish Passage Design at Road Culverts: A design manual for fish passage at road crossings. Olympia WA.

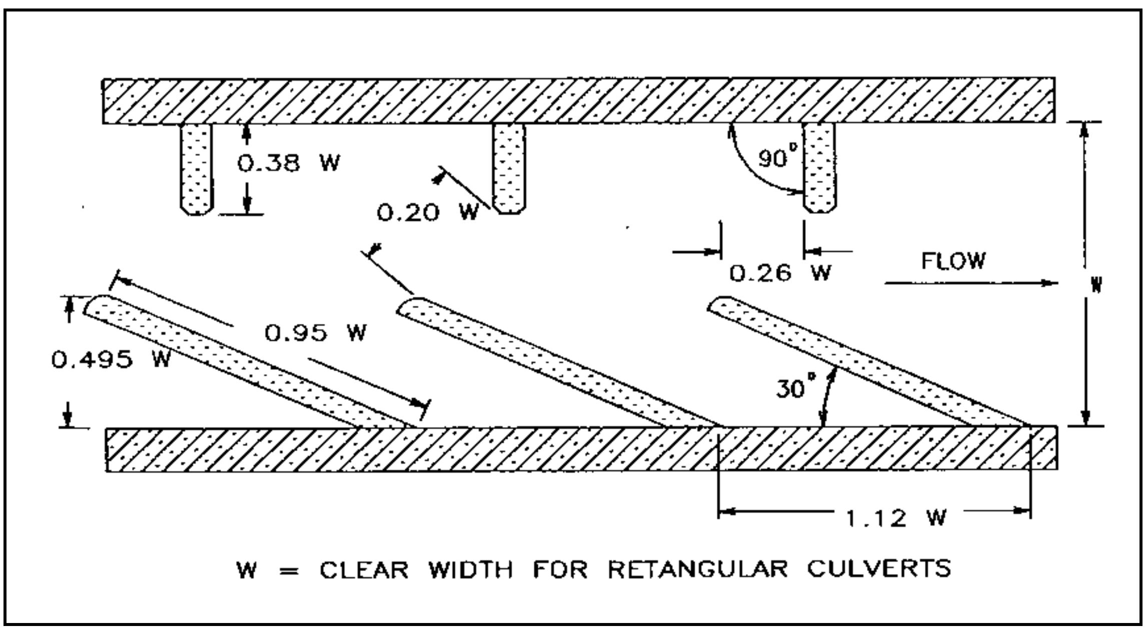
Washington Baffles with Separator Wall

(for culverts > 7 ft. width)



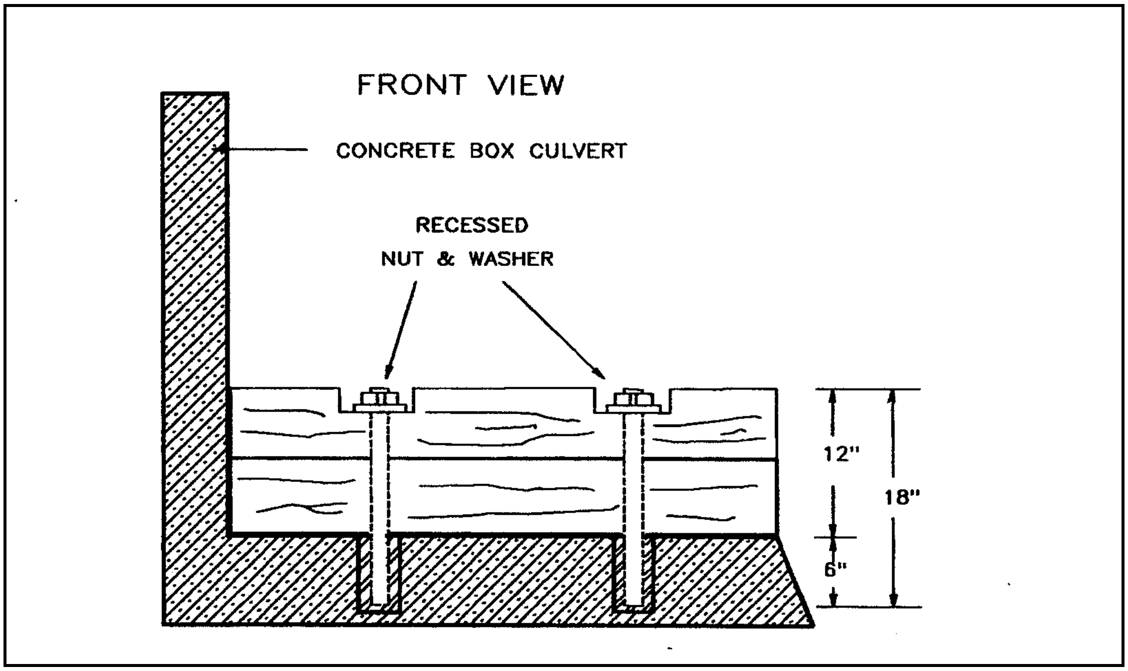
Source: CDFG, 1998

Washington Baffles



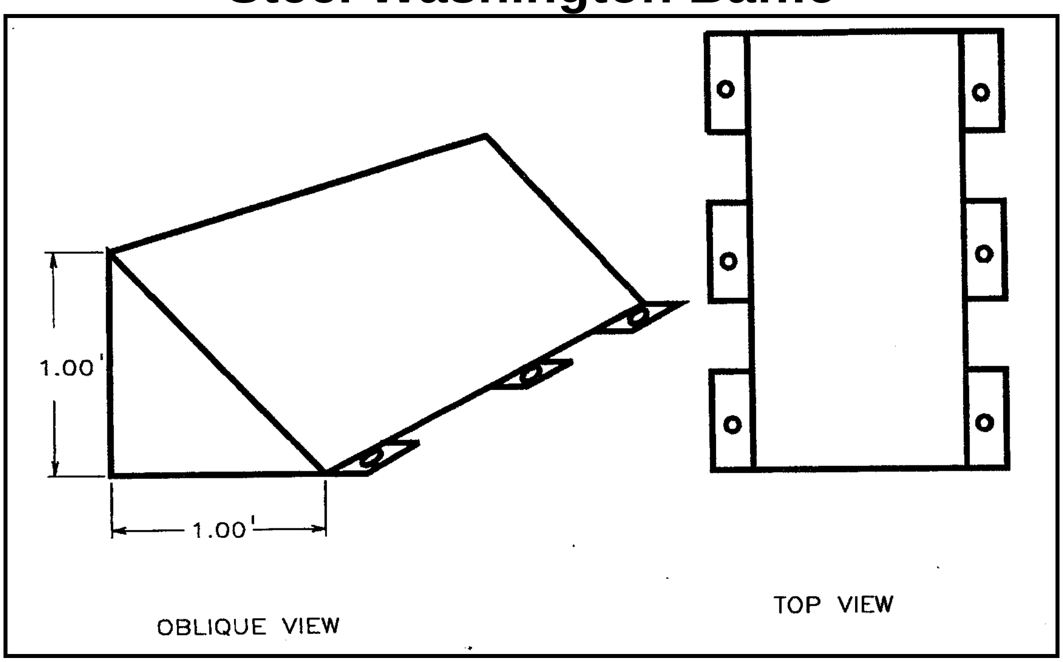
Source: CDFG, 1998

Redwood Washington Baffle Construction



Source: CDFG, 1998

Steel Washington Baffle



Source: CDFG, 1998

EROSION CONTROL BMPs

Source: FishNet4C

BMP – BLANKETS/GEOTEXTILE FABRICS

DESCRIPTION

Erosion control blankets and mats are installed to protect the prepared soil surface of a steep slope.

APPLICATIONS

Erosion control blankets are used on steep slopes to temporarily stabilize and protect disturbed soil from raindrop impact and surface erosion, to increase infiltration, decrease compaction and soil crusting, and to conserve soil moisture. Erosion control blankets also protect seeds from predators, reduce desiccation and evaporation by insulating the soil and seed environment. Some types of erosion control blankets and turf reinforcement mats are specifically designed to stabilize channelized flow areas.

LIMITATIONS

- ✓ This BMP should not be used in areas subject to scour from high flows (e.g. streambanks) unless designed by an engineer. Permits shall be obtained prior to any streambank or shoreline installation.
- ✓ Blankets and mats manufactured with plastic netting shall be avoided.

CONSTRUCTION GUIDELINES

1) Proper site preparation is essential to ensure complete contact of the protection matting with the soil.

2) Grade and shape area of installation.

3) Remove all rocks, clods, and vegetative or other obstructions so that the installed blankets, or mats will have direct contact with the soil.

4) Prepare seedbed by loosening 2-3 inches (50-75 mm) of topsoil above final grade.

5) Seed area before blanket installation for erosion control and re-vegetation. (Seeding after mat installation is often specified for turf reinforcement application.)

6) U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats to the ground surface. Wire staples should be a minimum of 11 gauge. Metal stake pins should be 3/16-inch diameter steel with a

Source: FishNet4C

1 1/2 inch steel washer at the head of the pin. Wire staples and metal stakes should be driven flush to the soil surface. All anchors should be 6-8 inches long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils.

Installation on Slopes:

1) Begin at the top of the slope and anchor its blanket in a 6 inch deep x 6-inch wide trench. Backfill trench and tamp earth firmly.

2) Unroll blanket downslope in the direction of the water flow.

3) The edges of adjacent parallel rolls must be overlapped 2-3 inches and be stapled every 3 feet.

4) When blankets must be spliced, place blankets end over end (shingle style) with 6-inch overlap. Staple through overlapped area, approximately 12 inches apart.

5) Lay blankets loosely and maintain direct contact with the soil - do not stretch.

6) Blankets shall be stapled sufficiently to anchor blanket and maintain contact with the soil. Staples shall be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 to 2:1, require 2 staples per square yard. Moderate slopes, 2:1 to 3:1, require 1-2 staples per square yard (1 staple 3' on center). Gentle slopes require 1 staple per square yard.

BMP MAINTENANCE

✓ All blankets and mats should be inspected periodically following installation.

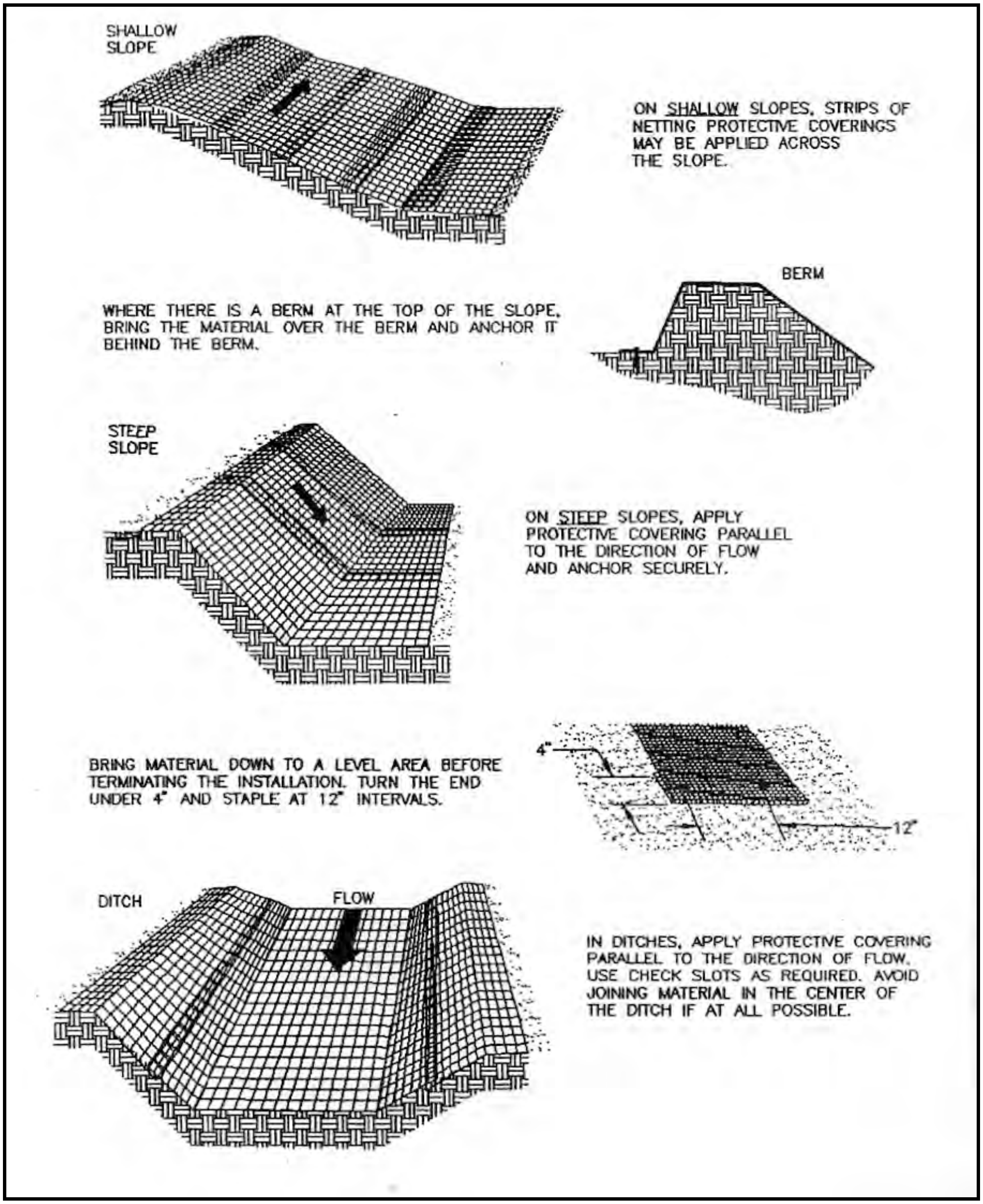
✓ Inspect installation after significant rainstorms to check for erosion and undermining. Any failure should be repaired immediately.

✓ If washout or breakage occurs, re-install the material after repairing the damage to the slope or drainage way.

BMP REMOVAL

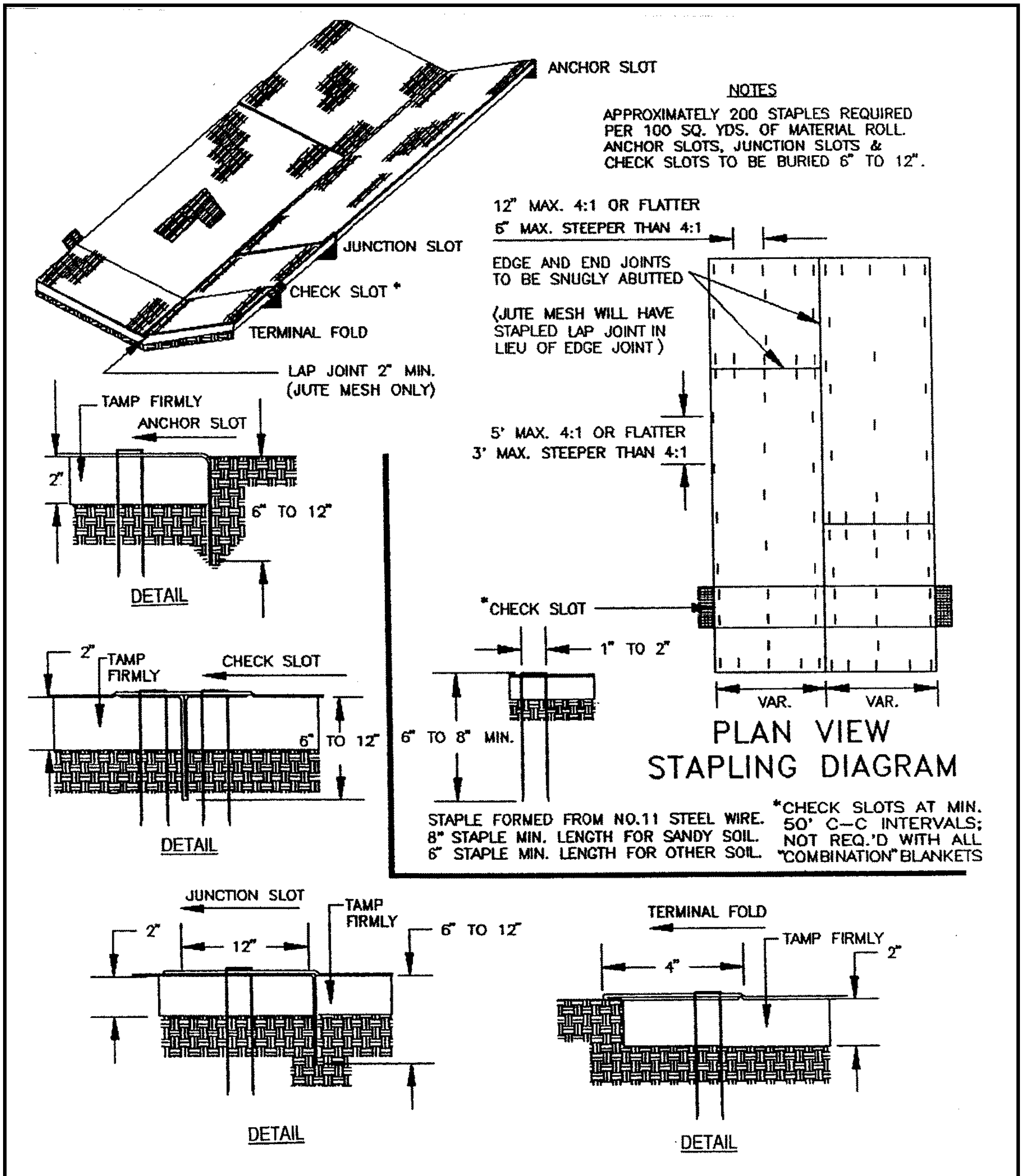
✓ BMP removal should not be necessary.

Placement of Biodegradable Blankets



(Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures. Oakland CA.)

Installation of Biodegradable Blankets

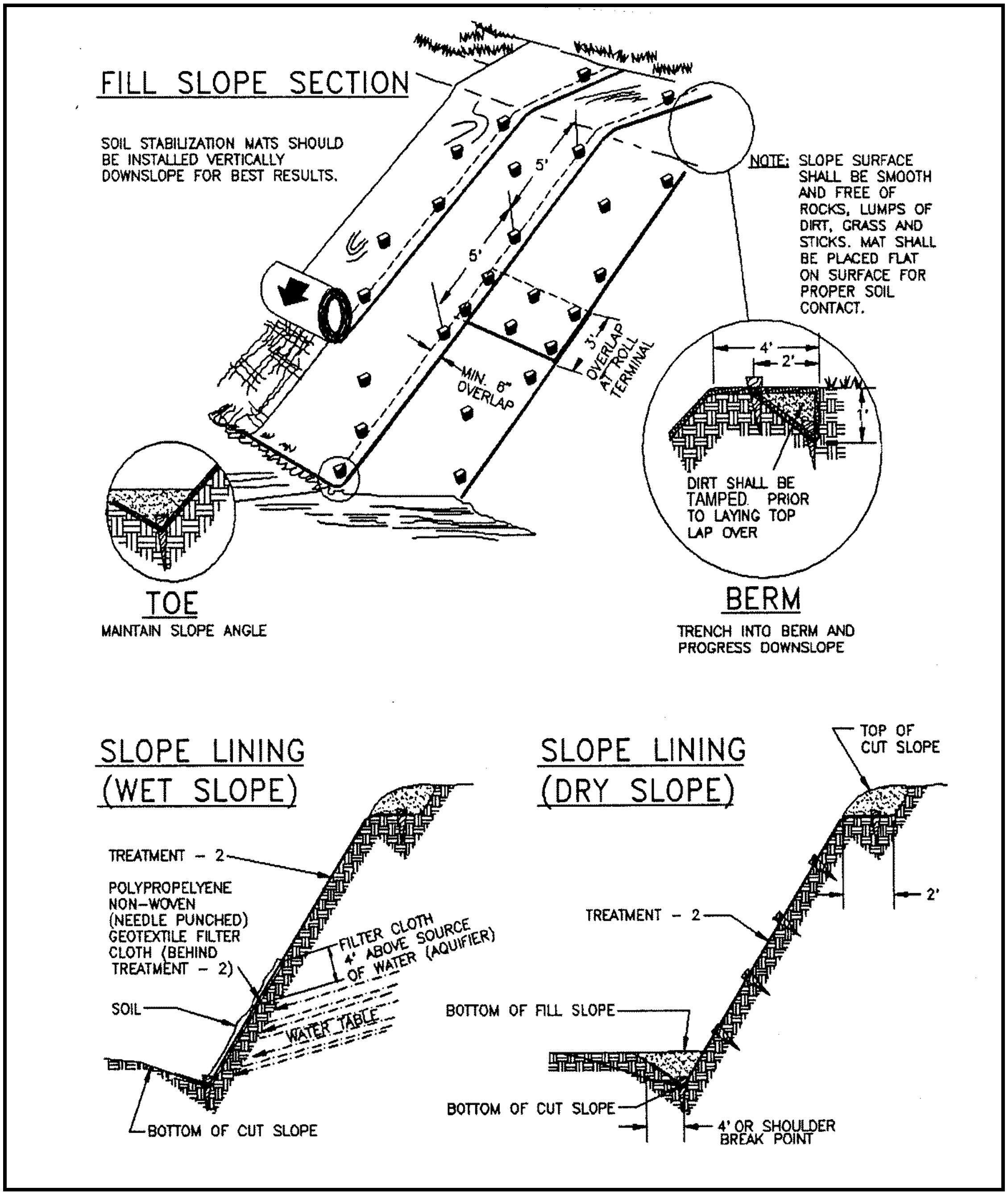


NOTE: Follow Manufacturer's recommended installation procedures.

Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures. Oakland CA.

Placement of Non-biodegradable Blankets

*** Important Note:** Non-biodegradable blankets should not be used in fish bearing streams and US Fish and Wildlife Service prohibits their use on stream crossings in the bankful channel.



(Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures. Oakland CA.)

Anchoring of Blankets

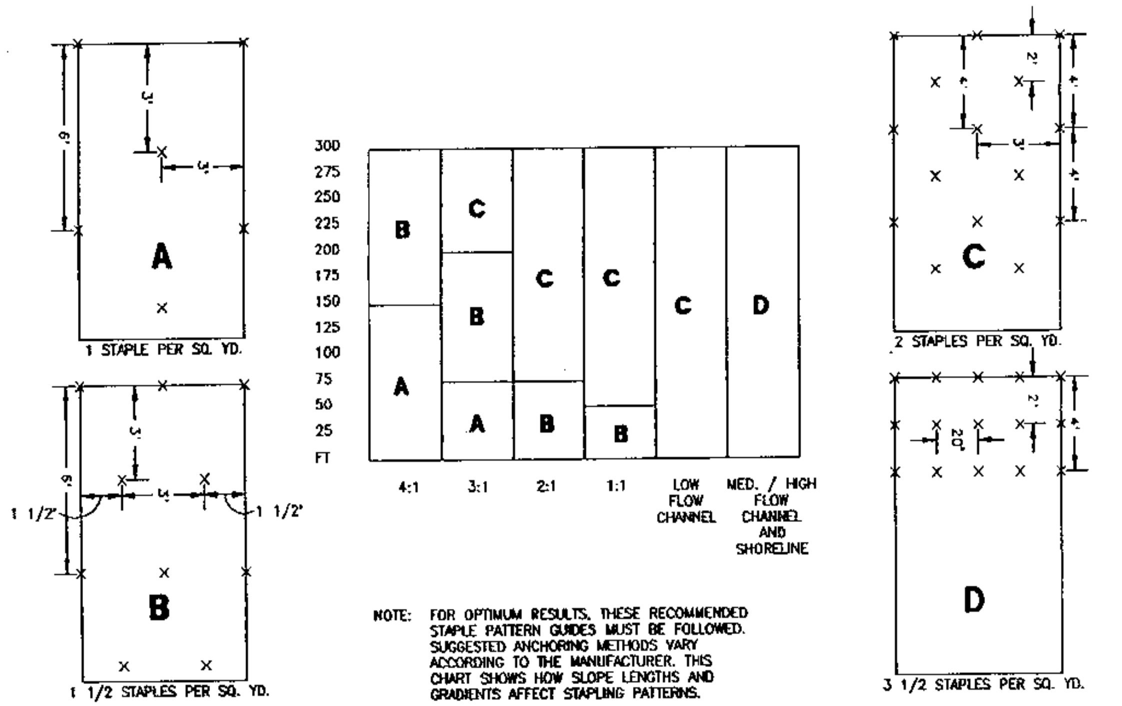
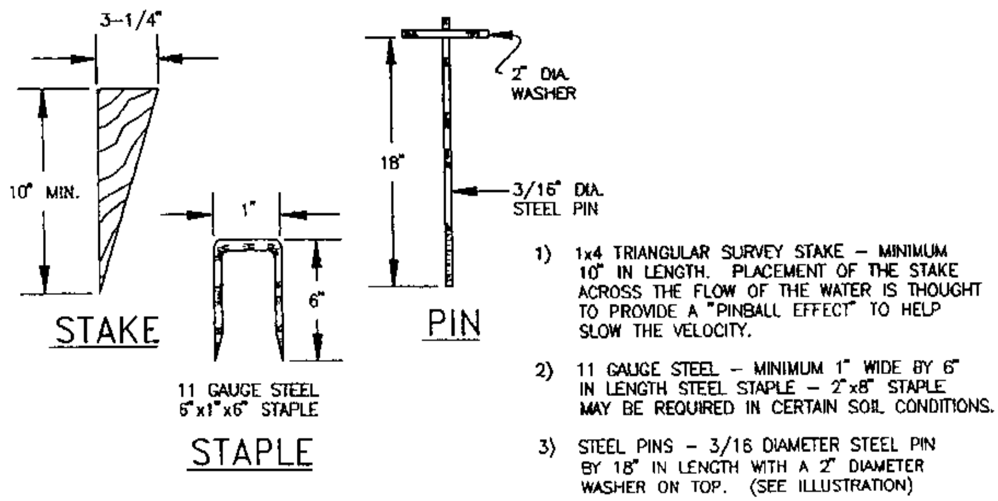
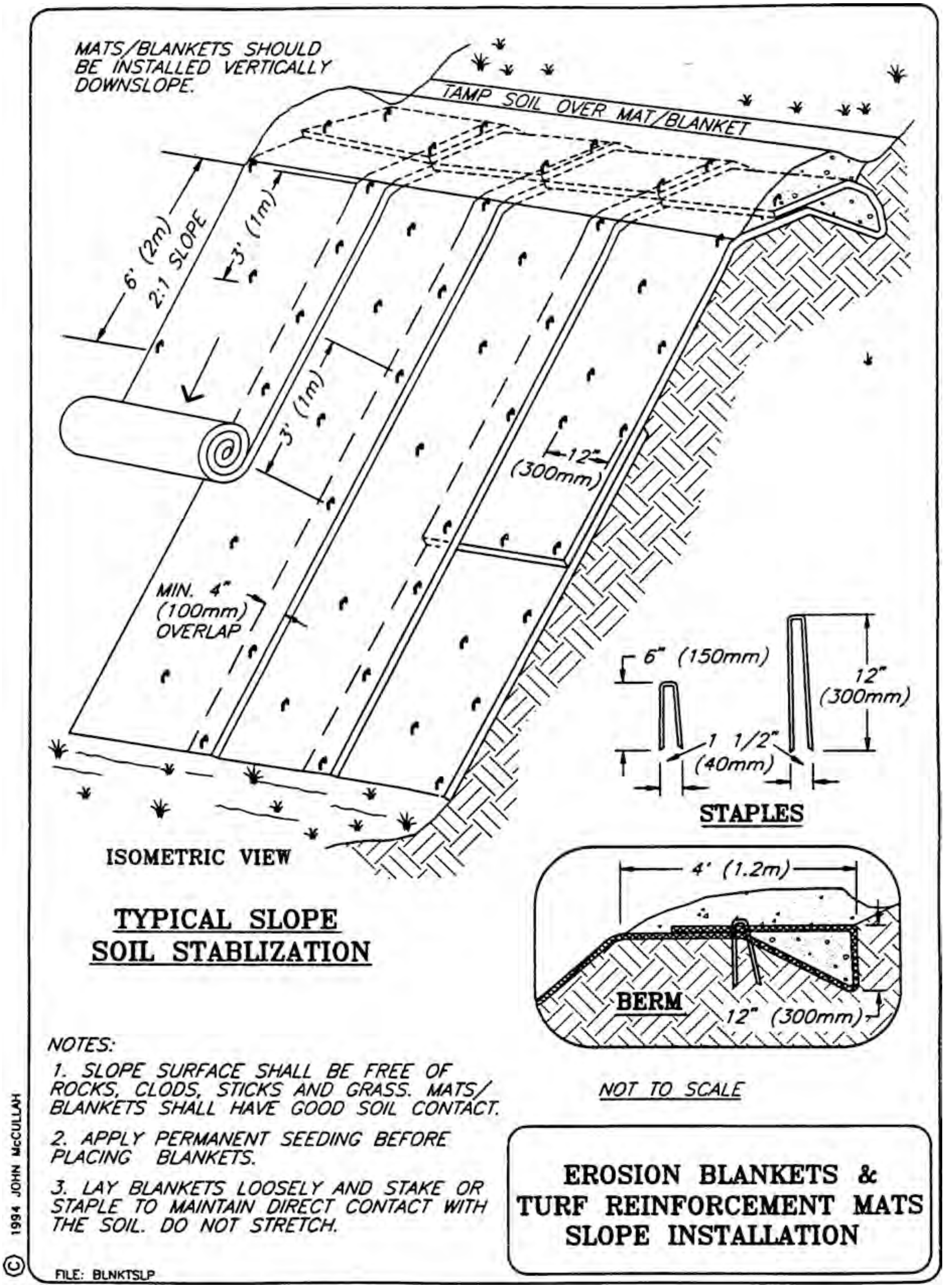


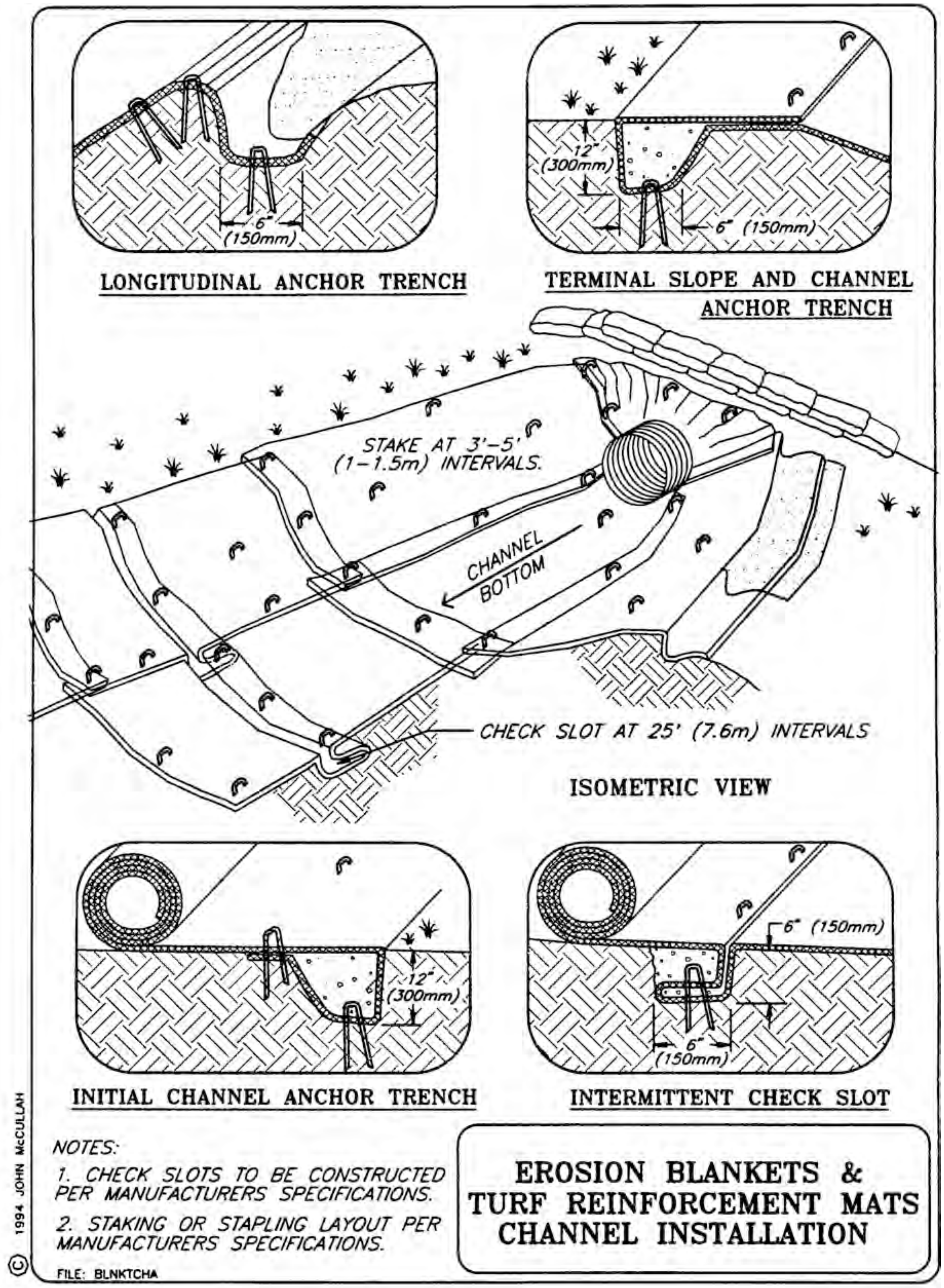
Figure 5. Installation Anchors



(Source: ABAG. 1995. Manual of Standards for Erosion & Sediment Control Measures. Oakland CA.)



Source: FishNet4C



Source: FishNet4C

BMP - COIR FABRIC/NETTING

DESCRIPTION

Coir fabric/netting is a geo-textile product made from coconut fibers loosely woven into a fabric usually packaged in roll form. This fabric can be used to provide a reduction in water velocity/erosive forces and/or habitat protection and topsoil stabilization.

APPLICATIONS

This BMP may be used in areas to provide stabilization/protection to the soil surface of steep slopes or stream banks. It can be used in combination with vegetation and/or seeding to reinforce soil in high flow/high velocity waters and on slopes as steep as 1:1. It may be used as bank stabilization before vegetation efforts have occurred. Coir fabric or netting is preferred to jute. Jute fabrics are often treated with preservatives that will discourage the growth of vegetation. Jute will also degrade much more quickly than coir.

LIMITATIONS

This BMP should *not* be used:

- ✓ In the streambed.
- ✓ When short-term biodegradability is desired.

CONSTRUCTION GUIDELINES

1) When used near watercourses or streams, coir fabrics/nettings must be used in accordance with permit requirements.
2) Fabric may be laid out horizontally or vertically on slope.
3) Stakes or staples must be used to anchor fabric to ground.
4) Lay loosely on the surface so fabric makes contact with the ground (do not stretch for extra coverage).
5) Overlap fabric edges at least 12 inches.
6) The fabric should be trenched in at least 12 inches deep at the top and bottom ends of the installation to prevent undercutting.

Source: FishNet4C

7) If used in conjunction with hand seeding or hydroseeding, place seeding first and cover with fabric.

8) Live staking may be done after the fabric is placed by piercing the fabric.

BMP MAINTENANCE

- ✓ During construction, inspect daily during the workweek.
- ✓ Schedule additional inspections during storm events.
- ✓ Make any required repairs immediately.

Source: FishNet4C

BMP - COIR LOGS AND STRAW ROLLS

DESCRIPTION

Straw rolls are manufactured from straw wrapped in netting. Coir logs are similar, but are filled with coconut fiber rather than straw. The logs are placed and staked in shallow trenches along the contour of newly constructed or disturbed slopes. They can be used to provide perimeter protection, settling, reduction in water velocity/erosive forces and habitat protection.

APPLICATIONS

The BMP may be used for temporary soil stockpile protection, drop inlet protection, temporary check dams, bank or slope stabilization, and streambank toe protection. This BMP may be used for perimeter sediment control, and is preferred over silt fencing and straw bales. It may also be used to replace missing sections of earthen berms (example: above new ditch relief culverts). Straw rolls should be manufactured of rice straw or a sterile (non-seed bearing) straw to prevent the introduction of non-native grasses. Polypropylene or coir netting is preferred over plastic netting.

LIMITATIONS

This BMP should *not* be used:

- ✓ where flow volume or water velocity inhibit its usefulness.

CONSTRUCTION GUIDELINES

1) Logs are placed in 2 to 3 inch deep trenches and staked along the contours of newly constructed or disturbed slopes.
2) Log spacing depends on soil type and slope steepness.
3) Adjacent logs shall be tightly abutted to prevent water flow and gully formation between logs.
4) Ensure that logs are in contact with the ground in the trenches to prevent water flow under logs.
5) Live staking may be used in conjunction with logs.

Source: FishNet4C

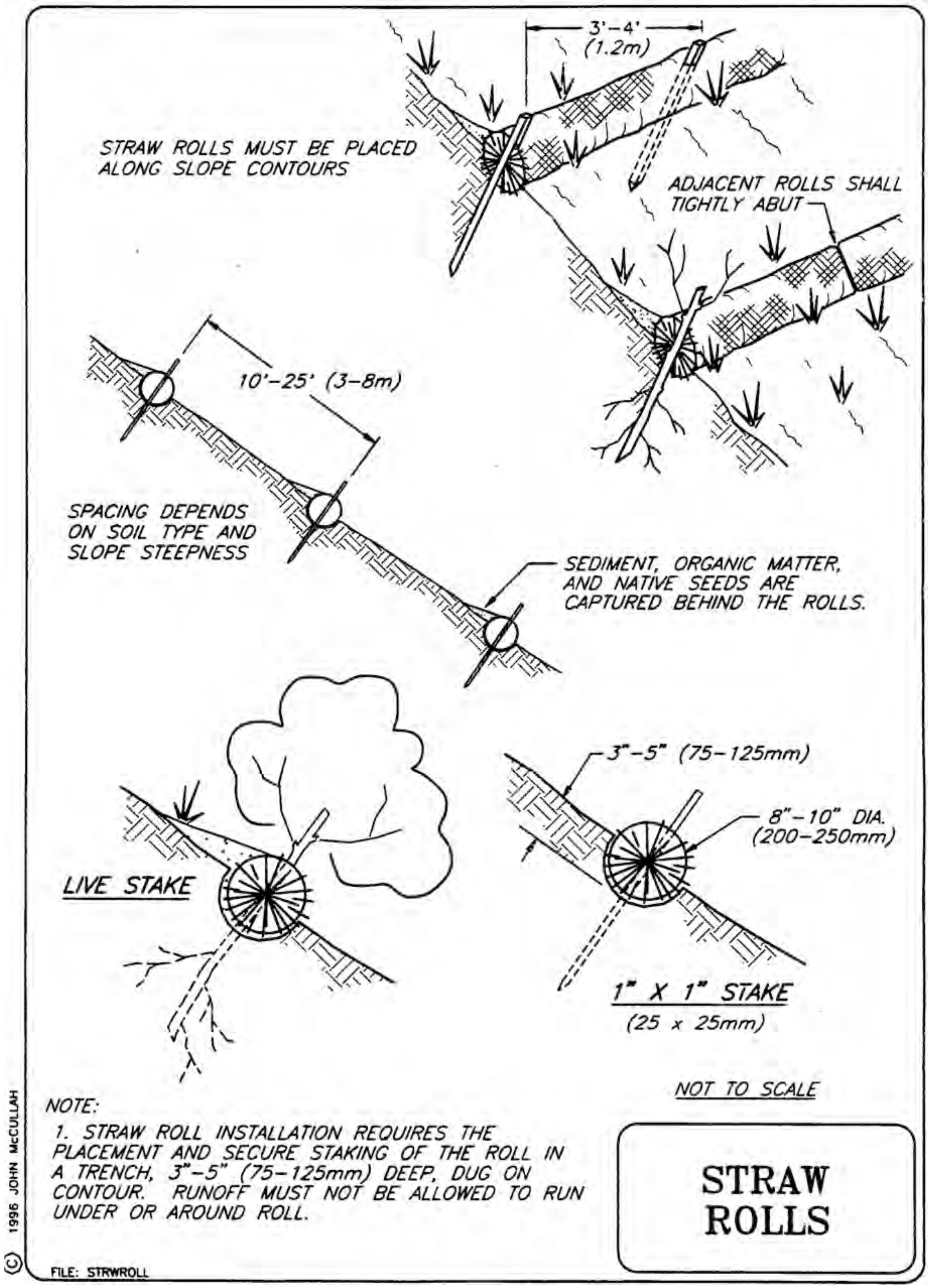
BMP MAINTENANCE

- ✓ During construction, inspect daily during the workweek.
- ✓ Schedule additional inspections during storm events.
- ✓ Make any required repairs immediately.
- ✓ For perimeter control installations (securing spoils, etc.), remove sediment deposits when they reach ½ the height of the log/roll.

BMP REMOVAL

- ✓ Remove sediment buildup in front of BMP.
- ✓ Revegetation of the site may be necessary.
- ✓ Dispose of netting properly. Straw or coir filling may be used as mulch.
- ✓ BMP removal may not be necessary.

Source: FishNet4C



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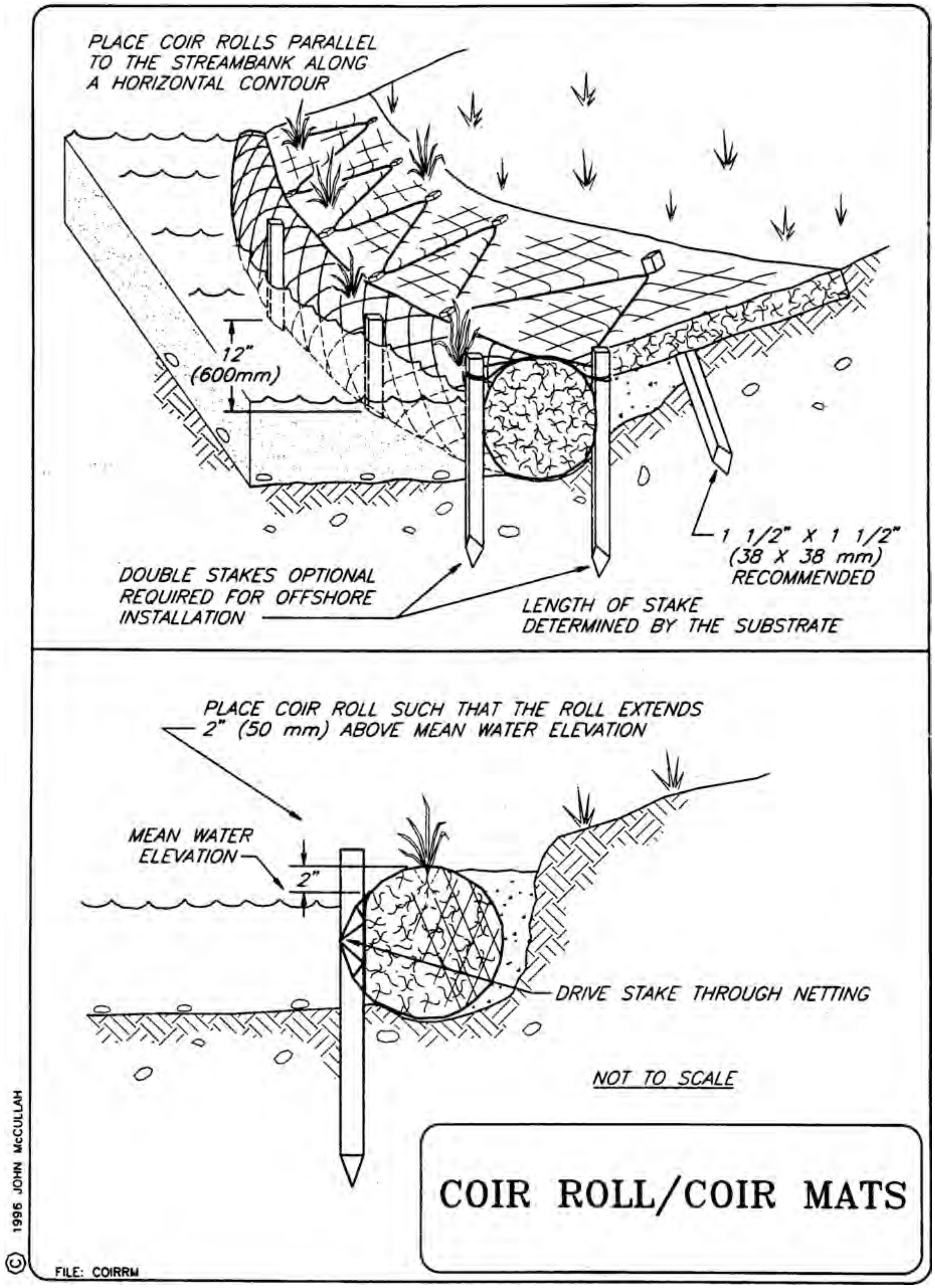


Source: FishNet4C

BMP – BROADCAST SEEDING

DESCRIPTION

Hand seeding is broadcasting grass seed on disturbed or bare soil areas by hand or a hand seeding device. This BMP reduces the potential for soil to become water or air borne, reduces erosion after vegetation establishment, provides for vegetative buffers and aids in habitat protection. Seeding with appropriate seed mixes also helps discourage colonization by non-native and invasive plant species.

APPLICATIONS

We encourage hand seeding whenever possible to aid in controlling erosion on construction sites. Seed only areas intended to be left dormant for a year or more, such as soil berms.

LIMITATIONS

- ✓ After broadcast seeding, mulch the area and/or install erosion control blankets or mats.
- ✓ Schedule seeding to fit the germination timing for the specific grasses to be used. Typically this is October and November for cool season California grasses. If seed is applied earlier, increase the seed and mulch quantities.
- ✓

CONSTRUCTION GUIDELINES

1) Select seed mixes appropriate to the season and site conditions. Permit conditions and/or sensitive locations may require special seed mixes. Avoid the use of tall growing flashy fuel types or types with known allelopathy such as annual rye grass. Consider native perennials whenever possible.

2) Grade as needed and feasible to permit the use of equipment for seedbed preparation.

3) Grade and scarify the site as needed and feasible to permit good seed to soil contact. See BMP Surface Roughening and Soil Tracking. Commercial fertilizers are seldom recommended as they can leach into the stream and the high nitrogen promotes broadleaf weed growth over native perennial growth. In areas where there is no longer topsoil, consider amending the soil with mycorrhizal inoculants and/or mature screened compost.

4) Install needed erosion control practices, such as sediment basins, diversion dikes and channels, prior to seeding. Divert concentrated flows away from seeded areas.

5) Surface roughening: If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted or hardened the soil shall be loosened with disking, raking or harrowing.

6) Spread seed uniformly and according to manufacturer's recommendations.

7) Straw mulch, erosion control blankets or mulch and tackifiers/soil binders should be applied over the seeded areas.

BMP MAINTENANCE

✓ Inspect during seed establishment period. Re-seed, due to mortality, as necessary. Areas that fail to establish cover adequate to prevent sheet and rill erosion will be reseeded as soon as such areas are identified. Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.

BMP REMOVAL

✓ BMP removal should not be necessary.

BMP – HYDROSEEDING

DESCRIPTION

Hydroseeding is broadcasting grass seed, tackifier, wood fiber mulch and water on disturbed areas using a hydroseeding machine. This BMP is used to reduce the potential for soil becoming water or air borne, to reduce erosion after vegetation is established, provide vegetative buffers and to aid in habitat protection. Seeding with appropriate seed mixes will also help discourage colonization by non-native and invasive plant species.

APPLICATIONS

Hydroseeding may be used after soil disturbance is completed at construction sites and/or on bare slopes.

LIMITATIONS

- ✓ Hydroseeding should not be used on streambanks or in areas subject to scour.
- ✓ Schedule seeding to fit the germination timing for the specific grasses to be used. Typically this is October and November for cool season California grasses. If seed is applied earlier, increase the seed and mulch quantities

CONSTRUCTION GUIDELINES

1) Select seed mixes appropriate to the season and site conditions. Permit conditions and/or sensitive locations may require special seed mixes. Avoid the use of tall growing flashy fuel types or types with known allelopathy [1]such as annual rye grass. Consider native perennials whenever possible. Commercial fertilizers are seldom recommended as they can leach into the stream and the high nitrogen promotes broadleaf weed growth over native perennial growth. In areas where there is no longer topsoil, consider amending the soil with mycorrhizal inoculants and/or mature screened compost

2) Install needed erosion control practices, such as sediment basins, diversion dikes and channels, prior to hydroseeding. Divert concentrated flows away from hydroseeded areas.

[1] If a plant type is alleleopathic, it exudes chemicals into the surrounding soil that discourage or inhibit other plant types from growing. Eucalyptus is a commonly known alleleopathic species.

3) Surface roughening: If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted or hardened the soil shall be loosened with discing, raking or harrowing.

4) Spread hydroseed mix uniformly and according to manufacturer's recommendations.

5) Cover hydroseeded areas with other methods as needed.

BMP MAINTENANCE

- ✓ Inspect during seed establishment period. Re-seed, due to mortality, as necessary. Areas that fail to establish cover adequate to prevent sheet and rill erosion will be reseeded as soon as such areas are identified. Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.

BMP REMOVAL

- ✓ BMP removal should not be necessary.

Source: FishNet4C

BMP – MULCHING

DESCRIPTION

Mulching is the application of sterile *weed-free* straw, wood fiber *(as in hydromulch),* local leaf litter, mature screened compost or other suitable materials to the soil surface. This BMP is used to reduce the potential for soil becoming water or air borne, and to encourage vegetation establishment.

Typically, apply an erosion control seed mix to scarified bare ground and cover bare areas where surface erosion and sediment delivery could occur. Rates of about 4,000 pounds/acre, or approximately 50 bales/acre of straw, meet this standard. Use mulch to cover seed to improve microclimatic conditions for germination and seedling survival. Seeding and mulching rates are highly variable, depending on the seed mix used. Consult your local extension office or seed supplier for recommended rates of application and local site conditions.

APPLICATIONS

This BMP may be used to provide protection to the soil surface and to protect newly seeded areas. This BMP may be used in combination with plantings.

LIMITATIONS

- ✓ Mulch may not adhere well to slopes steeper than 2:1.
- ✓ Mulch should not be placed in water bodies or in ditches where water flow is continuous.

CONSTRUCTION GUIDELINES

1) Mulch should be applied so that the soil is covered enough to allow seeds to protect against erosion, but still allow seeds to germinate.

2) Select the appropriate mulch for the site. Local leaf litter or on-site grass mowings may be preferred if available. Rice straw is relatively weed free in upland areas but not necessarily the best choice for wetlands. Irrigated cereal grains and sterile wheat straw may be appropriate, but residual germination may compete with target revegetation species. Wood fiber mulch provided by hydromulchers is the most sterile medium. Mature screened compost is effective both for erosion control and as a soil builder."

3) In areas subject to runoff or wind erosion, mulch shall be secured to the soil by mechanical or manual crimping, anchoring with branches, plant-derived tackifiers, or other appropriate methods.

BMP MAINTENANCE

- ✓ Conduct periodic inspections and reapply mulch where missing.

BMP REMOVAL

- ✓ BMP removal is not necessary.

BMP – PLANTING

DESCRIPTION

Planting, as outlined in this BMP, involves the establishment of native woody perennial species for the purpose of erosion control and/or habitat enhancement. See also Hand Seeding, Hydroseeding, and Mulching BMPs.

APPLICATIONS

Wherever riparian or upland woody vegetation is required and it is determined that natural recruitment will not be sufficient.

LIMITATIONS

- ✓ Sources of good quality locally native plant materials may be limited.
- ✓ An extended establishment period may require years of maintenance.
- ✓ Sources of water for irrigation may be limited.
- ✓ Permit requirements may guide design and maintenance planning.

CONSTRUCTION GUIDELINES

1) Choose the appropriate species for the site as determined by what is growing in the surrounding areas, soil type, water requirements, exposure, wildlife species requirements and permit requirements. Spacing and structure must also be considered.

2) Schedule the planting time as appropriate for the species and project maintenance capabilities. Riparian and upland species should be planted in November and December. The planting window for willow sprigs may be extended into the late summer (but <u>not</u> spring) if irrigation is provided. Emergent species may be planted after high flows if sufficient water will be available.

3) Order plant materials from a reputable native plant nursery well in advance to allow the nursery time to collect and propagate local species. Nine months to two years lead time may be required.

4) Inspect nursery-grown plant materials prior to accepting. Avoid tree species grown in one gallon flat bottom pots which promote root girdling. Revegetation plans typically specify tree size – for example:

   - <u>Tree Species:</u> Trees, with the exception of cottonwood, willows, and dogwood, shall be grown from locally collected seed. Tree species shall be grown in 14-inch deep Treepots™ for at least 9 months and shall have root systems that fill the containers but are not root bound; roots shall show active growing tips. The minimum stem caliper of the main trunk shall be 0.2 inches at 1 inch above the root crown. Tops shall be at least 6 inches tall and have healthy, live buds and/or leaves, with no broken leaders.
   - <u>Shrub and Vine Species: Shrubs and vines shall be grown from seeds or cuttings, except elderberry, which shall be grown from seed. Shrubs and **_vines_**</u> shall be grown in 10-inch deep Deepots™ or one gallon pots for at least 9 months and shall have root systems that fill the containers but are not root bound; roots shall show active growing tips. The minimum stem caliper of the main trunk of elderberries shall be 0.2 inches at 1 inch above the root crown. All other species shall either have a similar caliper or have sufficient number of stems of a sufficient size to be equivalent to a 0.2-caliper single stem. Tops shall have healthy, live buds and/or leaves.
   - Plants shall show no signs of deleterious infection from bacteria, fungus, or insects. Reject plants with open wounds or unusual swelling of stems or branches.
   - Willow sprigs shall be 0.75 inch to 1.5 inches in diameter at the base and 3 feet long. Sprigs shall be cut clean with sharp hand saws. Branches shall be pruned off with sharp shears close to the main stem but just outside the branch collar. Sprigs with swelling, scar tissue, boring insects, or disease shall be rejected. Sprigs shall be cut from live healthy materials. Donor trees or areas of trees from which sprigs are cut shall be pre-approved by the owner. No more than 50% of an existing cottonwood or willow clump shall be removed for sprigs, unless the clump is scheduled to be destroyed by grading. No sprigs shall be taken from within 20 feet of a willow or cottonwood with an active bird nest in it.

✓ Site preparation includes the removal of all vegetation in the planting area. Scalp a 3 foot by 3 foot area free of vegetation and debris down to bare mineral soil.

5) Install plants according to attached drawings. If significant rain is not forecast, water-in the plants.

6) Where deer or rabbit browse is anticipated, it may be necessary to install browse protectors. If the riparian zone has high velocity floods, wait until early spring to

install protectors. Welded wire cages around cottonwoods may be required if beavers are in the area.

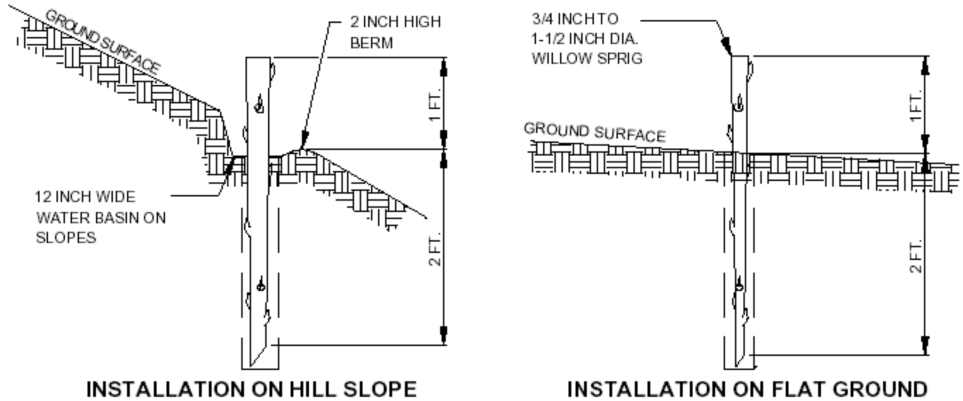
7) Schedule irrigation and maintenance requirements according to the needs of the plants and conditions. Maintenance may be required for one to three years. If watering is required, supplemental watering must begin in early spring (March) or as soon as the surface soil begins to dry.

BMP MAINTENANCE

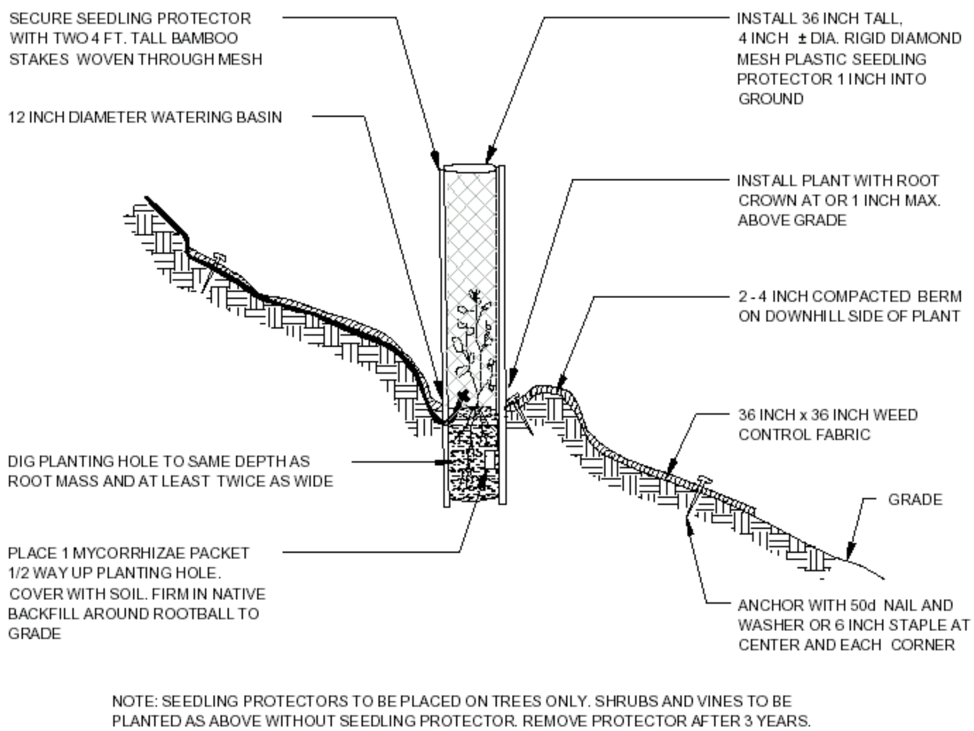
- ✓ Regular inspection of plantings should be anticipated. As often as once per week, but no less than once per month for the first year.
- ✓ Maintenance includes weeding, watering, repair to browse protectors at a minimum.
- ✓ Where irrigation is required, it is essential to begin irrigation in the spring (March or April) before the soil begins to dry. This is the time when the plant and nearby weedy species put on the most growth and have the highest water demand. Transplants are most susceptible to drought in the spring and early summer. At the same time, it is important not to waterlog native species. Allow the soil surface (top ½ inch) to dry between waterings.
- ✓ Monitor plant survival in October to anticipate plant replacement that may be required by permit.
- ✓ Trimming lower branches of willows to allow for unrestricted stream flow may be desirable.

BMP REMOVAL

- ✓ It may be necessary to remove irrigation lines, browse protectors, and other materials at the end of the establishment period.



WILLOW OR COTTONWOOD SPRIG PLANTING DETAIL



CONTAINER - GROWN PLANTS PLANTING DETAIL

Source:
©Prunuske Chatham, Inc.
Occidental, CA

PLANTING

Source: FishNet4C

BMP – SURFACE ROUGHENING and SOIL TRACKING FOR PLANTING PREPARATION

DESCRIPTION

Surface roughening is a technique for roughening a bare soil surface with furrows running across the slope, stair stepping, or tracking with construction equipment. Surface roughening is intended to aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping.

APPLICATIONS

All construction slopes require surface roughening to facilitate long-term stabilization with vegetation, particularly slopes steeper than 3:1.

LIMITATIONS

Slopes may be impossible to get machinery on due to steepness of slope or difficult access. Hand raking across the slope may be the only way to roughen the surface.

Do *not* use this BMP:

- ✓ on slopes with a rock surface.
- ✓ unless simultaneous revegetation/seeding is planned.

CONSTRUCTION GUIDELINES

Cut Slope Roughening:

1) Stair-step grade or groove the cut slopes that are steeper than 3:1.
2) Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.
3) Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
4) Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening:

1) Place fill slopes with a gradient steeper than 3:1 in lifts not to exceed 8 inches, and make sure each lift is properly compacted.

2) Ensure that the face of the slope consists of loose, uncompacted fill 4-6 inches deep.

3) Use grooving or tracking to roughen the face of the slopes, if necessary.

4) Apply seed, fertilizer and straw mulch then track or punch in the mulch with the bulldozer.

5) Do not blade or scrape the final slope face.

Roughening With Tracked Machinery:

1) Limit roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.

2) Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

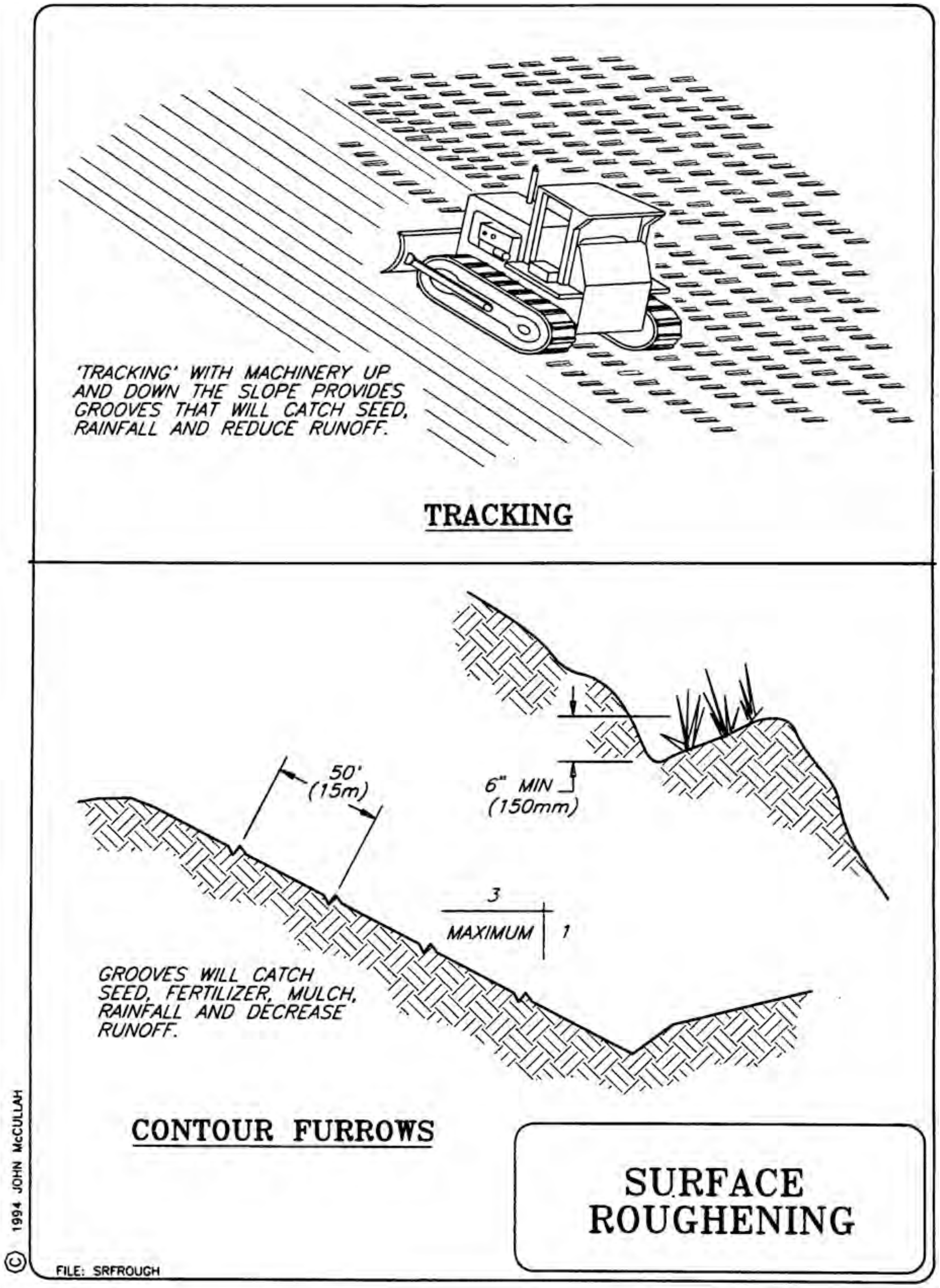
3) Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.

BMP MAINTENANCE

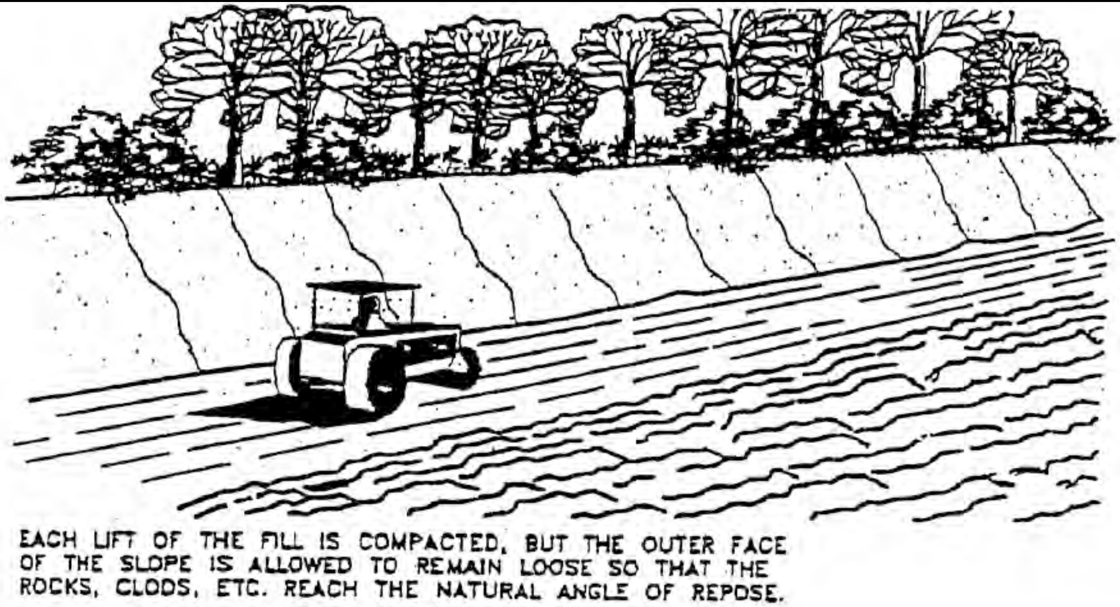
- ✓ During construction, inspect BMPs daily during the workweek.
- ✓ Schedule additional inspections during storm events. Check for erosion and sloughing, and make any required repairs.

BMP REMOVAL

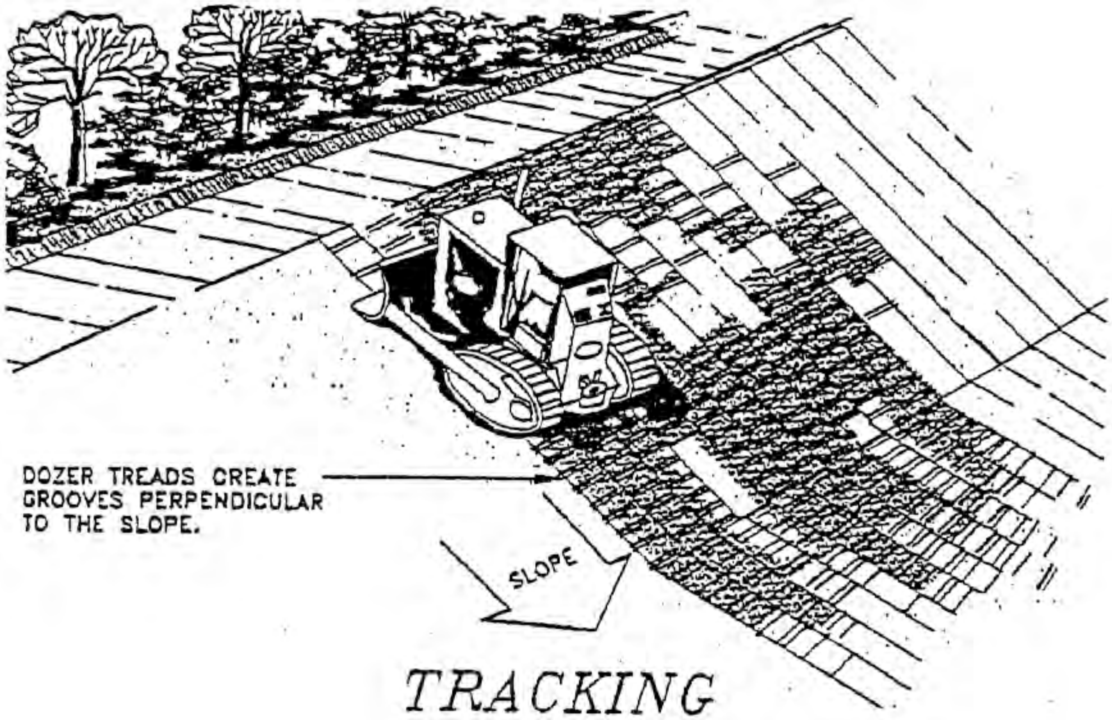
- ✓ BMP removal is not necessary.



Source: FishNet4C

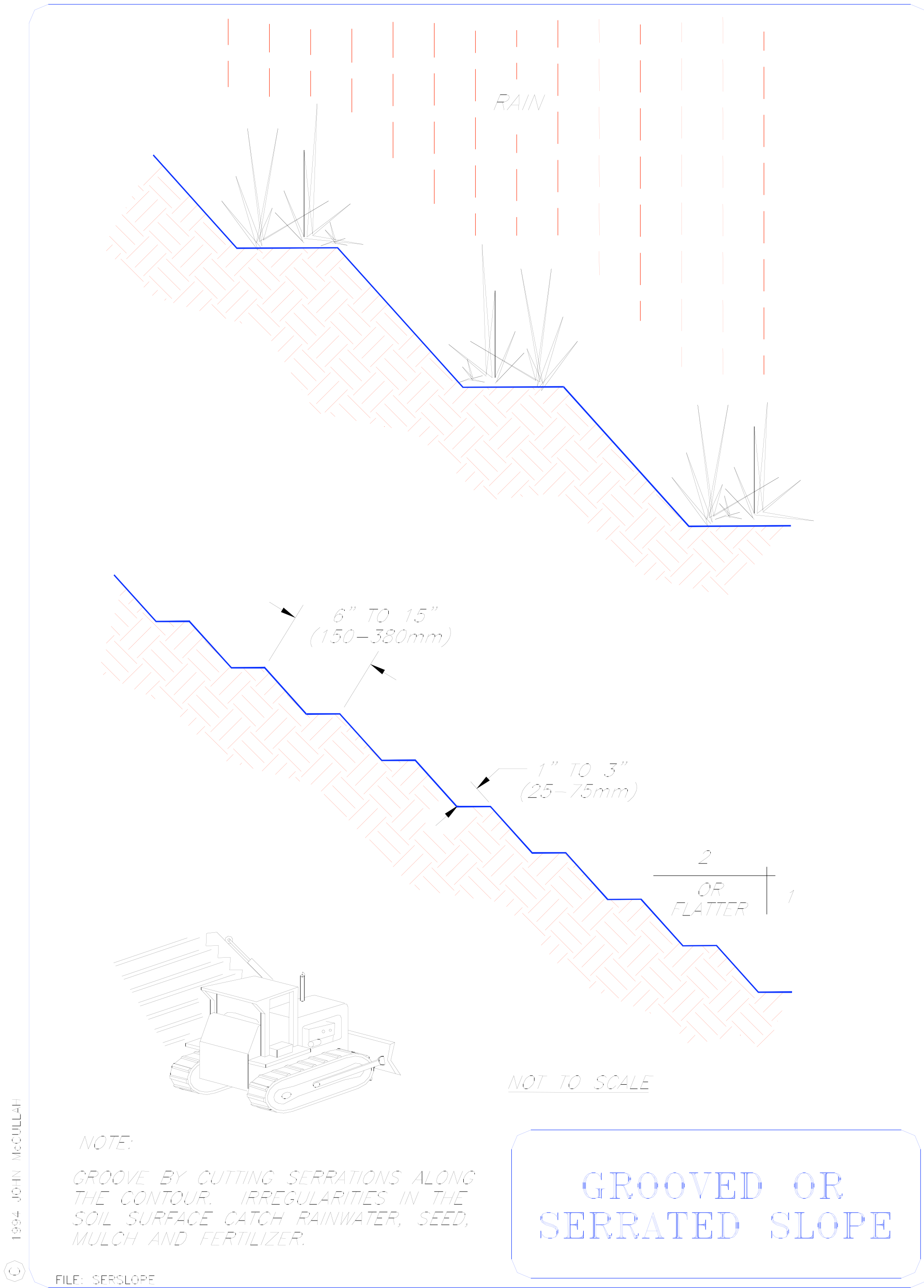


FILL SLOPE TREATMENT



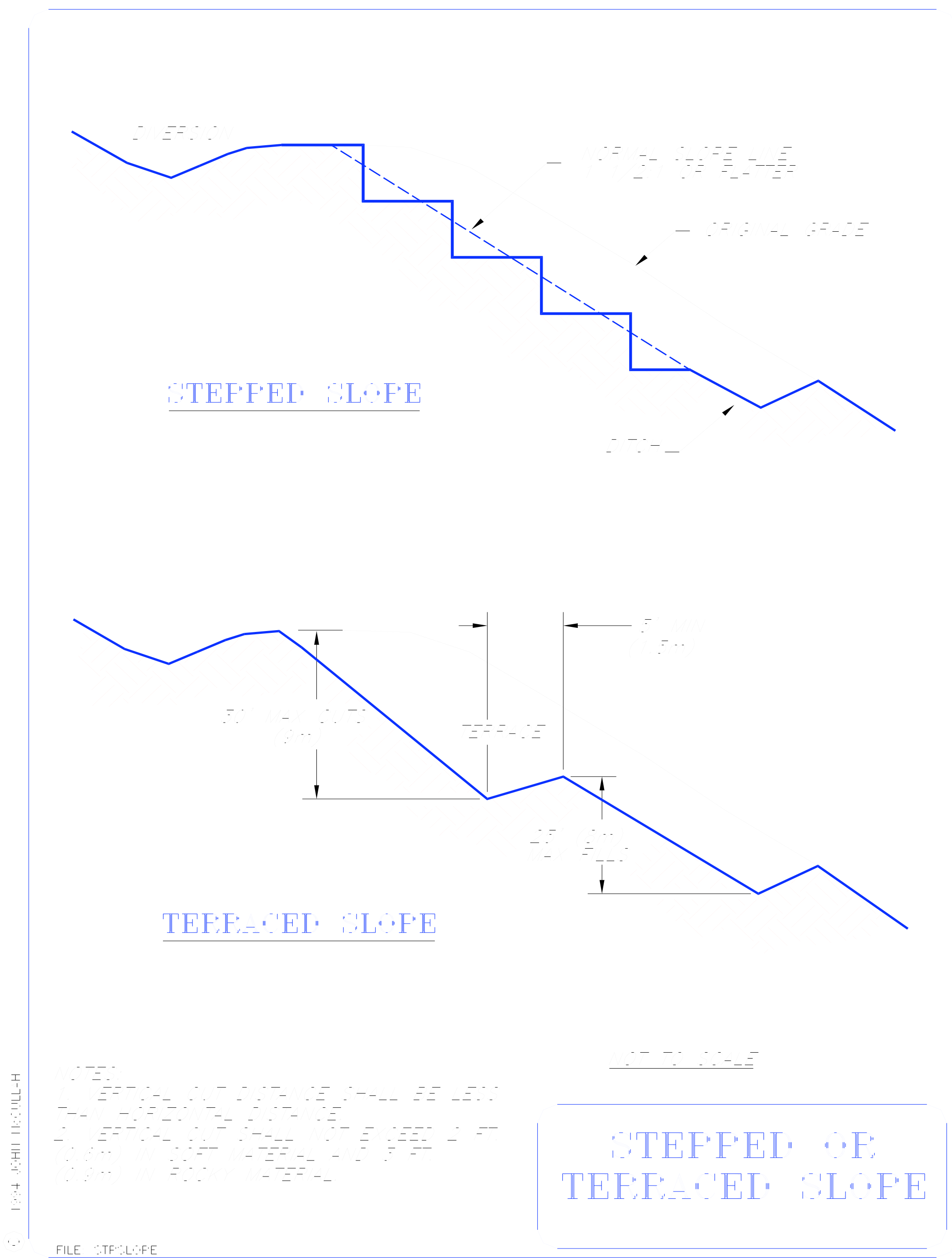
TRACKING

Source: Tri-County Regional Road Maintenance ESA Program Guidelines, Washington State, July 2000



Source: FishNet4C

BMP – STEPPED OR TERRACED SLOPE



Source: FishNet4C

BMP – PLASTIC COVERING

DESCRIPTION

Plastic covering is a temporary soil stabilization method. Material should be polyethylene sheeting at least 6 mils thick.

APPLICATIONS

Plastic covering can be used to stabilize stockpiled materials and unfinished slopes to protect from erosion caused by wind and water. Also used to cover spills during rainfall to reduce pollutant dispersion as clean-up proceeds.

LIMITATIONS

- ✓ Plastic is easily vandalized, torn, and photodegradable and must be disposed of in a landfill.
- ✓ Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.

CONSTRUCTION GUIDELINES

1) Plastic covering should be anchored by sandbags placed no more than 10 feet apart and by keying into the tops of slopes to prevent infiltration of surface waters under the plastic. On steep slopes, attach rope between bags to keep them from sliding.

2) Seams should be taped or weighted down along their entire length and there should be at least a 12 to 24-inch overlap of all seams.

3) Stockpiles should be located a minimum of 50 feet away from concentrated flows of stormwater, drainage courses, and inlets.

4) Perimeter sediment barriers such as silt fences, berms, or straw wattles may be required.

BMP MAINTENANCE

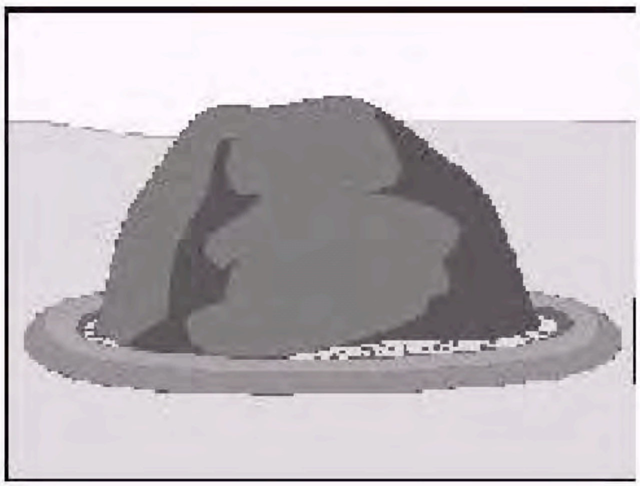
- ✓ Plastic covering should be checked regularly during construction.
- ✓ Installation should be checked during and after any significant storms to check for erosion and undermining.

Source: FishNet4C

- ✓ Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.

BMP REMOVAL

- ✓ Plastic covering and related materials may be reused if in good condition, otherwise materials should be removed from the site and disposed of properly.



- Plastic sheeting shall be polyethylene and have a minimum thickness of 6 mil.
- No runoff shall be allowed to run under the plastic covering.
- Covering shall be installed and maintained tightly in place by using sandbags on ropes with a maximum 10 foot grid spacing in all directions. All seams shall be taped or weighted down full length and there shall be at least a 12-inch overlap of all seams. For seams parallel to the slope contour, the uphill sheet shall overlap the downhill sheet.
- Drainage from areas covered by plastic sheeting shall be controlled such that no discharge occurs directly onto uncontrolled, disturbed areas of the site.

Source:
CASQA California Stormwater Quality Association. California Stormwater BMP Handbook for Construction www.cabmphandbooks.com and Cowlitz County, WA www.co.cowlitz.wa.us

PLASTIC COVERING: TEMPORARY

BMP – ROCK BREAST WALL

DESCRIPTION

A low retaining wall (usually 10 feet or less in height) constructed against the base of a slope. The wall is usually built by stacking rocks atop one another in a single, one-rock width course. Synonyms include gravity wall, loose rock retaining wall, rock armoring.

APPLICATIONS

Constructed to protect the toe of the slope and to prevent slope damage by erosion, especially piping and spring seepage from the face of the slope.

LIMITATIONS

- ✓ Careful rock placement is required to prevent injuries to construction workers and others.
- ✓ Existing slope must be geologically stable.

CONSTRUCTION GUIDELINES

1) Toe or footing trench into native material is required as shown.
2) Method of placement must meet Caltrans Method A standards for ½ ton class rock: “Larger rocks shall be placed in the footing trench. Rocks shall be placed with their longitudinal axis normal to the embankment face and arranged so that each rock above the foundation course has a 3-point bearing on the underlying rocks. Foundation course is the course place on the slope in contact with the ground surface. Bearing on smaller rocks which may be used for chinking voids will not be acceptable. Placing of rocks by dumping will not be permitted. Local surface irregularities of the slope protection shall not vary from the planned slope by more than 0.3-m measured at right angles to the slope.”
3) Slope face of wall shall not be steeper than 0.5 horizontal to 1 vertical.
16) Walls need to be engineered. Rock size, rock thickness, and toe width will vary.

BMP MAINTENANCE

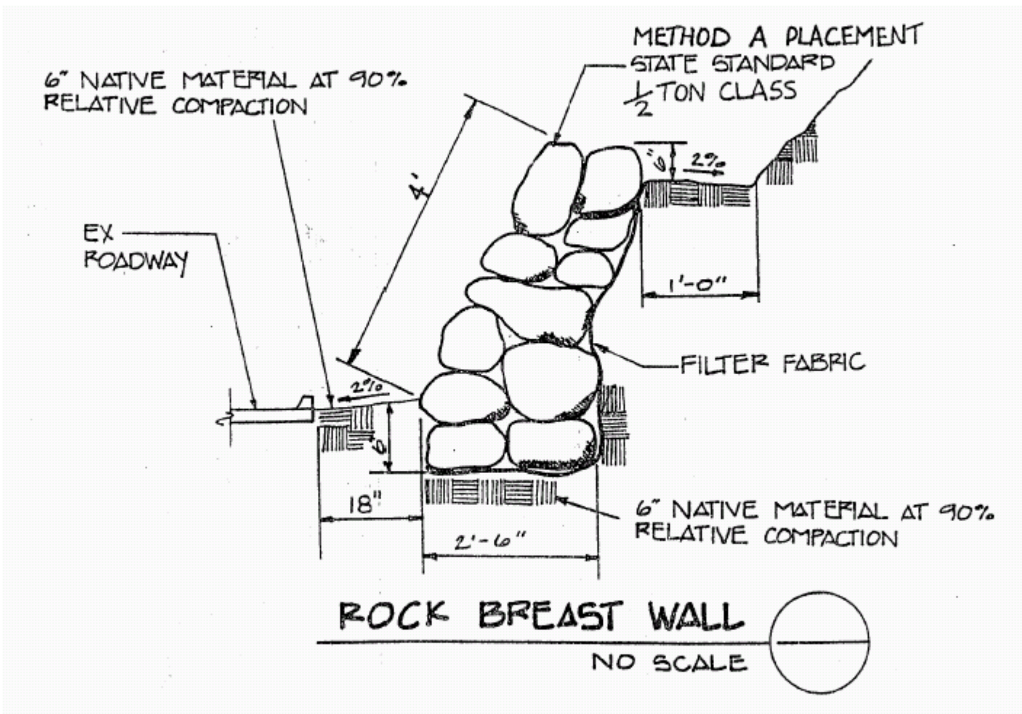
- ✓ Inspect wall for movement and settling. Repair as needed.

Source: FishNet4C

ROCK BREAST WALL

Description: A rock breast wall is a low retaining wall (usually 10 feet or less in height) constructed against the base of a slope. The wall is usually built by stacking rocks atop one another in a single, one-rock width course.

Purpose: To defend the toe of the slope and to prevent slope damage by erosion, especially piping and spring sapping as a result of seepage exiting from the face of the slope.



Source: Caltrans – Lake Tahoe district office (1994).

BMP – VEGETATED GEOBERM TOE WALL

DESCRIPTION

A vegetated geoberm toe wall consist of continuous berms that are filled with gravel, sand or soil and then constructed with brush layering techniques. The continuous berms are geotextile tubes filled with soil. They can be used to stabilize and reinforce the toe of the eroding streambanks or the raveling toe of slides and road cuts.

APPLICATIONS

Continuous Berm toe walls can be constructed on over-steepened road cuts and at the toe of shallow landslides on sandy and glacial till material. May be constructed in place of retaining walls, rock toe walls, or slope toe protection measures.

LIMITATIONS

- ✓ Currently, only a Continuous Berm Machine (CBM) can make the berms. A "spreader bar" is necessary to lift the individual berms into place.
- ✓

CONSTRUCTION GUIDELINES

1) Geoberm Toe Walls are easy to construct. They are very conducive to brush layering techniques. Branch cuttings, live stakes and pole planting techniques are incorporated into the design and construction. The berms can be made from woven or non-woven geotextile fabric. However 6-10 oz non-woven fabric has worked well in the past.

2) For toe walls, construct the first course of berms on a stable base approximately 3 m (10 feet) wide, which is dipping into the slope at an angle. Use MBW Inc.'s CBM or wrap soil lifts with geotextile material to construct the geo revetments. Use Brush Layering techniques between each lift 0.2-0.5 m (8-18 inches) high. Each lift should be moderately compacted with the surface dipping into the slope.

3) Place cuttings with butt ends dipping down and into the bank and backfill with gravel and soil if possible. Geo grids can be used in the lifts to further reinforce the slopes.

4) Place next berm or soil lift sloped back to the desired angle. Live stakes, driven through the fabric at angles (toe nailed) and pole cuttings may be used to secure

the continuous berms and soil wraps. Install some live stakes and poles deeply to reach moisture and to secure the structure.

BMP MAINTENANCE

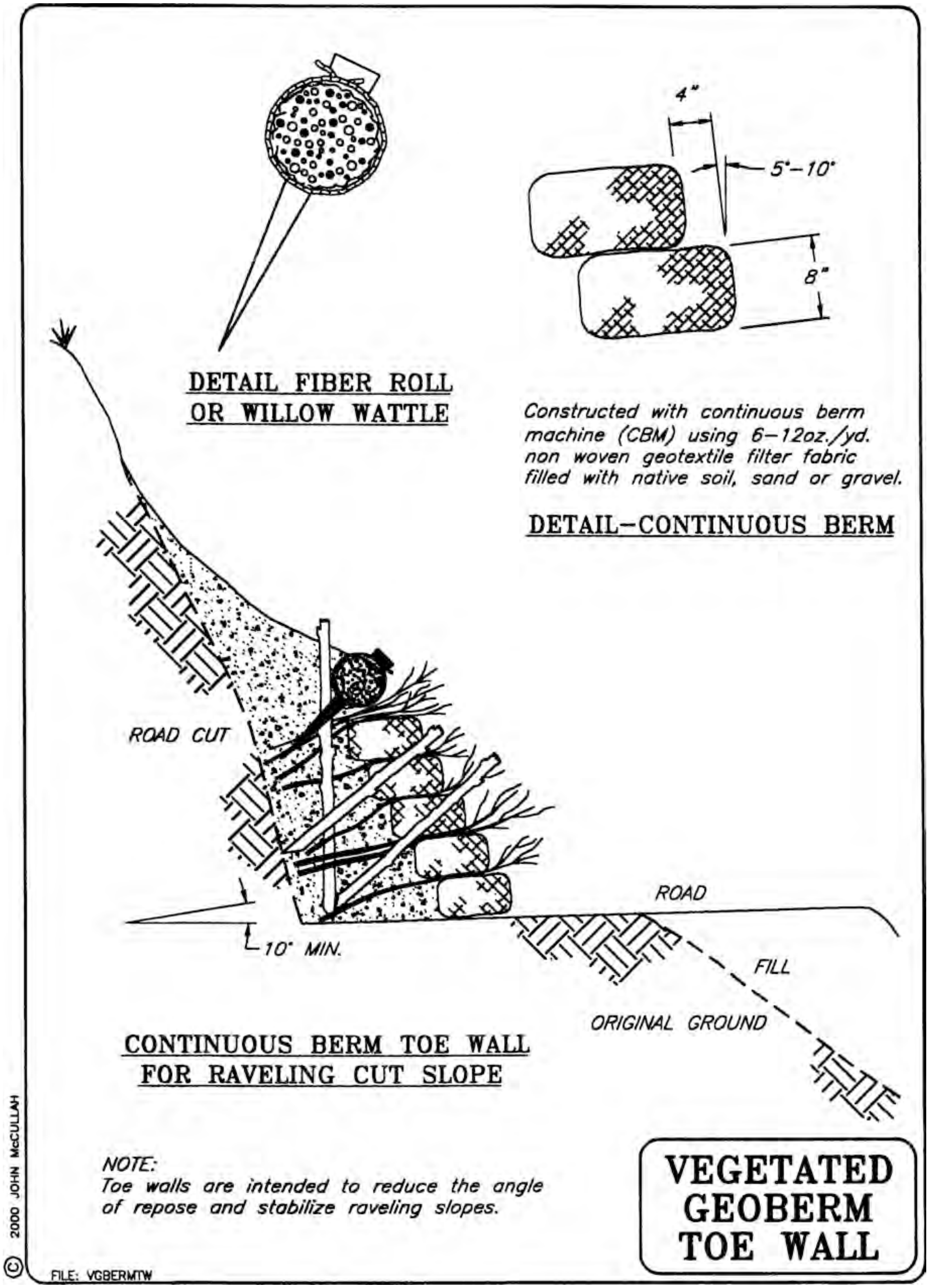
- ✓ Conduct periodic inspections and repair berms as necessary.
- ✓

BMP REMOVAL

- ✓ Removal should not be necessary.
- ✓

ADDITIONAL RESOURCES

MBW, Inc. (Continuous Berm Machine), PO BOX 378, 250 Hartford Rd. Slinger, WI 53086-0378, (414) 644-5234, www.mbw.com



Source: FishNet4C

SEDIMENT MANAGEMENT BMPS

Source: FishNet4C

BMP - BRUSH PACKING

DESCRIPTION

Brush packing is a biotechnical gully and slump repair technique. Brush packing utilizes alternating layers of live branch cuttings (from rootable plant species) and soil to repair large rills, gullies, and slumps. The brush packing technique is more appropriate for the repair of gullies on slopes, and it can be implemented with hand labor.

Brush mattresses employ the same principles and are typically used on road slipouts and bioengineered streambank stabilization projects. (See BMP-Brush Mattress, Streambank Protection-Biotechnical BMPs.)

APPLICATIONS

Since brush packing involves refilling the gully with soil between successive layers of branches, this practice is not recommended for gully repair in drainages or ephemeral stream channels. The slope and gully must have soil material available with which to fill the slumps and gullies. Brush packing should be used in conjunction with slope scaling or slope grading activities where rills, gullies, and other channels are removed by re-grading.

LIMITATIONS

- ✓ Not suitable for the stabilization of deep, organic topsoil layers.
- ✓ Live materials should be harvested and constructed during the dormancy stage of plant growth.
- ✓ Permits may be required for installation along stream banks.
- ✓ Usually requires manual labor to fill and re-grade slope.

CONSTRUCTION GUIDELINES

1) It is imperative to treat any source of concentrated flows or other causes of gullying, before performing brush-packing treatments. Cut branches to a length which corresponds to the depth of the gully. Branches should extend the entire depth of the rill or gully, with tips protruding from the slope face when grading is complete. Branch cuttings shall be a mixture of younger wood and older wood, from 6-50 mm (¼-2 inches) diameter.

Source: FishNet4C

2) Fill the bottom of the rill, gully, or slump with soil, approximately 12 inches, and shape and compact the soil terrace such that it dips into the slope. Place branch cuttings, 3-8 inches thick, in a crisscross or overlapping configuration. The growing tips shall protrude 6-12 inches from the slope face, with the basal ends dipping back into the slope. It is important that the basal ends of the branches are lower than the branch tips. Live stakes may be driven through the soil-branch layers for extra stabilization.

3) Continue re-grading the slope and cover the brush layer with a 150-300 mm (6-12 inch) layer of soil. Compact to ensure good soil contact with the branch cuttings. Then, continue brush packing and soil layering until the gully is filled and the slope is re-graded. The final installation should match the existing slope with the in-field section slightly higher to ensure that runoff collection and channelization does not occur.

4) Seed and mulch the slope. Shallow slopes, generally 3:1 or flatter, may be seeded and mulched by hand. Steeper slopes should have seed applied hydraulically and the mulch shall be anchored with tackifier or other approved methods.

BMP MAINTENANCE

- ✓ Conduct regular inspections and maintenance, particularly during the first year.
- ✓ Immediately correct and repair failures of fill or drainage structures.

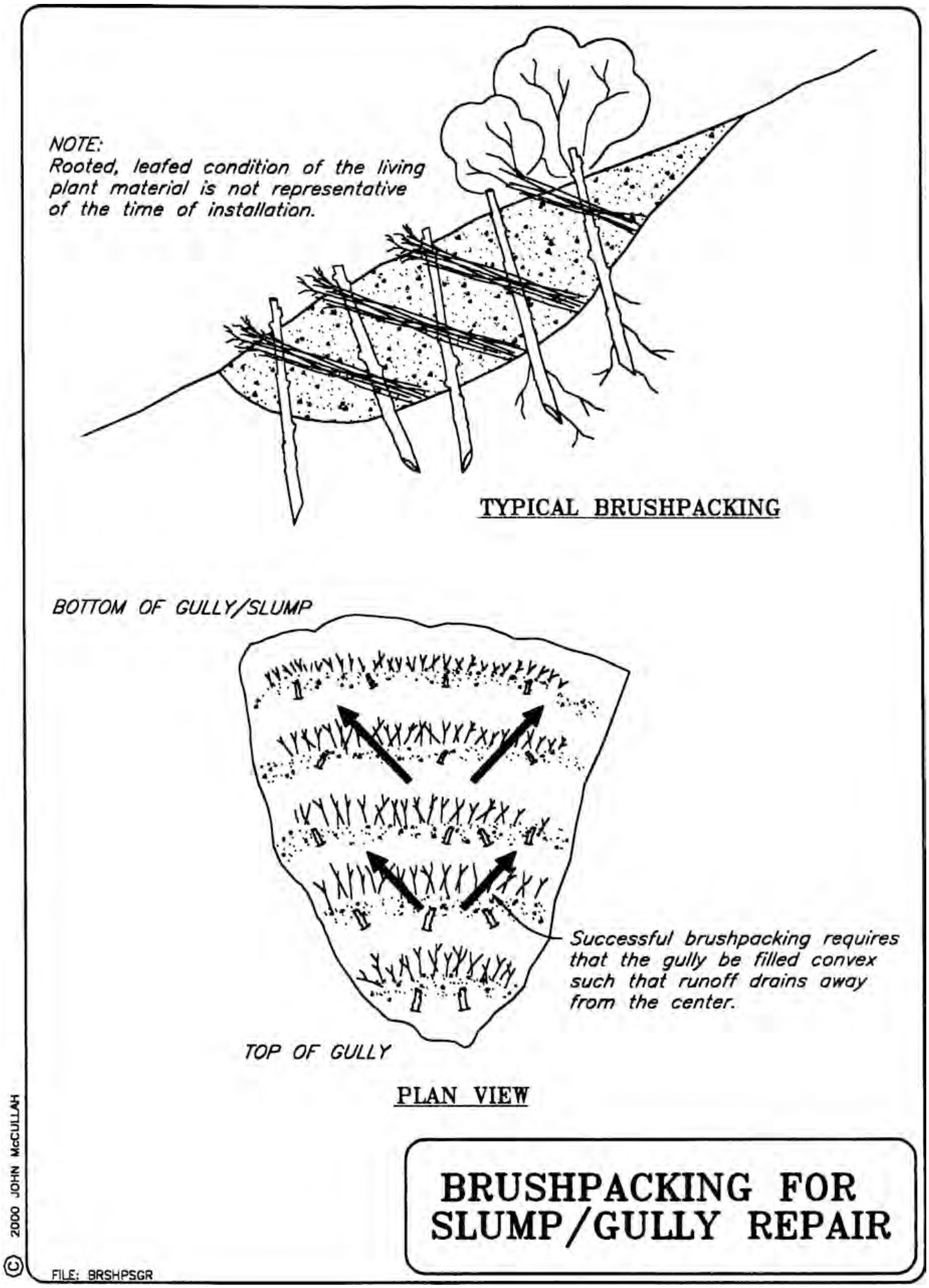
MATERIALS

- ✓ Live materials needed include branches and cuttings of deciduous woody plants capable of producing adventitious roots, most appropriately willow. Straw or other mulch can be mixed with soil to help fill in the gully.
- ✓ Coir netting or erosion control blanket material can be wrapped around the soil layers to protect the slope face (see Reinforced Earthfill with Brush Layering).
- ✓ Polypropylene geogrids can be incorporated into the soil layers if additional strength and durability are desired.

BMP REMOVAL

- ✓ Not required.

Source: FishNet4C



Source: FishNet4C

BMP – CHECK DAM: ROCK

DESCRIPTION

A semi-porous rock grade control structure.

APPLICATIONS

Use only in small upland drainages and gullies. Used to provide channel grade stability. May be designed to trap sediment for removal. See BMP Sediment Sump - Trap.

LIMITATIONS

- ✓ Maximum weir height is 5 feet.
- ✓ Check dams tend to flatten the channel grade and can cause upstream meandering which may erode stream banks and cut around the structure.
- ✓ An adequate cutoff trench into competent native ground is essential.
- ✓ The rock on the weir must be correctly placed and sized or the structure will fail.
- ✓ Cannot be used in fish bearing streams.

CONSTRUCTION GUIDELINES

1) Weir opening must be large enough for the design flow (25 year or greater) plus one foot of freeboard.

2) Center cutoff trench must be keyed into native ground to a depth of 2 feet both underneath and on the sides of the structure.

3) Toe trench at downstream end is critical to prevent undercutting. See drawing.

4) Rock is placed in an interlocking matrix with each rock supported at a minimum of three points. Fill voids between large rocks with small rock. Typically rock shall have a minimum specific gravity of 2.7 and a minimum diameter of 18 inches (rock size and density may be specified by project engineer). Use smaller rocks to chink into voids.

5) Coir mat, filter fabric, or a gravel blanket is used as shown to prevent fines from moving through rock voids.

6) Rock check dams may be constructed in a series with the toe of the upstream dam approximately level with the weir opening of the downstream dam.

Source: FishNet4C

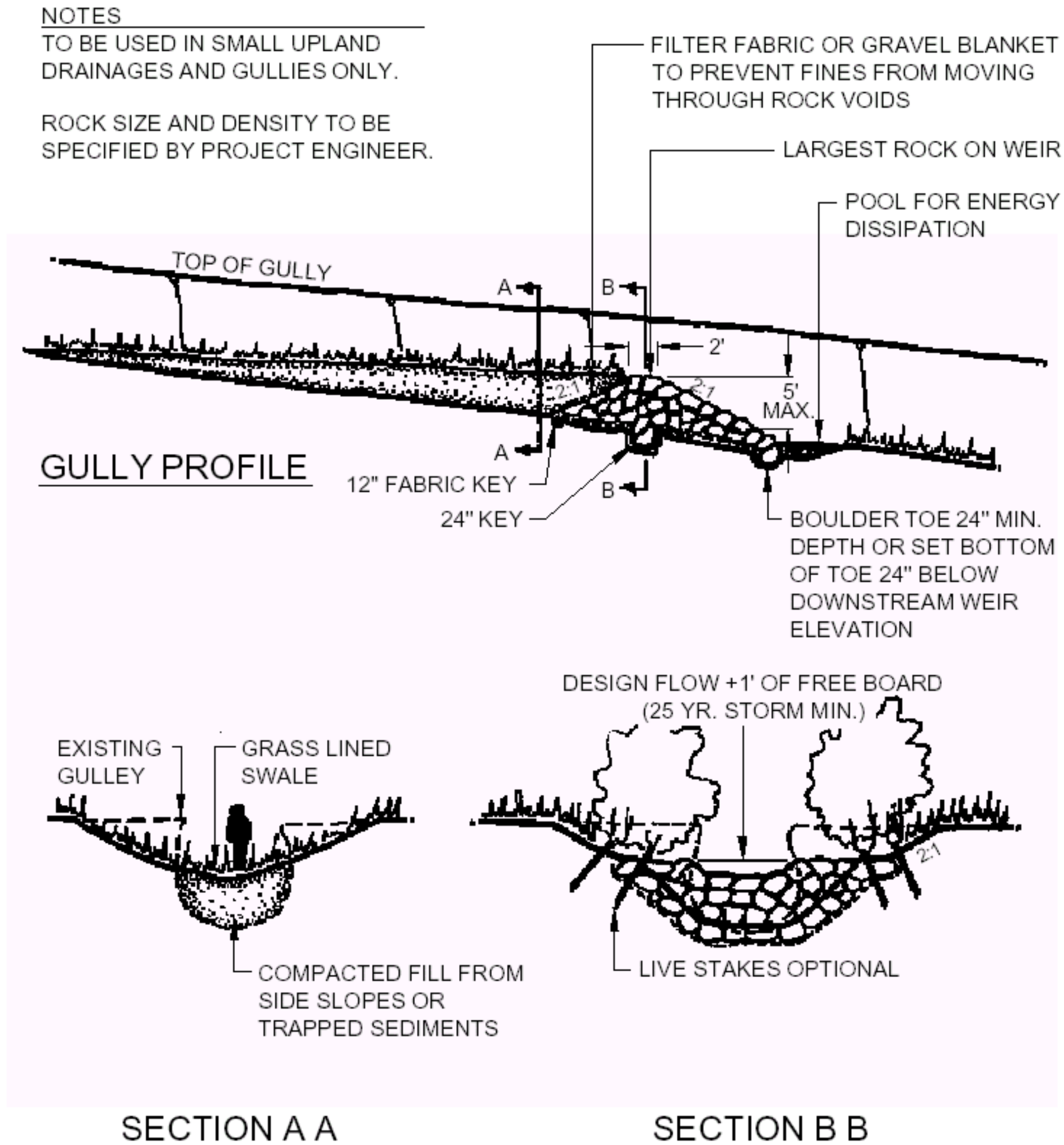
7) Engineered fill placed to a designed gradient upstream of the check dam is preferable to random sediment accumulation.

BMP MAINTENANCE

- ✓ Adjust rock if displaced.
- ✓ If upstream channel begins to cut around structure, remove rock in middle of weir to widen and lower opening.

BMP REMOVAL

- ✓ N/A



Source:
©Prunuske Chatham, Inc.
Occidental, CA

CHECK DAM: ROCK

BMP – CHECK DAM: STRAW BALE

DESCRIPTION

Temporary sediment catchments constructed of straw bales. Also used as grade control structures to facilitate vegetation establishment.

APPLICATIONS

Use in small upland drainages and gullies only. Used to trap sediment from dewatering operations. (See BMP: Dewatering – Pumping or Draining). May also be used to allow for revegetation in eroded swales.

LIMITATIONS

- ✓ When used as sediment catchments, must be inspected and cleaned out regularly.
- ✓ Temporary structures. Rely on vegetation to stabilize over the long run.
- ✓ Check dams tend to flatten channel grade causing upstream bank-full meandering which may erode stream banks.
- ✓ Adequate cutoff trench into competent native ground is essential. Incorrect installation may cause increased erosion.

CONSTRUCTION GUIDELINES

7) Never use metal stakes or rebar to anchor bales unless a provision is included to remove these materials. Metal stakes pose a serious safety hazard.
8) Key bales 4 inches into the ground and side banks. Compact moist soil around side banks.
9) Center must be lower than sides to act as a spillway. Add rock downstream of center weir bale.
10) Secure with a minimum of two wooden stakes per bale.

BMP MAINTENANCE

- ✓ When used as sediment catchments, must be inspected and cleaned out when basin is 60% full.
- ✓ Inspect sediment catchments after each significant storm (1 inch in 24 hours).

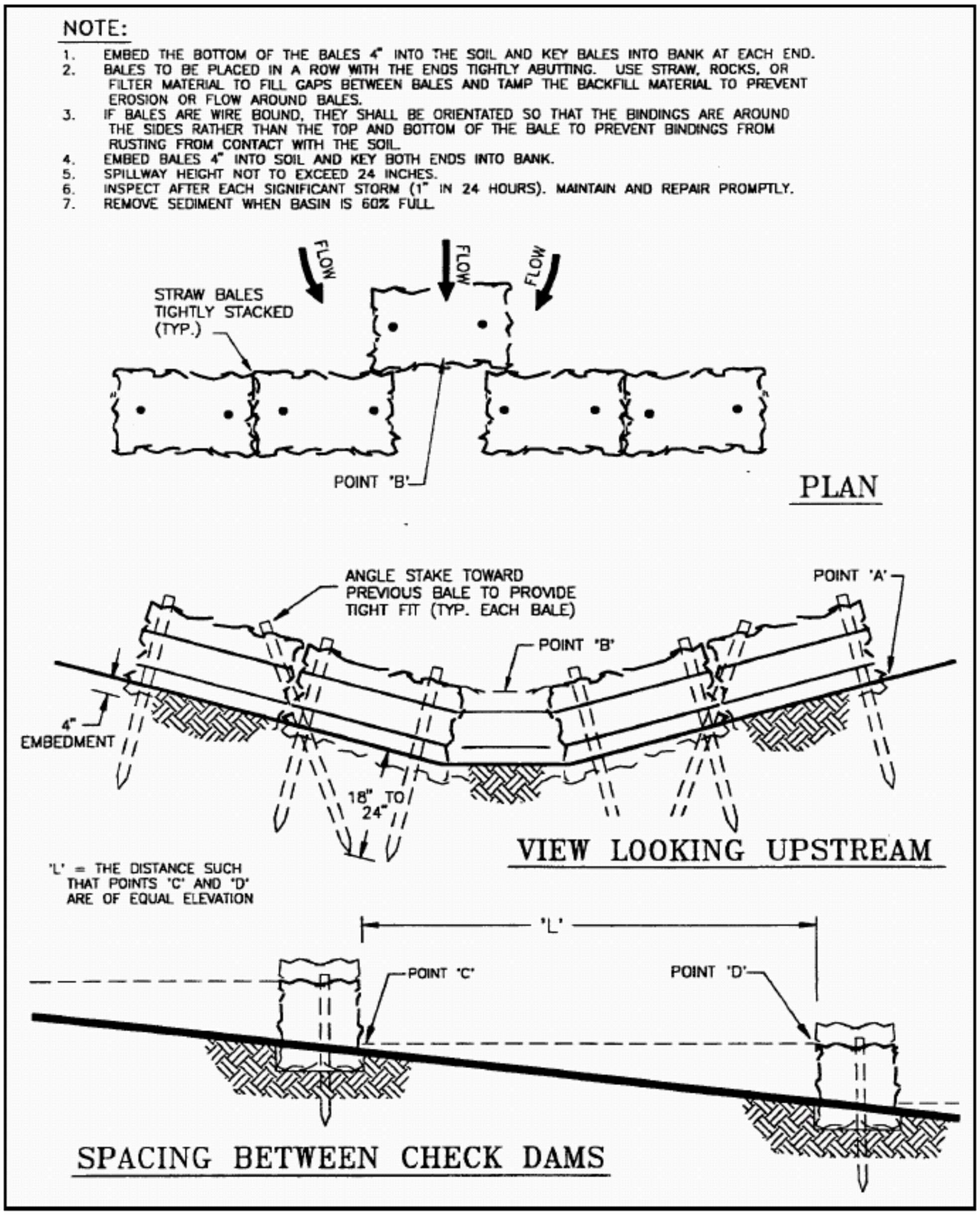
BMP REMOVAL

- ✓ Straw bales and stakes used as a catchment basin are removed after the project has stabilized. The area is then smoothed, reseeded and mulched (see Seeding BMP and Mulching BMP).

Source: FishNet4C

✓ When used as grade control to facilitate vegetation establishment, removal is not required.

CHECK DAM – STRAW BALE



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

BMP - CONCRETE WASHOUT

DESCRIPTION

Concrete washout areas prevent concrete waste discharges to waterways and storm drains. Concrete and cement-related mortars are toxic to fish and the aquatic environment.

APPLICATIONS

Concrete washouts are applicable for projects that require;

- on-site preparation and use of Portland cement concrete, asphalt concrete, or cement mortar
- equipment washouts

LIMITATIONS

4) An appropriate area for the washout must be identified at least 50 feet away from watercourses and storm drains in case of accidental breaching.
5) The storage capacity of the basin must be sized correctly for the job.

CONSTRUCTION GUIDELINES

1) The location of the concrete washout should be clearly labeled and all employees should be educated about proper concrete disposal.
2) Avoid mixing excess amounts of fresh concrete or cement mortar on-site.
3) Wash out concrete mixers only in designated washout areas where the water will flow into temporary sealed basins or onto stockpiles of aggregate base or sand. Use as little water as possible to reduce hardening and evaporation time of waste products.
4) Construct a basin large enough to contain all liquid and waste concrete materials generated during washout procedures. A minimum basin size is 9 feet x 9 feet and 2 feet deep. Plastic liner materials shall be a minimum of 60-mil polyethylene sheeting free of holes and defects.
5) Recycle washout by pumping back into mixers for reuse when possible.

BMP MAINTENANCE

✓ The concrete washout should be checked frequently to ensure proper use and effectiveness.
✓ At 75% capacity, the washout must be cleaned or new facilities must be constructed and ready for use.

Source: FishNet4C

BMP REMOVAL

- ✓ The hardened concrete and materials related to the washout must be broken up, removed, and disposed of in accordance to local regulations.
- ✓ Area disturbed by the concrete washout must be repaired.

REFERENCES AND ADDITIONAL INFORMATION

California Regional Water Quality Control Board. *Erosion and Sediment Control Field Manual*, page 108, Third Edition, July 1999.

Caltrans. *Storm Water Quality Handbooks: Construction Site Best Management Practices Manual*, November 2000.

Source: FishNet4C

Source:
California Regional Water Quality Control Board. Erosion and Sediment Control Field Manual, Third Edition, July 1999.

CONCRETE WASHOUT

Source: FishNet4C

BMP- CONTAINMENT OF CONCRETE POURS

DESCRIPTION

Proper management and techniques of pavement construction materials will greatly reduce or eliminate discharge into waterways resulting from paving, surfacing and the materials related to the removal of paving waste. Concrete and cement-related materials are toxic to fish and the aquatic environment.

APPLICATIONS

Containment of concrete will be necessary when forming, cutting, surfacing, paving, cleaning, or removal activities occur.

LIMITATIONS

6) Fine particulate matter may not be removed by the filtering methods.
7) Some containment controls become ineffective during wet weather.

CONSTRUCTION GUIDELINES

1) Apply concrete in dry weather to prevent runoff.
2) Drip pans or absorbent materials should be placed under paving machines when parked or stored on site.
3) Straw bales, sand bags, silt mats, or other controls should be used in drainage areas to filter runoff.
4) Use as little water as possible to reduce runoff.
5) Sweepings should be returned to the stockpile or disposed of in the trash, not washed into the street or a waterway.
6) Recycle broken concrete and asphalt.

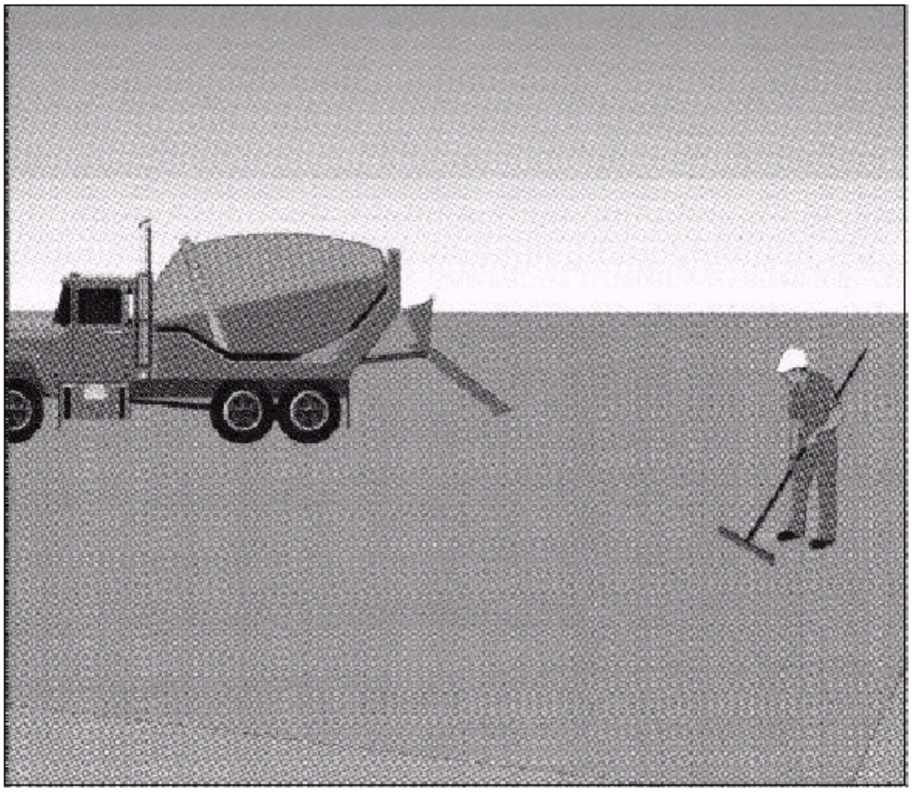
BMP MAINTENANCE

- ✓ Check filter areas to ensure effective control of concrete waste. Remove waste build-up before filters are filled to capacity.
- ✓ Inspect and maintain machinery to minimize leaks and drips.
- ✓ Check with employees and subcontractors to ensure that measures are being followed.

BMP REMOVAL

- ✓ Drip pans, absorbent materials, wash water, and solids must be disposed of at approved facilities.

Source: FishNet4C



Source:
California Regional Water Quality Control Board. Erosion and Sediment Control Field Manual, Third Edition, July 1999.

CONTAINMENT, CONCRETE POUR

BMP – SILT MAT INLET

DESCRIPTION

A silt mat inlet protector is a filter fabric with an erosion control blanket and riser placed over a storm drain drop inlet to help reduce the introduction of sediment into the watercourse during construction.

APPLICATIONS

During construction, silt mats are the last line of defense to trap sediment before runoff enters the storm drain.

LIMITATIONS

- ✓ The silt mat inlet protection is only effective at low flows.
- ✓ Only effective for drop inlets which have been designed in a concave area – not for use on street side curb gutters.
- ✓ Inlet filters may cause stormwater to by-pass the inlet only to re-enter the watercourse at an unprotected location.
- ✓ Silt mat inlet protection must be monitored and maintained frequently.

CONSTRUCTION GUIDELINES

1) All upstream erosion control measures must be in place prior to installation of silt mat.

2) Clear and smooth the area to be covered by the erosion control blanket.

3) Roll out the blanket over the cleared area. Secure the edges of the blanket with staples or washed angular gravel.

4) Install the inlet protection device to the blanket as shown in the attached manufacturer's details.

BMP MAINTENANCE

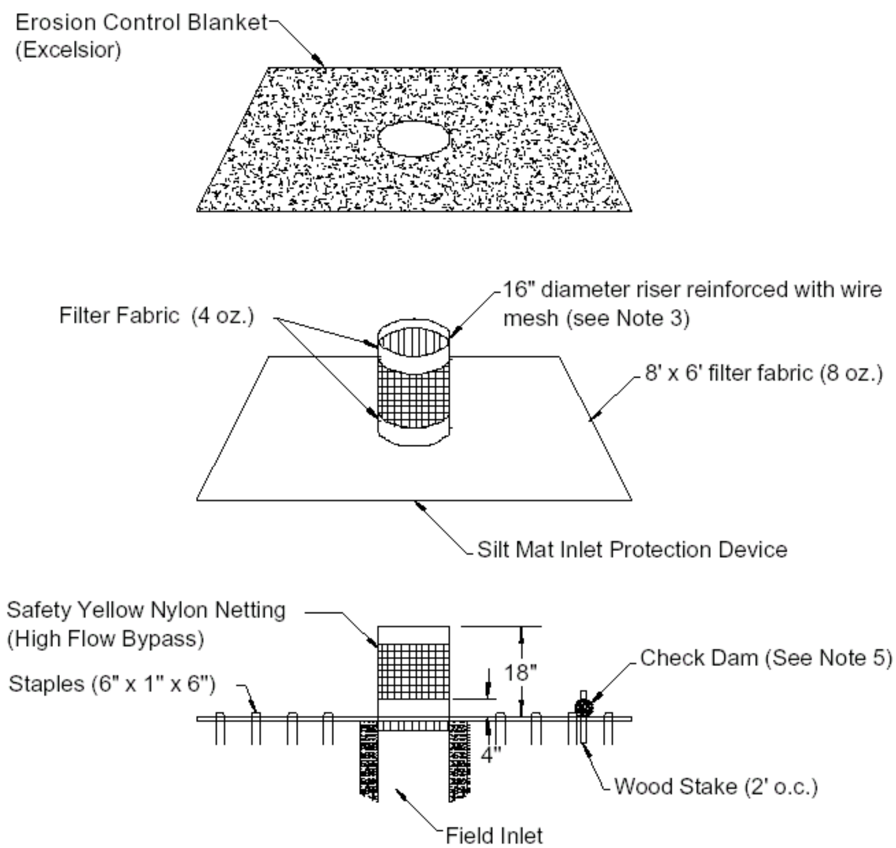
- ✓ Filter maintenance requirements vary with the application. Silt mats should be inspected before and after every rain event.
- ✓ During extended periods of rainfall, inspection should be at least every 24 hours.
- ✓ Silt and debris should be removed when the depth exceeds three inches (3") and disposed of in accordance with local agency requirements.

Source: FishNet4C

- ✓ The silt mat should be replaced when ripped or damaged.

BMP REMOVAL

- ✓ Silt mat can be removed when no longer necessary for inlet protection. All materials should be disposed of properly.



NOTES:

1. Clear and level area (6'-0" x 8'-0" min.) surrounding field inlet.
2. Roll out mat and center riser over inlet grate.
3. Install wire mesh frame into riser.
4. Secure mat in place using staples (6" x 1" x 6" min.) at approximately 1'-0" o.c.e.w. On hard surfaces, anchor with washed angular gravel or rock.
5. Side(s) of erosion control blanket may be rolled to form check (silt) dam to further slow or direct flows. Stake in place as shown.
6. Inspect inlet protection device before and after rain events, and weekly throughout the rainy season. During extended rain events, inspect at least once every 24 hours.
7. Remove and properly dispose of accumulated silt and debris to allow for proper function of device.

Source:
www.kristar.com/media/pdf/
siltmat.pdf
KriStar Enterprises, Inc., Santa Rosa, CA
(800) 579-8819

SILT MAT - INLET

BMP – SILT MAT/VEGETATED GRASSY SWALE

DESCRIPTION
An erosion control blanket installed in a swale or drainage ditches and outlets at construction sites, functioning to both prevent erosion and collect water-borne sediments. The mat maybe seeded to establish vegetation which aides in sediment entrapment.

APPLICATIONS
A last line of defense to trap sediments before construction site waters enter the natural watercourse.

LIMITATIONS

- ✓ Not for large volumes or high flows – swale slope must be low gradient.
- ✓ Plastic netted erosion control blankets may entrap wildlife. Use plastic-netted erosion control blankets only when the design shear stress exceeds the manufacturer’s recommendations for non-plastic products <u>and</u> wildlife entrapment will not be an issue.

CONSTRUCTION GUIDELINES

5) All upstream erosion control measures must be in place prior to installation of silt mat.

6) Where installation is downstream of a discharge point such as a culvert or discharge hose, a rock energy dissipater will be required over a portion of the silt mat.

7) There are many types and grades of erosion control blanket. The blanket chosen should be non-plastic, consisting of natural fibers such as coir or excelsior. The blanket must meet the manufacturer’s design specifications for the flow rates, velocities, and shear stresses anticipated.

8) Install as per manufacturer’s instructions. See accompanying details. It is essential that pre-installation soil surfaces are smooth to provide good soil to silt mat contact without tenting.

9) If used with an appropriate perennial seed mix, the effectiveness of the silt mat may increase as the grass grows. (see Broadcast Seeding BMP)

10) Do not use fertilizers in conjunction with the silt mat and seeding, as the fertilizer may mobilize and contaminate downstream waters.

Source: FishNet4C

BMP MAINTENANCE

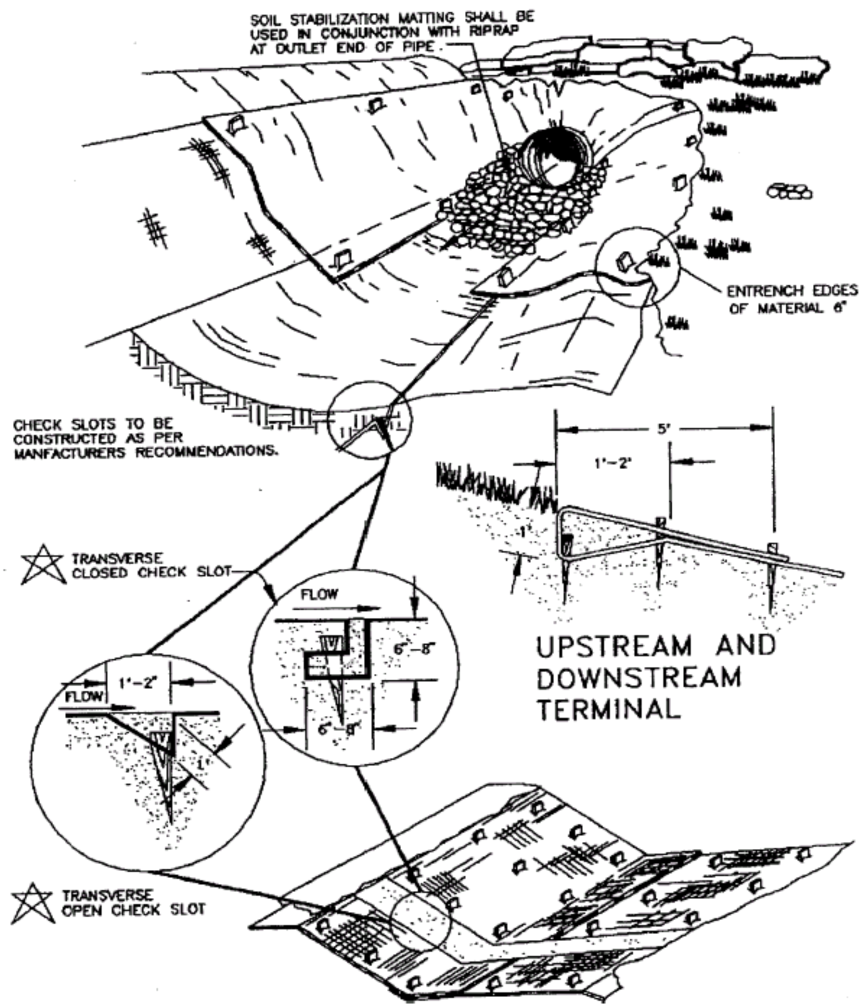
- ✓ Inspect silt mat during and after flow events. Re-fasten any loose areas, or replace damaged sections.

BMP REMOVAL

- ✓ Removal may not be required as the natural materials decompose on site.

SILT MAT- SWALE

Purpose: To capture sediment and prevent erosion at culvert discharge points where there are no high flow rates.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

BMP- SILT FENCE

DESCRIPTION

A silt fence is a temporary sediment barrier consisting of filter fabric entrenched into the soil and attached to supporting posts. Silt fence installed with a trencher or by slicing is the most effective installation method to ensure against common silt fence failures.

The slicing method for silt fence installation utilizes an implement towed behind a tractor to “plow” or slice the silt fence material into the soil. The slicing method requires the “Tommy” silt fence machine or equivalent. Silt fence machines install the silt fence by slicing through the soil, rather than excavating it. Slicing minimally disrupts the soil upward and slightly displaces the soil, maintaining the soil’s profile and creating an optimal condition for future mechanical compaction. Compacted soil resists water infiltration and moisture saturation, thus nearly eliminating washouts.

APPLICATIONS

Silt fence is a sediment control practice. Silt fence is intended to be installed where sediment-laden water can pond, thus allowing the sediment to fall out of suspension and separate from the runoff. It is not intended to be an erosion control practice. Improperly applied or installed silt fence will increase erosion. Only install silt fence where water can pond. Silt fence placed off contour will effectively divert runoff if that is desired.

Silt fence can be used where:

- ✓ sheet and rill erosion would occur;
- ✓ protection of adjacent property or areas beyond the limits of grading is needed (perimeter control);
- ✓ the size of the drainage area is no more than 1/4 acre per 100 linear feet of silt fence;
- ✓ the maximum flow path length above the barrier is 100 feet (30.5 m);
- ✓ the maximum slope gradient above the barrier is 2:1;
- ✓ small swales are carrying silt, the slope is less than 2%, and the drainage area is less than 2 acres (0.8 ha);
- ✓ silt fence is the only feasible option.

LIMITATIONS

The high failure rate of silt fences is often due to:

- ✓ Improper placement on the site
- ✓ Inadequate quantities relative to the area contained
- ✓ Shallow trenches with little or no soil compaction.
- ✓ Inadequate attachment to posts
- ✓ Failure to maintain the silt fence after installation.

When installing, remember these important facts:

- ✓ No formal design is required. Silt fences have a useful life of one season. Their principal mode of action is to slow and pond the water and allow soil particles to settle. Silt fences are not designed to withstand high heads of water, and therefore should be located where only shallow pools can form. Their use is limited to situations in which sheet or overland flows are expected.
- ✓ Silt fences should be placed on contour to be most effective. Site perimeters and property boundaries rarely follow slope contour. If silt fences are placed along property boundaries, water may be diverted to the low point and failure may occur.
- ✓ The slicing method has the capability to turn in a short distance, thus properly installing silt fence where needed. Turning enables upturns on the ends of silt fence runs, maneuvering around obstacles on construction sites, protection along property lines, and following contours as prescribed in Best Management Practices.
- ✓ Silt fences normally cannot filter the volumes generated by channel flows. When installed across a concentrated flow path, undercutting of the fence often occurs. Silt fences should not be designed to impound sediment or water more than 18 inches (0.5 m) high. Sediment shall be cleaned from behind the fence when it reaches 50% of the designed impoundment height (9 inch (0.2 m)).

CONSTRUCTION GUIDELINES

Some design considerations include:

1) Determine what kind of runoff, and how much, is coming onto the site; too much volume of water per silt fence area means failure will happen;

11) Determine where and how the total volume is going to exit; total drainage area is the prime consideration of silt fence quantity, not necessarily slope;

12) Soil type can play a role in the placement and quantity requirements; sandy soils might require more silt fence per area to contain the volume of potential sediment; clay soils might need fewer fences because the volume of potential sediment loss is less, although the volume of water might be greater because clay soils allow less rainfall infiltration;

13) Type, size and spacing of fence posts; wood posts are inadequate and should not be used; steel t-posts weighing at least 1.25 lbs per ft. are required, as they can be driven 24 inches into compacted soil, which is necessary to hold a horizontal load 18 inches high, and they can also be recycled and used repetitively; improper spacing of posts causes failures;

14) Type of filter cloth; if all the elements of the silt fence installation are properly adhered to, the fabric does not make much difference; even lightweight non-woven fabric will hold 18 inches of sediment; wire supported fence is costly and ineffective.

15) Typical silt fence specifications were written 25 years ago and have changed little since. Some states have recognized some of the inherent problems, such as inadequate trench depth, and implemented minor changes to improve efficacy. The 25 year-old specifications, referred to as the trenching method, have never been tested for efficacy and proven worthwhile. A trencher was simply the only piece of equipment available at the time capable of securing the fabric into the soil, regardless of efficacy. Today, many contractors just open a furrow with a blade and backfill onto the fabric with the crumbs. Loose soil, both from the trencher or the blade, absorbs water quickly and becomes saturated easily, washing out under the fabric.

16) The soil should be sliced and the fabric mechanically installed into the soil

17) The height of a silt fence shall not exceed 36 inches (0.9 m). Storage height and ponding height shall never exceed 18 inches (0.5 m).

18) To minimize erosion, install silt fence at the head of a slope to slow velocity and to create a large storage area.

19) The fence line shall follow the contour as closely as possible.

20) The ends of the fence should be turned uphill.

21) Steel support posts should be utilized, properly spaced and driven into compacted soil

22) Post spacing shall not exceed 6 feet (1.8 m).

23) The filter fabric is stapled or wired directly to the posts. Filter fabric shall not be stapled to existing trees.

24) Fabric should be attached to the posts with three diagonal ties

25) Set any silt fence placed at the toe of a slope at least 6 feet (1.8 m) from the toe in order to increase ponding volume.

BMP MAINTENANCE

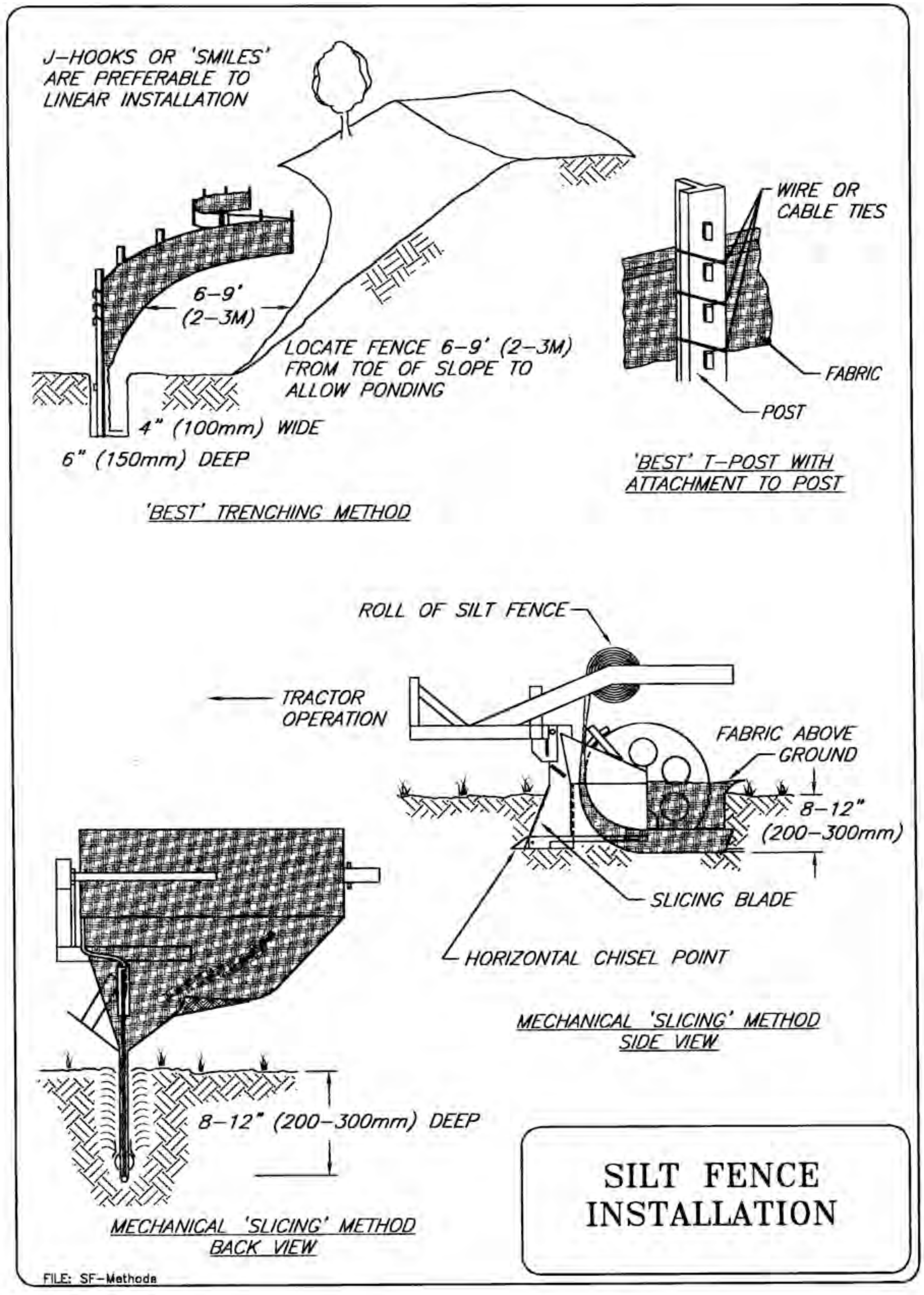
- ✓ Inspect silt fences and filter barriers weekly after each significant storm, i.e. 1 inch (25.4 mm) in 24 hours. Make any required repairs immediately.
- ✓ Remove sediment when it reaches 1/3 height of the fence or 9 inches (0.3 m) maximum.
- ✓ The removed sediment shall conform to the existing grade and be vegetated or otherwise stabilized.

BMP REMOVAL

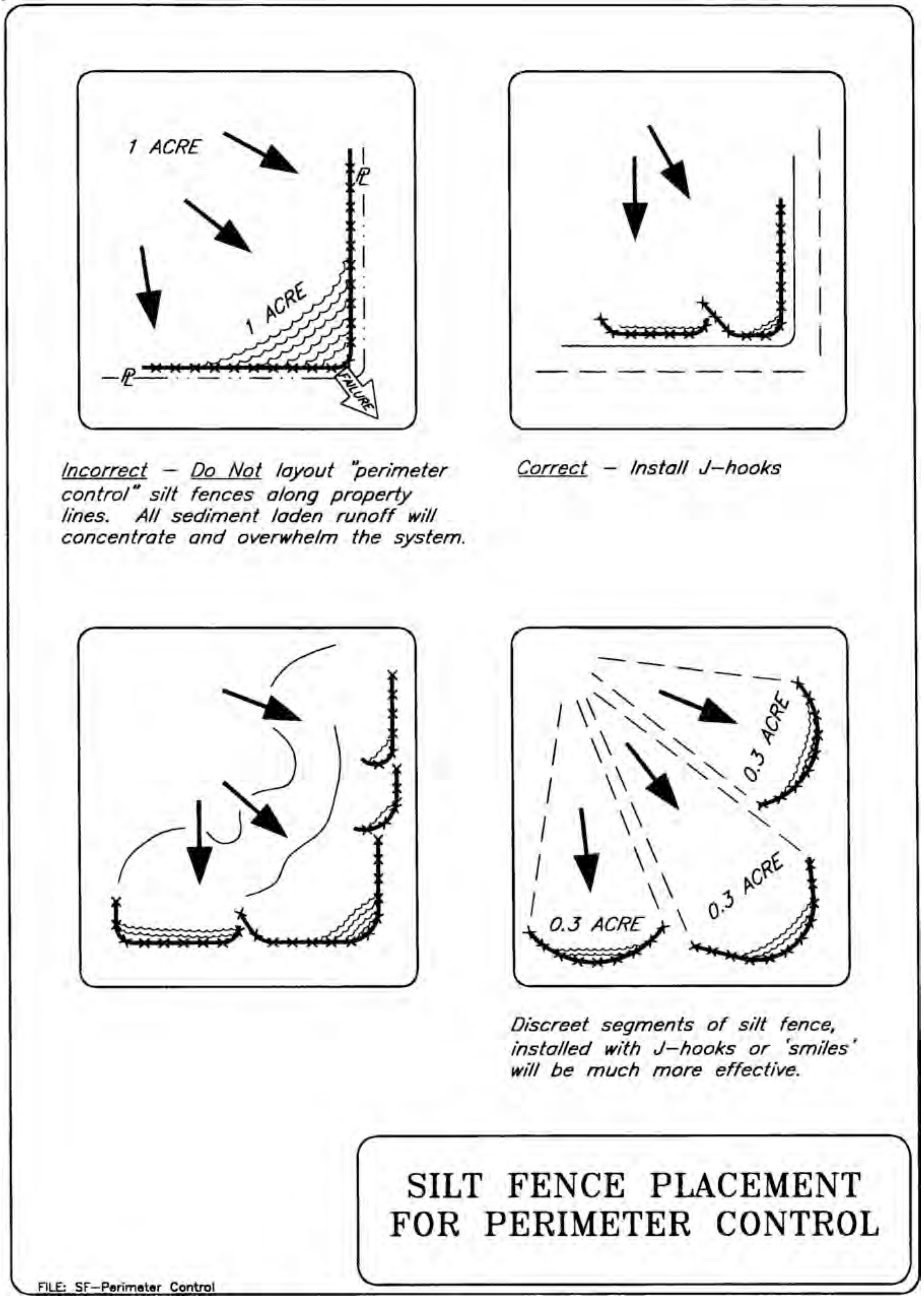
- ✓ Once a silt fence has served its purpose, make sure you permanently stabilize the upslope area and remove any sediment stored behind the silt fence *before* removing it.

ADDITIONAL RESOURCES

Silt Fence That Works, Thomas Carpenter, CPESC, 2000. Tommy Silt Fence Machine, 3718 S.W. Court Ave., Ankeny, Iowa, 50021 (800) 965-4665 www.tommy-sfm.com
Installation of Silt Fence Using the Tommy® Static Slicing Method, Environmental Technology Verification Report, Washington, DC, 2000



Source: FishNet4C



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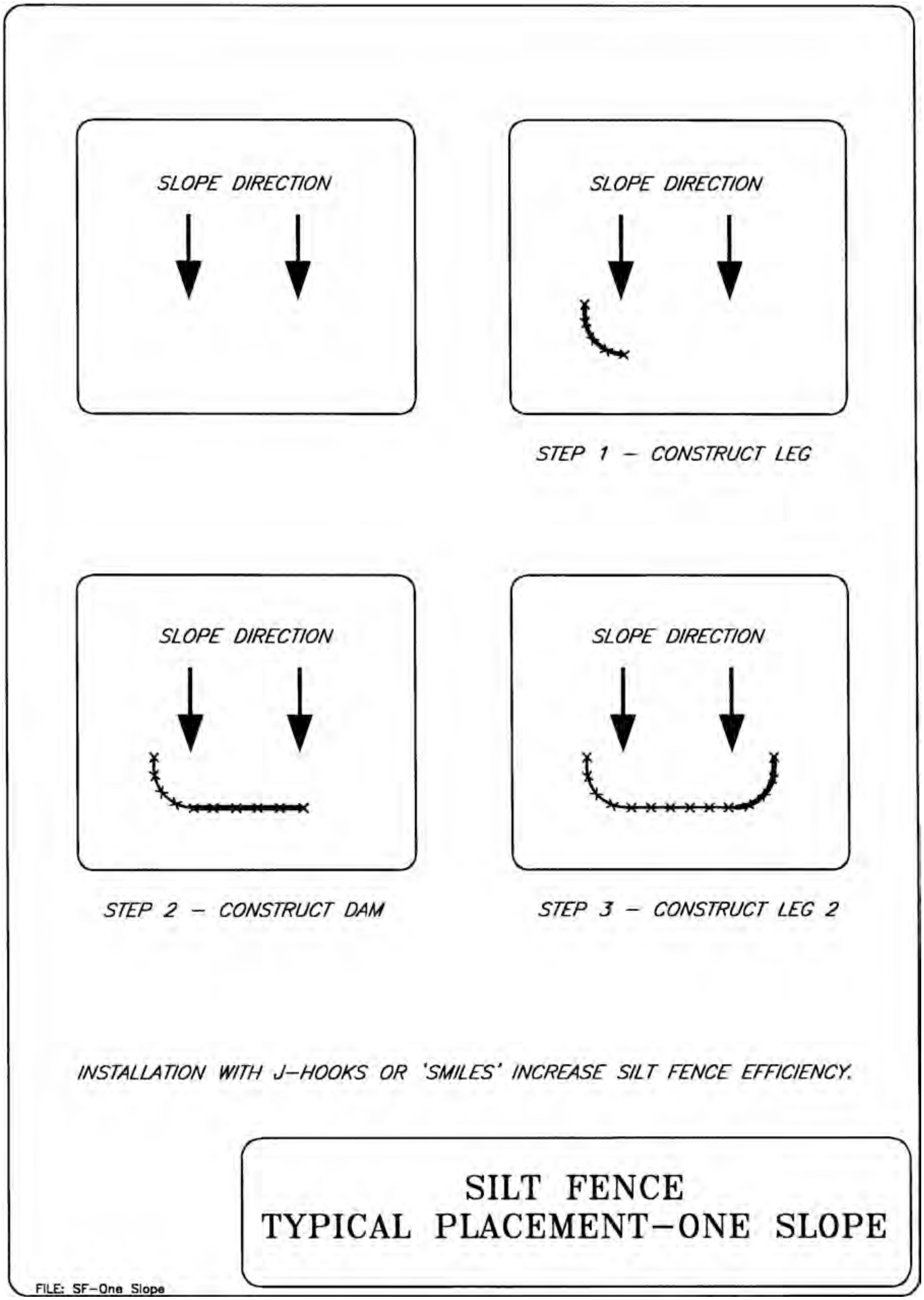
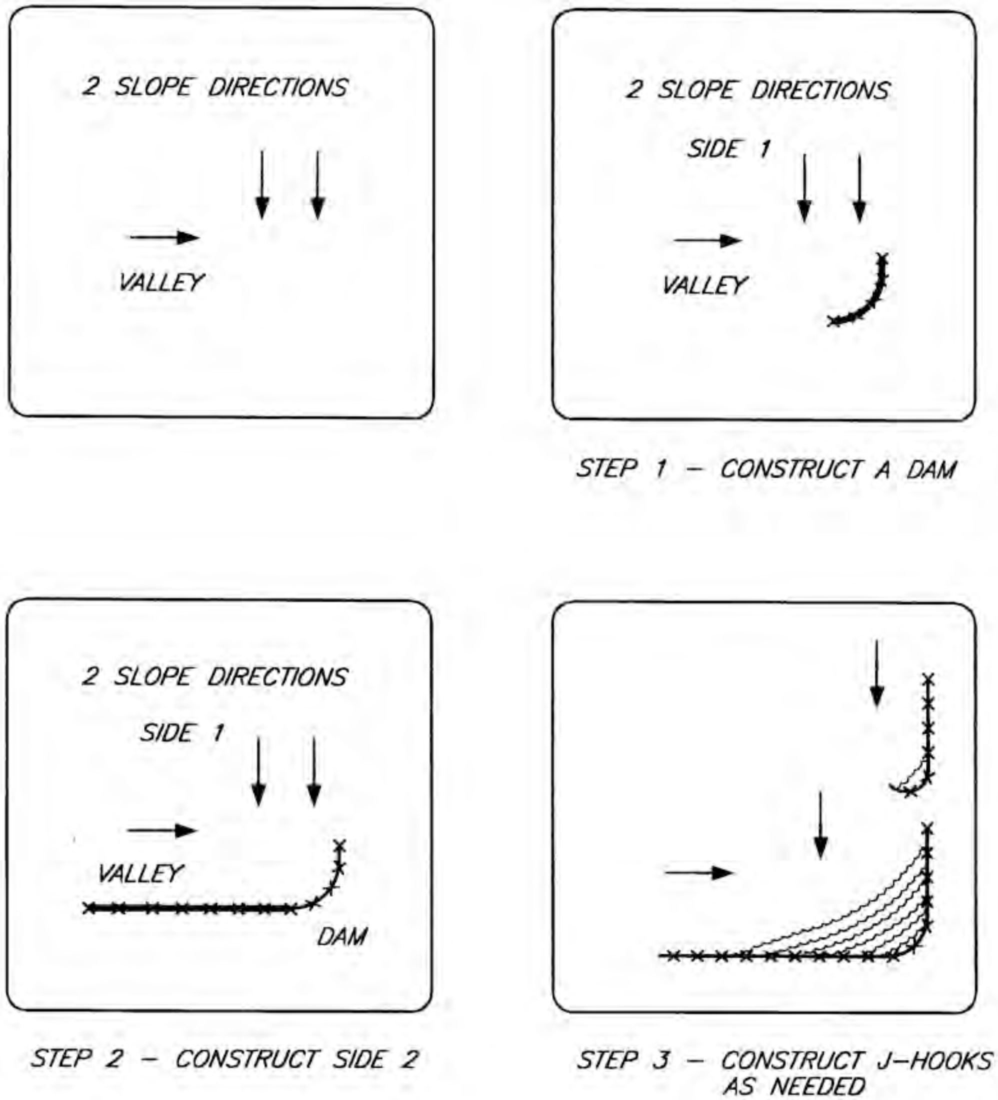


Source: FishNet4C



INSTALLATION WITH J–HOOKS WILL INCREASE SILT FENCE EFFICIENCY AND REDUCE EROSION–CAUSING FAILURES.

SILT FENCE
TYPICAL PLACEMENT–TWO SLOPES

FILE: SF–Two Slopes

Source: FishNet4C

BMP – SEDIMENT TRAP OR SUMP

DESCRIPTION

A sediment sump (also known as a sediment trap) is a small basin with a controlled release structure. The basin is formed by excavating or by constructing an earthen embankment, straw bale check dam, or gravel bag barrier across the drainage path. The trap is used only to retain larger size sediment and should only be used in conjunction with upstream erosion control measures and downstream sediment controls.

APPLICATIONS

Sediment traps may be used during wet construction periods for small drainages of less than 5 acres where sediment-laden storm water may enter the storm drain system or watercourse. See also BMP – Siltation Pond.

LIMITATIONS

- ✓ Requires an area large enough to settle water.
- ✓ Not appropriate for drainage areas greater than 5 acres or within fish bearing streams.
- ✓ Removes only larger materials (not excessive fines) and must be used in conjunction with other erosion control methods.
- ✓ May require safety fencing to keep people out.
- ✓ Not to be used in a live stream.
- ✓ Location must be approved by appropriate agencies to avoid unintended impacts to wetlands or other key habitats.

CONSTRUCTION GUIDELINES

1) Sediment traps should be constructed prior to rainy season and construction activities.
2) Trap shall be located: 1) by excavating a suitable area or where a low embankment can be constructed across a swale, 2) where failure would not cause loss of life or property damage, and 3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
3) Trap shall be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 cubic yards/acre and 33 cubic yards/acre of contributing drainage area, respectively, based on 0.5 inches of runoff volume over a 24 hour period. Multiple traps and/or additional volume may be required to accommodate site specific rainfall and soil conditions.

Source: FishNet4C

4) Traps with an impounding levee greater than 4.5 feet tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 1300 cubic yards, shall be designed by a professional Civil Engineer registered with the state of California.
5) Areas under embankments, structural work, and sediment traps shall be cleared and stripped of vegetation.
6) Trap length to width ratio shall be greater than 3:1 (L:W) or baffles are required to prevent short circuiting of the inlet flow.
7) Trap inlets shall be located to maximize the travel distance to the trap outlet. Use rock or vegetation to protect the trap outlets against erosion.
8) To dewater the trap, the outlet shall be constructed in one of the following two ways: 1) Use corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes encased in gravel to prevent floating debris from flowing out of the trap or obstructing the system; or 2) Construct a crushed stone outlet section of the embankment at the low point of the trap. The stone section serves as a non-erosive spillway outlet for flood flows and the bottom section provides a means of dewatering the trap between rainfall events.

BMP MAINTENANCE

- ✓ Inspect sediment traps before and after rainfall events and weekly during the rest of the rainy season. During extended rainfall events, inspect sediment traps at least every 24 hours.
- ✓ Check trap banks for seepage and structural soundness.
- ✓ Check outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- ✓ Check outlet area for erosion and stabilize if required.
- ✓ Remove accumulated sediment when the volume has reached one-third the original trap volume.
- ✓ Properly dispose of sediment and debris removed from trap.
- ✓ Check fencing for damage and repair as needed.

BMP REMOVAL

- ✓ Once site has stabilized, remove dam structure, re-grade to original contours, mildly compact if fill is placed, seed and mulch, or otherwise stabilize areas of bare soil.
- ✓ Dispose of imported fill material in approved stable areas away from watercourses.

BMP – SILTATION POND/SETTLING POND

DESCRIPTION

A siltation pond or desilting basin is a temporary basin formed by excavating and/or constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged. It is a last line of defense to prevent sediment from entering a watercourse after all other pertinent upslope erosion control measures have been installed.

APPLICATIONS

Desilting basins can be used on large construction projects with disturbed areas during the rainy season, and where sediment laden water may enter the drainage system or watercourses, or at outlets of disturbed soil with areas between 5-10 acres.

LIMITATIONS

- ✓ All erosion control BMPs must be in place to minimize amount of sediment entering the basin.
- ✓ Requires large surface area to permit settling of sediment.
- ✓ Not appropriate for areas greater than 30 ha (75 acres).
- ✓ Not to be located in live fish bearing streams.
- ✓ If safety is a concern, basins may require protective fencing.

CONSTRUCTION GUIDELINES

1) Limit the contributing area to the desilting basin to only runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the desilting basin.
2) Desilting basins shall be designed to have a capacity equivalent to 100 cubic meters of storage (as measured from the top of the basin to the principal outlet) per hectare of contributory area. This design is less than the required size to capture the 0.01 mm particle size but larger than that required to capture particles 0.02 mm or larger.
3) The length of the basin shall be more than twice the width of the basin; the length shall be determined by measuring the distance between the inlet and the outlet.
4) The depth must be no less than one (1) meter nor greater than 1.5 m.
5) Basins with an impounding levee greater than 1.5 m tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins

Source: FishNet4C

capable of impounding more than 1000 cubic meters shall be designed by a professional Civil Engineer registered with the state of California.

6) Design and locate desilting basins so that they can be maintained (cleaned out). Construct desilting basins prior to the rainy season and construction activities.
7) Desilting basins, regardless of size and storage volume, shall include features to accommodate overflow or bypass flows that exceed the design storm event.
8) Basins shall be designed to drain within 72 hours following storm events.
9) The outflow from the desilting basin shall be provided with outlet protection to prevent erosion and scouring of the embankment and channel.
10) Basin shall be located: 1) by excavating a suitable area or where a low embankment can be constructed across a swale, 2) where post-construction (permanent) detention basins will be constructed, 3) where failure would not cause the loss of life or property damage, and 4) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.
11) Areas under embankments, structural work, and sediment traps shall be cleared and stripped of vegetation.
12) Basin inlets shall be located to maximize water travel distance to the basin outlet.
13) Rock or vegetation shall be used to protect the basin inlet and slopes against erosion.
14) A forebay, constructed upstream of the basin, may be provided to remove debris and larger particles.
15) Principal outlet shall consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure shall be designed to accommodate the inflow design storm.
16) Structure shall be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
17) Attach riser pipe (watertight connection) to a horizontal pipe (barrel) which extends through the embankment to toe of fill. Provide anti-seep collars on the barrel.
18) Cleanout level shall be clearly marked on the riser pipe.
19) Avoid dewatering of groundwater to the desilting basin during the rainy season. Insignificant quantities of accumulated precipitation may be dewatered to the desilting basin unless precipitation is forecasted within 24 hours.
20) Area may require fencing if safety is a concern.
21) One of the dewatering configurations shown below for the principal outlet may be used. The Contractor shall verify that the outlet is properly designed to handle the design and peak flows.
22) Outlet #1 (see drawing): Perforate the top one-third of the riser with 13 mm (0.5 in) diameter holes spaced 200 mm (8 in) vertically and 250 mm (10 in) -300 mm (12 in) horizontally. Place 19 mm (0.75 in) gravel over perforated holes to approximately 50 mm (2 in) minimum thickness to assist in prevention of

clogging of dewatering holes. Gravel will naturally settle into a cone surrounding the riser pipe.

23) Outlet #2 (see drawing): Perforate the lower one-half of the riser pipe with 13 mm (0.5 in) diameter holes spaced approximately 75 mm (3 in) apart, in each outside valley (corrugated metal pipe). Place 19 mm (0.75 in) gravel over perforated holes to approximately 50 mm (2 in) minimum thickness to assist in prevention of clogging of dewatering holes. Gravel will naturally settle into a cone surrounding the riser pipe.
24) Outlet #3 (see drawing): Provide two 25 mm (1 in) diameter holes above the sediment storage volume on opposite sides of the non-perforated riser pipe. This will typically provide sufficient detention time for basins to drain approximately 4 ha (10 ac). Construct an emergency spillway to accommodate flows not carried by the principal spillway. Spillway shall consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap. Spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, shall be a minimum of 6 m (20 ft) in length. Use outlet protection at the pipe outlet.

BMP MAINTENANCE

- ✓ Inspect temporary desilting basins before and after rainfall events and weekly during the rest of the rainy season. During extended rainfall events, inspect sediment traps at least every 24 hours.
- ✓ Examine basin banks for seepage and structural soundness.
- ✓ Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- ✓ Check inlet and outlet areas for erosion and stabilize if required.
- ✓ Remove sediments when storage zone is one-third full.
- ✓ Properly dispose of sediment and debris removed from trap.
- ✓ Check fencing for damage and repair as needed.

BMP REMOVAL

- ✓ Re-grade dam and basin area to original slope unless another configuration is specified.
- ✓ Stabilize areas of bare soil with seed and mulch prior to the rainy season.

SOURCE

Caltrans. Storm Water Quality Handbooks: Construction Site Best Management Practices Manual, page SC-2, November 2000.

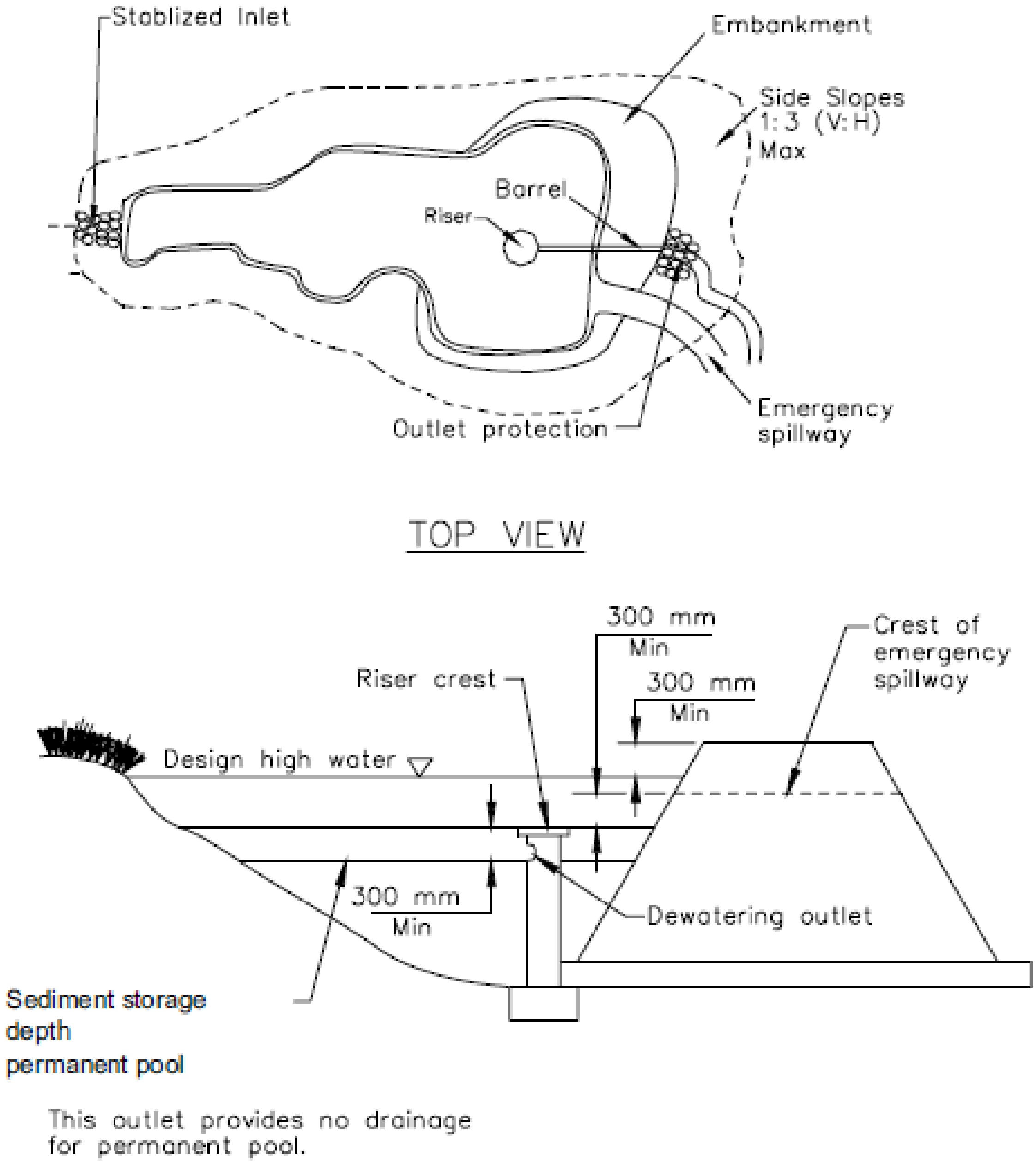


FIGURE 1: SINGLE ORIFICE DESIGN
NOT TO SCALE

Source: Caltrans Stormwater Quality Handbooks: Construction Site Best Management Practices Manual. March 2003. See Section 4 SC-2

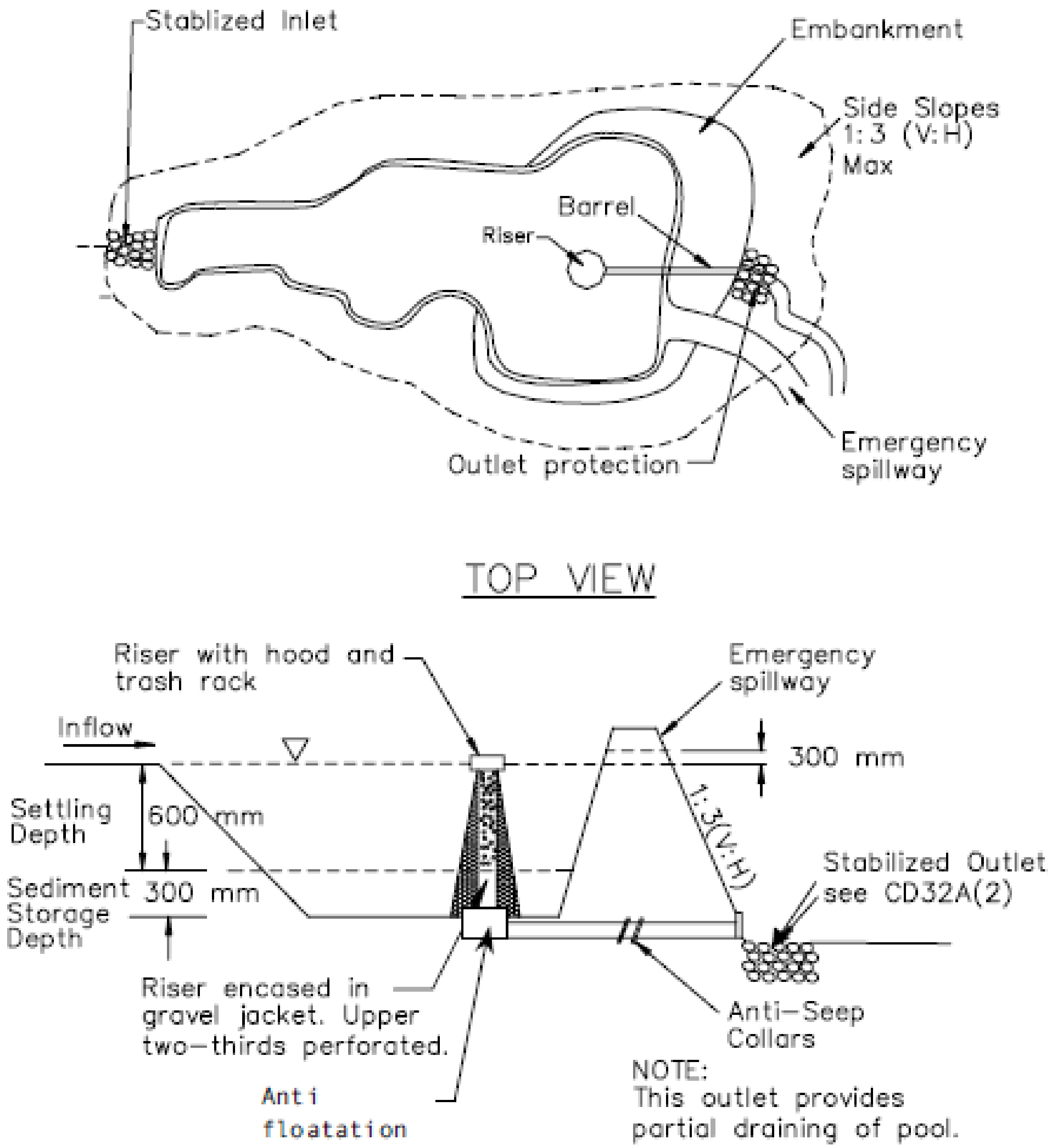


FIGURE 2: MULTIPLE ORIFICE DESIGN
NOT TO SCALE

Source: Caltrans Stormwater Quality Handbooks: Construction Site Best Management Practices Manual. March 2003. See Section 4 SC-2

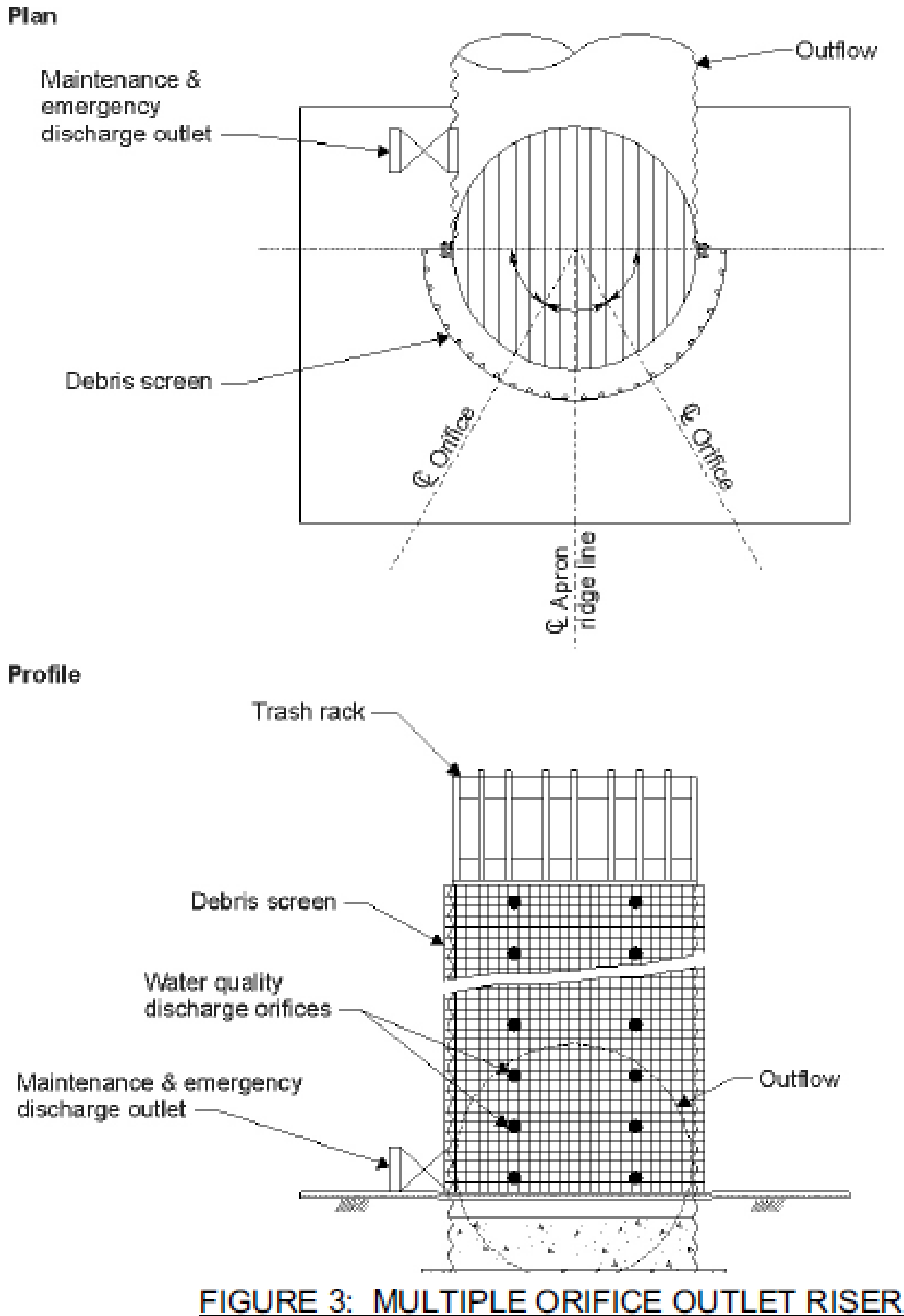


FIGURE 3: MULTIPLE ORIFICE OUTLET RISER
NOT TO SCALE

Source: Caltrans Stormwater Quality Handbooks: Construction Site Best Management Practices Manual. March 2003. See Section 4 SC-2

BMP – STORM DRAIN INLET PROTECTION

DESCRIPTION

Curb inlet sediment barriers on storm drains are temporary barriers constructed from concrete block and gravel or gravel filled sandbags.

APPLICATIONS

Curb inlet sediment barriers reduce the sediment discharged into storm drains by ponding the runoff and allowing the sediment to settle out. The structures allow for overflow from high runoff events and the gravel allows the ponds to dewater rapidly. Use this BMP where new construction, reconstruction and/or private development is generating sediment or polluted runoff.

LIMITATIONS

- ✓ Do *not* use this BMP on steep sloping streets.
- ✓ Consider this BMP a "backup," used *in addition to* controlling potential erosion at the source.

CONSTRUCTION GUIDELINES

1) Place the barriers on gently sloping streets where water can pond.
2) The barriers must allow for overflow from a severe storm event. A spillway shall be constructed with the sandbag structures to allow overflow.
3) Sandbags shall be filled with 3/4-inch drain rock or 1/4-inch pea gravel.
4) The sandbags shall be placed in a curved row from the top of curb at least 3 feet into the street. The row should be curved at the ends, pointing uphill.
5) Several layers of bags should be overlapped and packed tightly.
6) Leave a one-sandbag gap in the top row to act as a spillway.

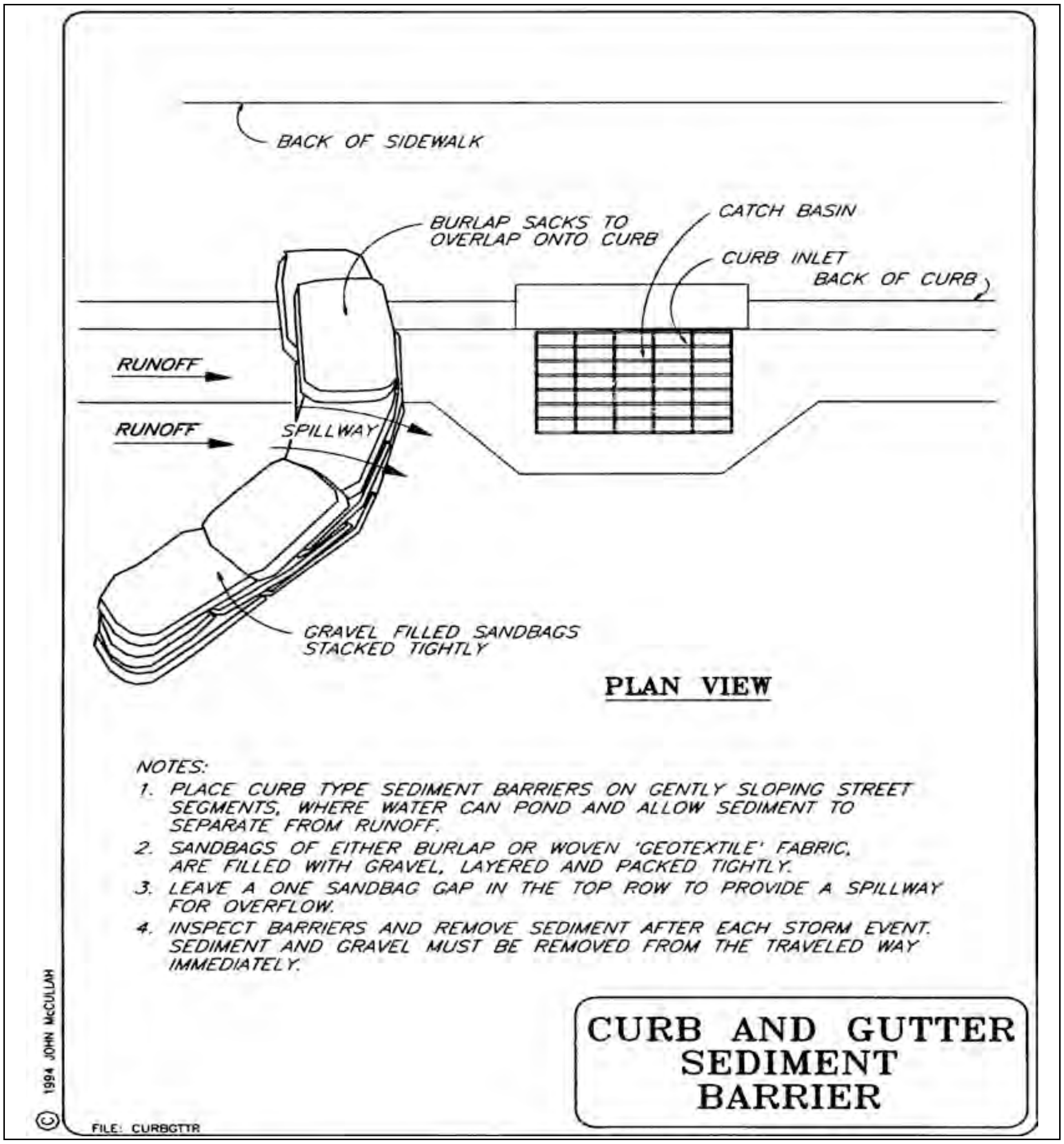
BMP MAINTENANCE

- ✓ Inspect and clean barrier during and after each significant storm and remove sediment from behind sandbag structure after every storm.
- ✓ Any sediment and gravel shall be immediately removed from the traveled way of roads.

- ✓ The removed sediment shall be placed where it cannot enter a storm drain, stream, or be transported off site.
- ✓ If the gravel becomes clogged with sediment, it must be carefully removed from the inlet and either cleared or replaced.

BMP REMOVAL

- ✓ BMP removal should not be necessary.



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Source: FishNet4C

BMP – SWEEPING

DESCRIPTION

Sweeping performed by hand or mechanical means is an effective way to clean debris and reduce the possibility for runoff into storm drains, watercourses, and streams.

APPLICATIONS

Sweeping is preferred to the use of water to clean up soil particles and debris. Use sweeping to help suppress dust on roadways and at construction sites. Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress.

LIMITATIONS

- ✓ Some dust particles may become air-born.
- ✓ May not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

CONSTRUCTION GUIDELINES

1) To prevent inhalation of dust and fine sediment, use respiratory protection.
2) Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be more focused and effective.
3) Collect waste and dispose of at permitted facilities. If material is not mixed with debris or trash, consider incorporating the removed sediment back into the project.
4) Use a minimum amount of water with mechanical brooms.
5) Do not pick up suspicious debris but instead call the appropriate agency or HazMat contractor.

BMP MAINTENANCE

- ✓ Keep brooms and sweeping machinery in good condition. Repair any leaks.
- ✓ Inspect potential sediment tracking locations daily.

BMP REMOVAL

- ✓ Collect waste frequently and dispose properly.

Source: FishNet4C

Source:
California Regional Water Quality Control Board. Erosion and Sediment Control Field Manual, Third Edition, July 1999.

SWEEPING

BMP – TURBIDITY CURTAIN

DESCRIPTION

A turbidity curtain is a temporary floating geotextile structure used to contain the flow of silt and debris in a waterway during construction. The curtain functions by limiting the flow of water to allow the sediments to settle out. **Other names**: floating boom, turbidity barrier, silt curtain, stillwater screen.

APPLICATIONS

Silt and debris must be contained by law to protect aquatic resources. The turbidity curtain can be ordered to specification depending on flow, depth, length, filtering properties, and the desired length of deployment.

LIMITATIONS

- ✓ Use of a turbidity curtain in a waterway is subject to federal, state, and local permits.
- ✓ The curtain is intended to be used as an enclosure, not a dam for turbid waters to settle out.
- ✓ Custom curtains are available.
- ✓ A site survey is required to assess the velocity, depth, and sediment type to select the proper curtain.

CONSTRUCTION GUIDELINES

1) Construction of the turbidity curtain varies with vendor: see manufacturer's specifications.
2) Choose the appropriate height and length of turbidity curtain.
3) Add a suitable weight or anchoring system to the bottom of the curtain
4) Ensure that water discharged from turbidity curtain meets permit requirements at point of discharge.

BMP MAINTENANCE

- ✓ Careful monitoring of the mud levels will be required to conform to the curtain's capability to hold the material.
- ✓ Anchor lines must be checked and replaced with any signs of wear.
- ✓ Tears and leaking connections must be checked and repaired.

BMP REMOVAL

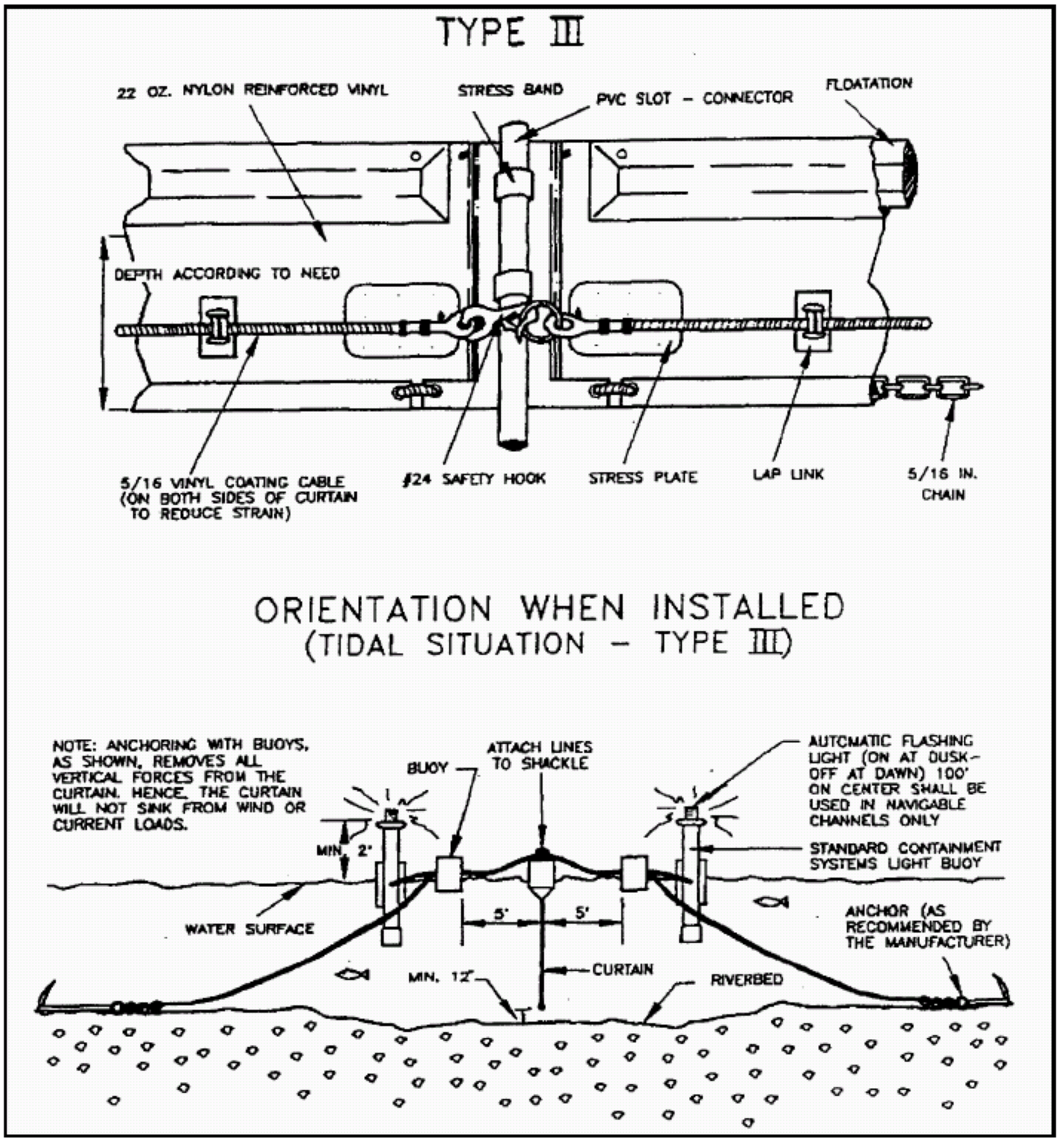
Source: FishNet4C

- ✓ Remove curtain in such a manner as to minimize turbidity. Remaining soil particles shall be sufficiently settled before removing the curtain.
- ✓ Discharge of turbid water will be subject to discharge requirements in waterways.

Source: FishNet4C

TURBIDITY CURTAIN

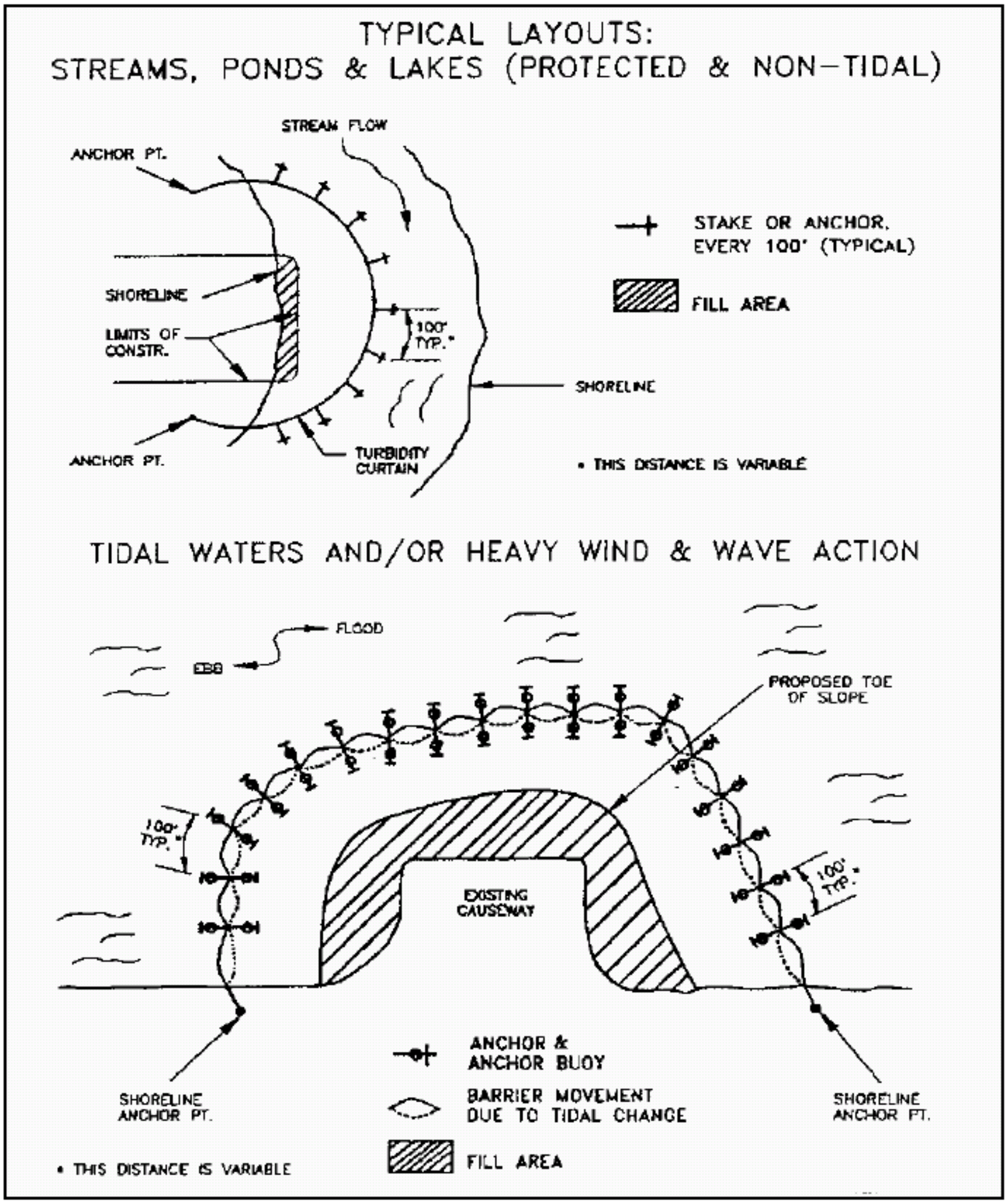
Figure 1. Turbidity Curtain – Type III, including tidal situation.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

TURBIDITY CURTAIN

Figure 2. Two typical layouts of a turbidity curtain.



Source: King County. 2000. Regional Road Maintenance Endangered Species Act Program Guidelines.

WATER MANAGEMENT BMPS

Source: FishNet4C

BMP - ASPHALT BERM

DESCRIPTION

An asphalt berm is a ridge of asphalt concrete or "cutback" constructed at the top of a disturbed slope. The purpose of the BMP is to direct stormwater runoff away from an unstable slope.

APPLICATIONS

This BMP may be used wherever stormwater runoff must be diverted away from a disturbed slope and toward a sediment containment facility or stable runoff.

LIMITATIONS

Do *not* use this BMP:

- ✓ to concentrate runoff onto unstable, eroded areas.
- ✓ near edges of slides or streambanks where cutback berms could slip into a stream.

CONSTRUCTION GUIDELINES

1) Construct asphalt berm to the minimum height and width needed to divert runoff without adding unnecessary weight.
2) Asphalt berms may be striped or marked for traffic safety.
3) Asphalt berms may be used to anchor temporary plastic sheeting.

BMP MAINTENANCE

- ✓ Conduct periodic inspections, and repair berms as necessary.

BMP REMOVAL

- ✓ Asphalt berm removal may not be necessary, or may be conducted during permanent slope or streambank repair activities.
- ✓ Recycle or reuse asphalt berm material.

Source: FishNet4C

BMP – AQUA BARRIER

DESCRIPTION

Aqua barriers are temporary, re-usable water-filled plastic tubes installed as dams. An aqua barrier can be used as a type of coffer dam.

APPLICATIONS

Aqua barriers can be used in any situation where water damming, water diversion, or silt containment is necessary. The dams are portable, re-usable, and come in a variety of sizes to fit any project.

LIMITATIONS

- ✓ Use of aqua barriers in a waterway are subject to federal, state, and local permits.
- ✓ A portable pump and abundant local water supply must be available.
- ✓ Sharp objects will puncture the plastic.
- ✓ Not suitable for steep channel gradients.
- ✓ Presents a temporary barrier to migrating aquatic species.

CONSTRUCTION GUIDELINES

1) Instructions for aqua barriers vary by manufacturer; however they are generally put in place in the waterway then filled with water.

2) Although the barriers are flexible and conform to varied terrain, some smoothing and leveling of the ground surface may be needed.

3) Substrate beneath the barriers must be of sufficient strength and uniformity to support the load.

4) Safety issues regarding potential breach of dam must be addressed in the planning stages.

5) 25% minimum freeboard is required. More freeboard may be needed for slick or weak soils, or higher velocities over 3 feet per second.

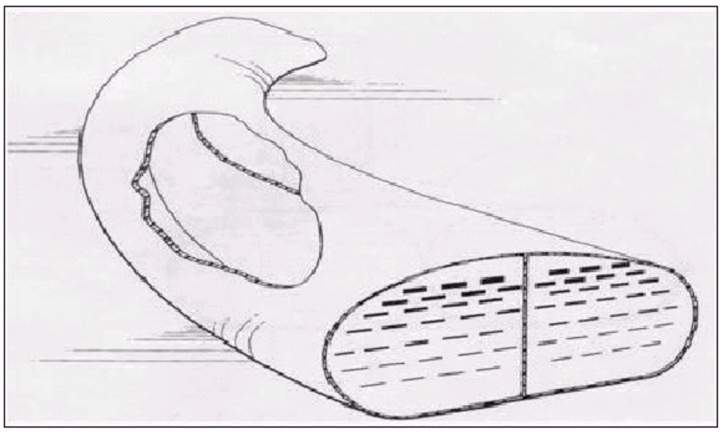
BMP MAINTENANCE

Source: FishNet4C

- ✓ Aqua barriers should be checked routinely for tears and stability.

BMP REMOVAL

- ✓ Water released from the aqua barrier on-site may require additional measures to ensure environmental compliance.
- ✓ An energy dissipating devise is required to prevent erosion from draining water.



PORTABLE, WATER-FILLED DAM

- Water diversion for dewatering
- Coffer dam
- Silt containment

Source:
AquaDams/Water Structures Unlimited
www.waterstructures.com/
Applications/page1.html

AQUA BARRIER

BMP- COFFERDAM

DESCRIPTION

A cofferdam is a temporary structure built into a waterway to enclose a construction area and reduce sediment pollution from construction work in or adjacent to water. Cofferdams may be made of rock, sand bags, wood or aqua barriers.

APPLICATIONS

This BMP may be used in construction activities such as streambank stabilization, culvert installation, bridges, piers or abutments. It may be used in combination with other methods such as clean water bypasses and/or pumps.

LIMITATIONS

A cofferdam is a potentially serious “taking” issue (could cause harm to listed species) and is not a routine road maintenance BMP. For information on incidental take permits for fish habitats, see Chapter 2-Permits. Consultation with a fisheries biologist and agency biologists is imperative if there are salmonids present in the stream system. A Streambed Alteration Agreement (1600permit) is needed from DFG which will outline the terms and conditions to protect aquatic habitat and species.

Do *not* use this BMP:

- ✓ if there is insufficient stream flow to support aquatic species.
- ✓ in deep water unless designed or reviewed by an engineer.
- ✓ to completely dam stream flows.

CONSTRUCTION GUIDELINES

1) When used in watercourses or streams, cofferdams must be used in accordance with permit requirements. Materials for cofferdams should be selected based on ease of maintenance and complete removal following construction activities.

2) Construct cofferdams of sandbags, placed by hand. Sandbags should be filled with clean river run gravels.

3) Cover dam covered in visqueen to minimize water infiltration

Source: FishNet4C

BMP MAINTENANCE

- ✓ During construction, inspect daily during the work week.
- ✓ Schedule additional inspections during storm events.
- ✓ Immediately repair any gaps, holes or scour.

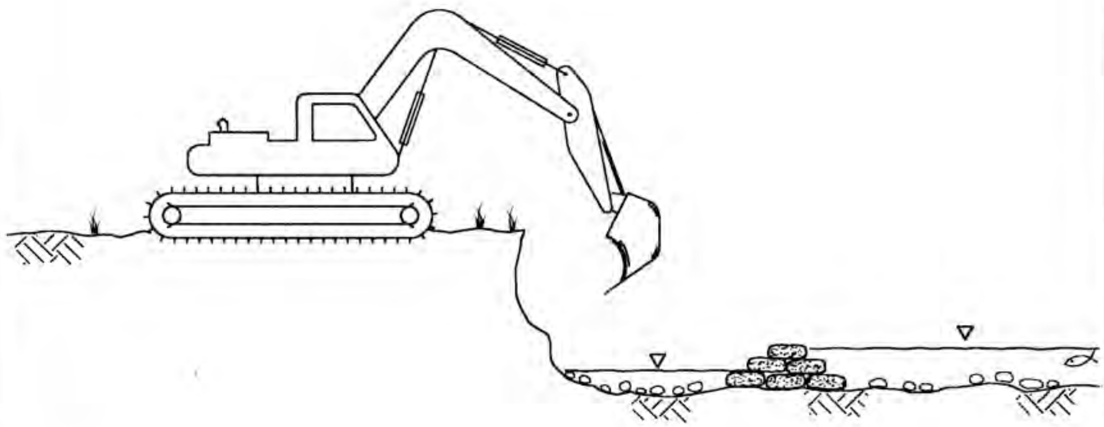
BMP REMOVAL

- ✓ Remove sediment buildup.
- ✓ Remove BMP. Recycle or re-use if applicable.
- ✓ Revegetate areas disturbed by BMP removal if applicable.

Source: FishNet4C

BENEFITS/LIMITATIONS

- *Difficult to dewater*
- *Inexpensive*
- *Labor intensive to install and remove*
- *Sand may be deposited in stream if bags break, better to use clean gravel*



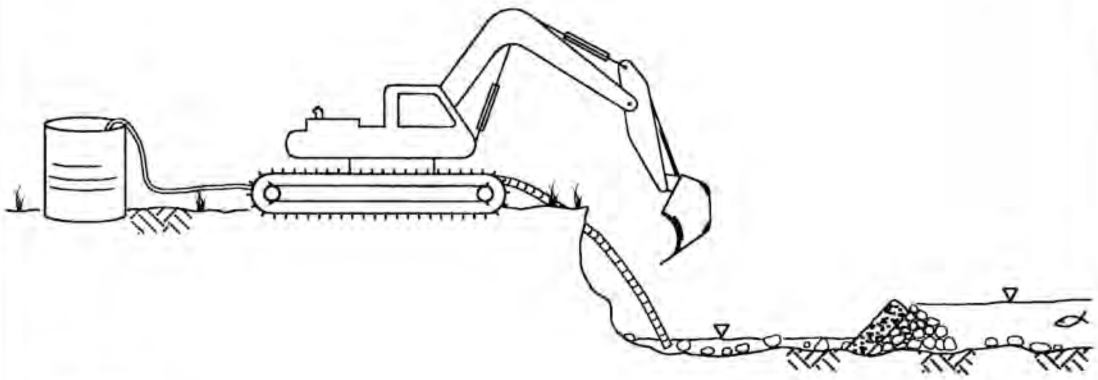
SAND BAG/GRAVEL BAG TECHNIQUE

INSTREAM EROSION AND SEDIMENT CONTROL ISOLATION TECHNIQUES

FILE: Instream Techniques3

Source: FishNet4C

BENEFITS/LIMITATIONS
- Allows partial dewatering
- Relatively inexpensive
- Useful for small streams
- Minimal TSS when removed



NOTES:

Step 1. Install clean gravel

Step 2. Place impermeable soil

Step 3. Do work

Step 4. Decommission berm by removing soil layer first

Step 5. Pump work area. Head differential will cause turbo water to flow into work area

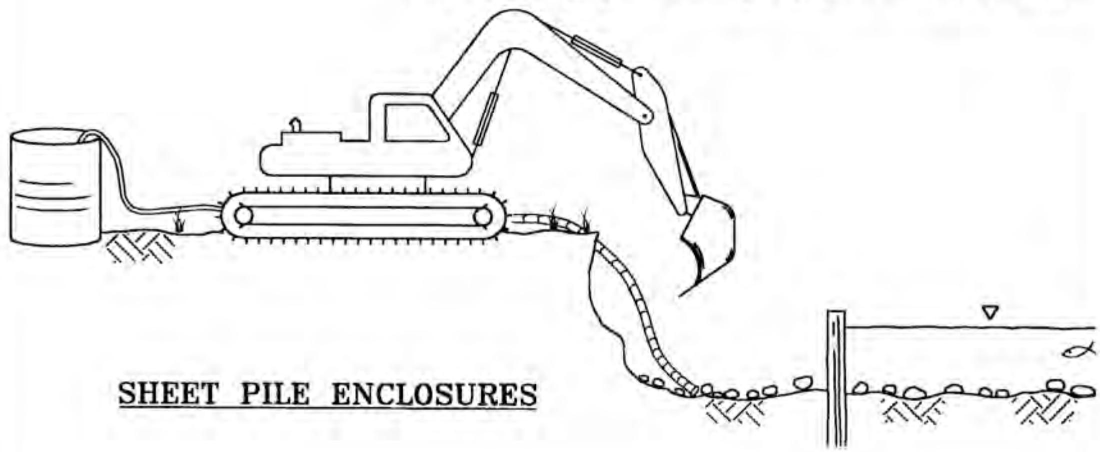
Step 6. Remove or spread gravel

GRAVEL/SOIL BERM INSTREAM ISOLATION TECHNIQUE

FILE: Berm Instream Techniques

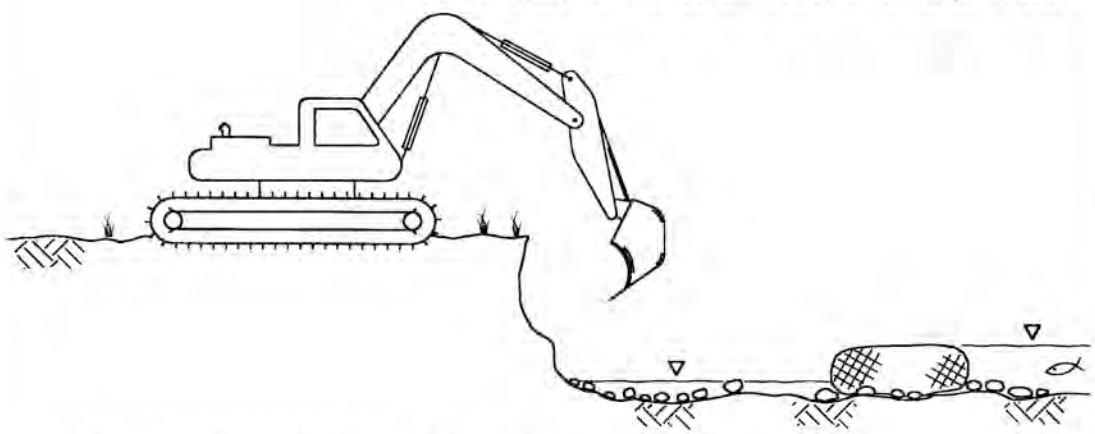
Source: FishNet4C

BENEFITS/LIMITATIONS
- Allows full dewatering
- Relatively expensive
- Useful in large rivers, lakes, high velocity
- Not really appropriate for small streams
- Requires staging and heavy equipment access areas



SHEET PILE ENCLOSURES

BENEFITS/LIMITATIONS
- Allows partial dewatering
- Moderately expensive
- Ease of installation and removal unknown
- Can be designed for small streams to large rivers



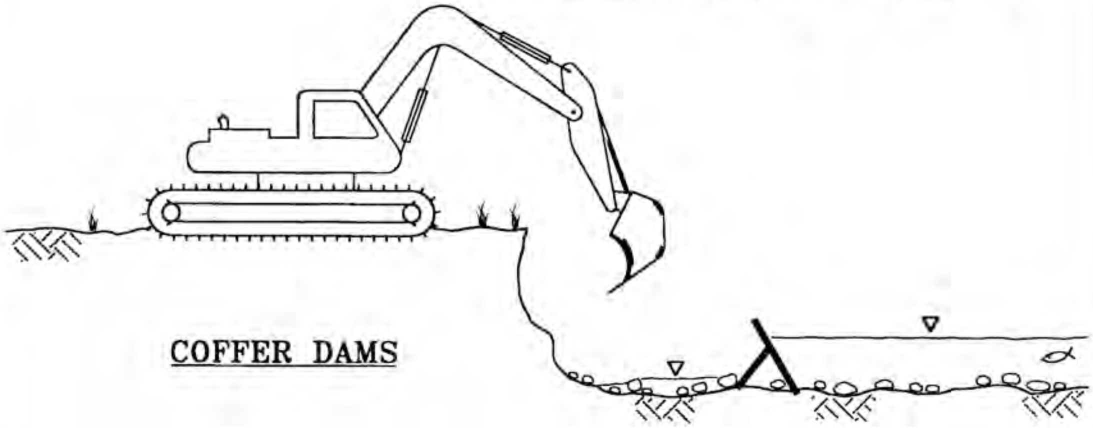
WATER-FILLED GEOTEXTILE (AQUA DAM)

INSTREAM EROSION AND SEDIMENT CONTROL ISOLATION TECHNIQUES

FILE: Instream Techniques2

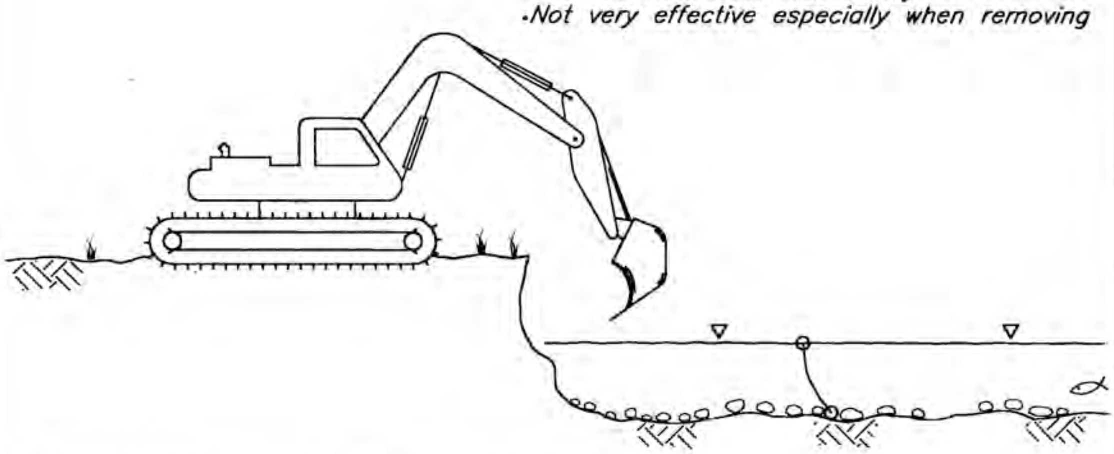
Source: FishNet4C

BENEFITS/LIMITATIONS
- Allows partial dewatering
- Many different types available
- Relatively expensive
- Can be designed for large and small streams
- Ease of installation and removal unknown



COFFER DAMS

BENEFITS/LIMITATIONS
- Does not allow dewatering
- Inexpensive
- Used in slow water lakes only
- Not very effective especially when removing



GEOTEXTILES, SILT BARRIERS, CURTAINS

INSTREAM EROSION AND SEDIMENT CONTROL ISOLATION TECHNIQUES

FILE: Instream Techniques1

Source: FishNet4C

BMP – DEWATERING

DESCRIPTION
A temporary method to remove and filter water from excavated areas on construction sites prior to discharge to the storm drain or surface waters. See also Aqua Barrier, Coffer Dam, and Stream Bypass BMPs.

APPLICATIONS
Used for draining creeks, lakes, ponds, sediment traps, basins, or excavations on construction sites. Also used wherever sediment-laden water must be removed from the construction site using a dewatering pump.

LIMITATIONS
- ✓ Conditions at individual sites will determine the scope and applicability of dewatering.
- ✓ Dewatering is subject to federal, state, and local permits.
- ✓ The discharge of sediment-laden water from a dewatering site into any water of the State without filtration is prohibited.
- ✓ A fish or aquatic wildlife rescue plan may be required.

CONSTRUCTION GUIDELINES-

See Chapter 6.5- Dewatering for detailed Best Management Practices to minimize impact on fish and other aquatic organisms when dewatering a project site.

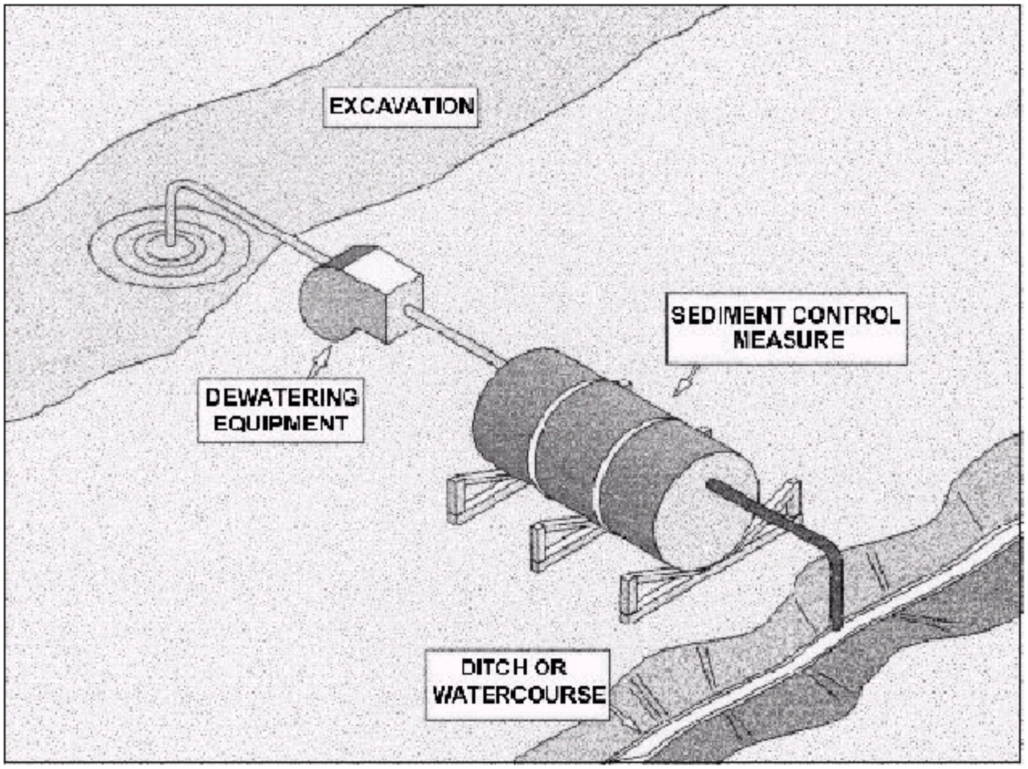
1) A dewatering structure should be sized to allow water to flow through any filtering media without overflowing the structure.

2) Adequate erosion and sediment control measures are to be considered first. Dewatering practices should be considered as a last-resort control measure.

3) Check water for odors, discoloration, or an oily sheen. If present, have the water tested by a certified lab. Discuss test results with Regional Water Quality Control Board Staff to determine how and where to discharge.

4) An energy dissipater may be needed to prevent erosion at the outlet.

BMP MAINTENANCE
- ✓ Inspect and clean sediment control devices frequently to prevent build-up or blockage of the sediment filters.
- ✓ Monitor effluent to ensure that no sediment is discharged into a storm drain or



SEE ALSO;
AQUA BARRIER
STREAM BYPASS (WATER DIVERSION)
COFFER DAM.

Source:
Caltrans. Storm Water Quality Handbooks: Construction Site Best Management Practices Manual, November 2000.

DEWATERING & FILTERING
(PUMPING OR DRAINING)

BMP - DIVERSION BERM

DESCRIPTION

A diversion berm is a temporary ridge of compacted soil or aggregate base material, sandbags or continuous bag berm constructed at the top or base of a disturbed slope. The purpose of the BMP is to direct stormwater runoff away from an unstable slope.

APPLICATIONS

This BMP may be used to temporarily divert stormwater runoff away from a disturbed slope and toward a sediment containment facility or stable runoff.

LIMITATIONS

A diversion berm is a potentially serious "taking" issue for endangered salmon and is not a routine road maintenance BMP. For information on incidental take permits for fish habitats, see *Chapter 2-Permits*.

Do *not* use this BMP:

- ✓ in fast flowing water.
- ✓ as a replacement for failing roadway shoulders.
- ✓ as slide debris storage within 150 feet of any water body.

CONSTRUCTION GUIDELINES

1) Adequately compact berm material to prevent failure.

2) Apply temporary seeding and mulch to all surfaces of a soil diversion berm according to the BMP-Seasonal Planning.

BMP MAINTENANCE

- ✓ Conduct periodic inspections, and repair berms as necessary.

Source: FishNet4C

BMP REMOVAL

- ✓ Evaluate site to determine BMP is no longer needed :verify that the area has stabilized and is no longer a potential source of sediment-laden water. .
- ✓ Remove sediment buildup.
- ✓ Remove BMP – recycle and/or re-use if applicable.
- ✓ Re-vegetate area disturbed by BMP removal.

Source: FishNet4C

BMP – FISH EXCLUSION

DESCRIPTION
Road maintenance activities may require work within streams that contain fish and other aquatic resources. Some of these activities require water to be diverted around the work site (see BMP – Stream Bypass) with the fish removed, relocated upstream of the work area, and excluded from the work site until work is completed.

APPLICATIONS
Fish exclusion may be necessary when work is done in watercourses and streams (slope stabilization, sediment removal, vegetation or habitat management, debris removal) and for repair, replacement, maintenance, or installation of stream crossings (pipes, culverts, fish ladders) and bridges.

LIMITATIONS

- ✓ Fish exclusion from the work site prior to dewatering must be with authorization from the National Marine Fisheries Service and the California Department of Fish and Game. Fish exclusion is done only under the supervision of a qualified fisheries biologist with the appropriate State and Federal permits.

CONSTRUCTION GUIDELINES

1) Isolate the work area (block nets).

2) Remove as many fish as possible using seines and relocate upstream or downstream in pools of adequate size.

3) Gradually dewater work area.

4) Remove as many remaining fish as possible using seines and dip nets, and relocate.

5) Electroshock, if required by permit, to avoid any strandings in pools where other methods are ineffective.

BMP MAINTENANCE

- ✓ Keep records of fish exclusion activities.
- ✓ Obtain any needed training from the qualified fishery biologist.
- ✓ Only assist the supervising fisheries biologist in accordance with State and Federal procedures when requested.

Source: FishNet4C

- ✓ Help clean fish screens of leaves and debris as necessary, and report any mortality to the supervising biologist.

BMP REMOVAL

- ✓ Once work is completed, gradually return the stream to its original condition so as not to cause a surge downstream or strand fish upstream.

SOURCES

Five Counties Salmonid Conservation Program. 2002. A Water Quality and Stream Habitat Protection Manual for County Road Maintenance in Northwestern California Watersheds. [http://www.5counties.org/]

BMP - LEVEL SPREADERS

DESCRIPTION

A non-erosive outlet for concentrated runoff constructed to disperse flow uniformly across a slope.

APPLICATIONS

Use to convert concentrated flow to sheet flow and release it uniformly over a stabilized area. The level spreader is most often used as an outlet for temporary or permanent diversions and diversion dikes. Runoff water containing high sediment loads must be treated in a sediment-trapping device before release in a level spreader.

LIMITATIONS

Use this BMP if:

- ✓ sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion.
- ✓ a level lip can be constructed without filling.
- ✓ the area below the spreader lip is uniform with the slope of 10% or less and is stable for anticipated flow conditions, preferably well vegetated.
- ✓ the runoff water will not re-concentrate after release.
- ✓ there will be no traffic over the spreader.

CONSTRUCTION GUIDELINES

1) The level spreader is a relatively low-cost structure to release small volumes of concentrated flow where site conditions are suitable. The outlet area must be uniform and well vegetated with slopes of 10% or less. Take particular care to construct the outlet lip completely level in a stable, undisturbed soil. Any depressions in the lip will concentrate the flow, resulting in erosion.

2) Determine the capacity of the spreader by estimating peak flow from the 10-year storm. Restrict the drainage area so that maximum flows into the spreader will not exceed 30 cfs.

3) When water enters the spreader from one end, as from a diversion, select the appropriate length, width, and depth of the spreader from the table below:

Source: FishNet4C

Design Flow (cfs)	Entrance Width (ft)	Depth (ft)	End Width (ft)	Length (ft)
0-10	10	0.5	3	10
10-20	16	0.6	3	20
20-30	24	0.7	3	30

26) Construct the level lip on undisturbed soil to uniform height and zero grade over the length of the spreader. (However, aprons frequently cannot be set at zero grade due to slope.) Protect it with an erosion-resistant material, such as erosion control blankets or mats, to prevent erosion and allow vegetation to become established.

27) The blankets or matting should be a minimum of 4 ft wide extending 6 inches over the lip and buried 6 inches deep in a vertical trench on the lower edge. The upper edge should butt against smoothly cut sod and be securely held in place with closely spaced heavy-duty wire staples at least 12 inches long.

28) Ensure that the spreader lip is level for uniform spreading of storm runoff.

29) Construct the level spreader on undisturbed soil (not on fill).

30) Construct a 20-ft transition section from the diversion channel to blend smoothly to the width and depth of the spreader.

31) Disperse runoff from the spreader across a properly stabilized slope not to exceed 10%. Make sure the slope is sufficiently smooth to keep flow from concentrating.

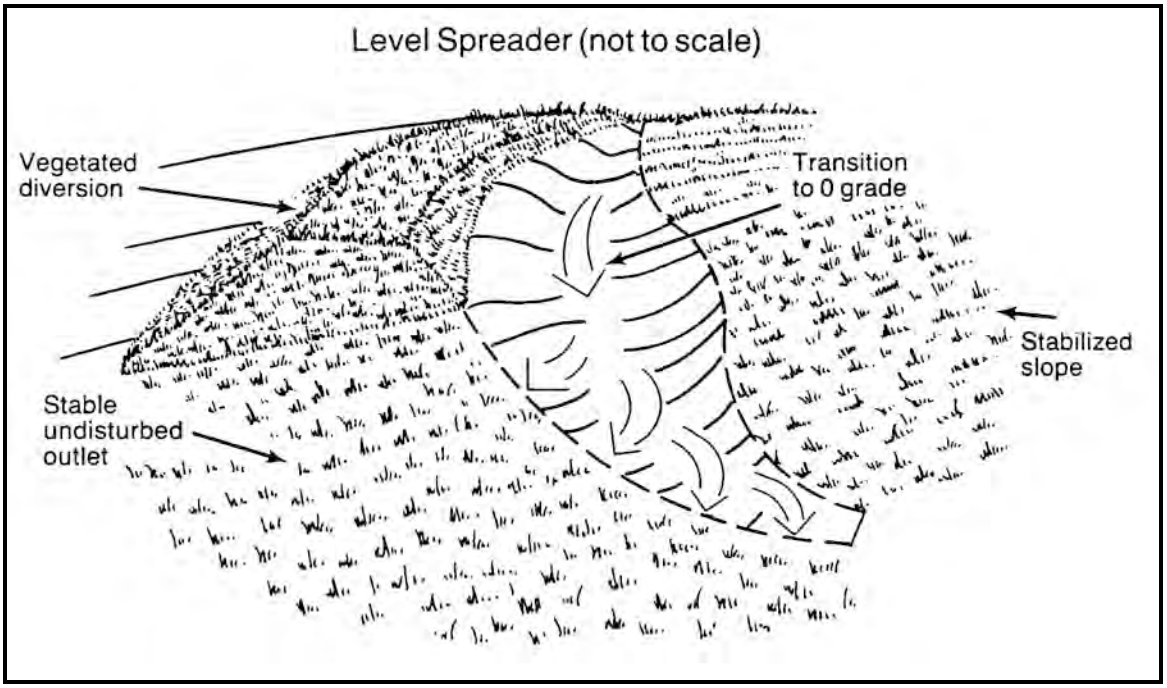
32) Immediately after its construction, appropriately seed the disturbed area with native grasses and mulch.

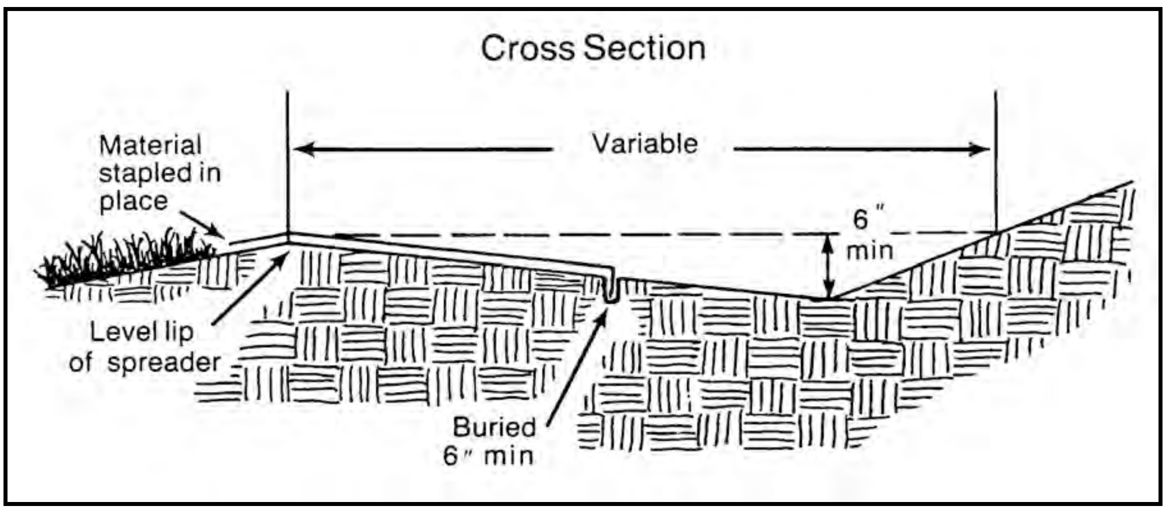
BMP MAINTENANCE

✓ Inspect level spreaders after every rainfall until vegetation is established, and promptly make needed repairs. After the area has been stabilized, make periodic inspections and keep vegetation in a healthy, vigorous condition.

BMP REMOVAL

✓ Removal is not necessary.





Source: FishNet4C

BMP – SANDBAG

DESCRIPTION

A sandbag is a pre-manufactured cloth or plastic bag filled with sand or gravel. Sandbags can be used to keep water away from work areas and unstable slopes, and to construct curb inlet sediment barriers. Sandbags are also used as protection against flooding, as ballast, and in the construction of cofferdams and clean water bypasses.

APPLICATIONS

This BMP may be used during emergencies to control the flow and level of water. It may be used during construction to form dewatered areas such as cofferdams and clean water bypasses.

LIMITATIONS

Do *not* use this BMP where prohibited by permit conditions or as a permanent structure.

\CONSTRUCTION GUIDELINES

1) When using this BMP in water bodies, fulfill appropriate permit conditions.
2) Secure ends of sandbags to ensure material does not scatter.
3) When used as a barrier, stack bags tightly together and in alternative (bricklayer) fashion.
4) Fill bags with clean sand or gravel.

BMP MAINTENANCE

- ✓ During construction, inspect daily with additional inspections during storm s.
- ✓ Replace damaged sandbags.
- ✓ Remove sediment when deposits reach the height of the sandbag barrier.

BMP REMOVAL

- ✓ Evaluate site to determine when BMP is no longer needed.
- ✓ Remove sediment buildup in front of BMP.
- ✓ Remove BMP, recycle and/or re-use if applicable.
- ✓ Revegetate area disturbed by BMP removal and spread material in sandbags on

BMP – SLOPE DRAIN –TEMPORARY

DESCRIPTION

A slope drain is a pipe used to temporarily intercept and divert runoff into stabilized areas. May be used with lined ditches to intercept and direct surface flow away from slope areas.

APPLICATIONS

Slope drains may be used at construction sites where slopes may be eroded by surface runoff.

LIMITATIONS

✓ Severe gully erosion may occur if the drain fails.

CONSTRUCTION GUIDELINES

1) The slope drain should be heavy duty flexible PVC, ABS or comparable pipe.
2) A dike should be used to direct runoff to the drain. The inlet should be lined with filter cloth.
3) The drainage area should be no larger than 10 acres per pipe.
4) Slope should be no greater than 2:1 (H:V).
5) Riprap or other energy dissipation device should be used at the outlet.
6) Drains should be perpendicular to the contour of the slope.
7) Compact soil around and under entrance, outlet, and along the length of the pipe.
8) The drain should be anchored and stabilized into the soil with water tight connections.
9) For drains 12 inches and larger a standard flared end section should be used.

BMP MAINTENANCE

✓ Check connections, inlet and outfall areas frequently for signs of distress to prevent slope drain failure.

Source: FishNet4C

- ✓ Inspect drains before and after rainfall or heavy use for signs of erosion or scour. Additional energy dissipaters or reduced flow may be necessary to accommodate flow.
- ✓ Remove sediment accumulation. If necessary, flush out debris from pipe and trap sediment before it enters a waterway.

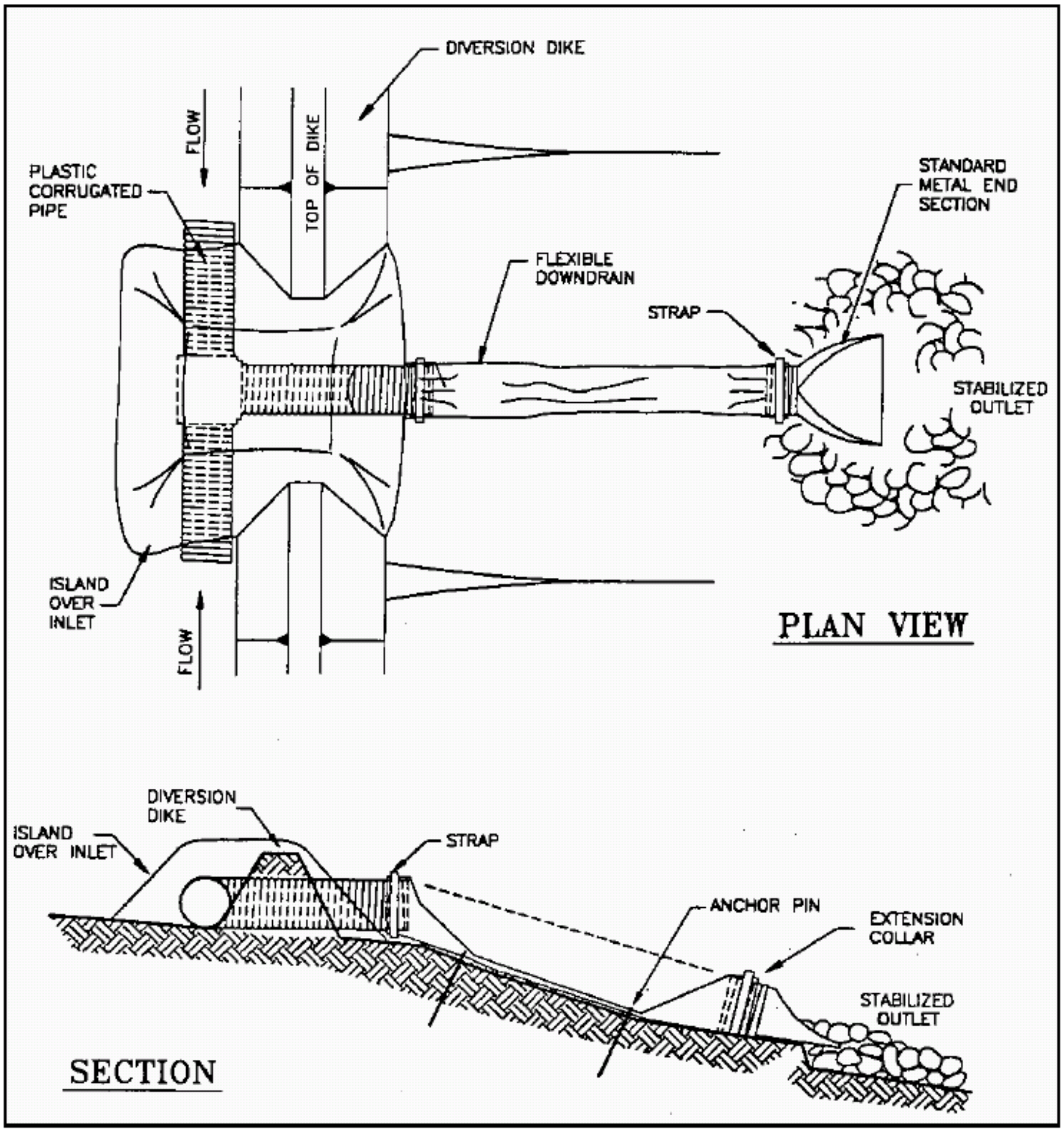
BMP REMOVAL

- ✓ When site is stabilized, remove structure, grade out slope, seed and mulch bare areas.

SOURCE

Caltrans. Storm Water Quality Handbooks: Construction Site Best Management Practices Manual, page SS-11.3, November 2000.

SLOPE DRAIN - TEMPORARY



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

BMP – SLOPE DRAIN –OVERSIDE

DESCRIPTION

A slope drain is a pipe or open chute used to intercept and divert runoff into stabilized areas.

APPLICATIONS

Slope drains may be used to drain certain bench or road way configurations where it is necessary to minimize flow onto cut or fill slopes.

LIMITATIONS

- ✓ Severe gully erosion may occur if the drain fails.

CONSTRUCTION GUIDELINES

1) The slope drain should be heavy duty flexible PVC, ABS, corrugated metal, or comparable pipe. It may be open trough shape (half culvert, lengthwise).
2) A dike should be used to direct runoff to the drain. The inlet should be lined with filter cloth.
3) The drainage area should be no larger than 10 acres per pipe.
4) Slope should be no greater than 2:1 (H:V).
5) Riprap or other energy dissipation device should be used at the outlet.
6) Drains should be perpendicular to the contour of the slope.
7) Compact soil around and under entrance, outlet, and along the length of the pipe.
8) The drain should be anchored and stabilized into the soil with water tight connections.
9) For drains 12 inches and larger a standard flared end section should be used.
10) Drains must be anchored to the slope with water tight connections.

Source: FishNet4C

See also: CalTrans Standard Plans, "Overside Drains," Plan #D87D.
www.dot.ca.gov/hq/esc/oe/project_plans/index.htm

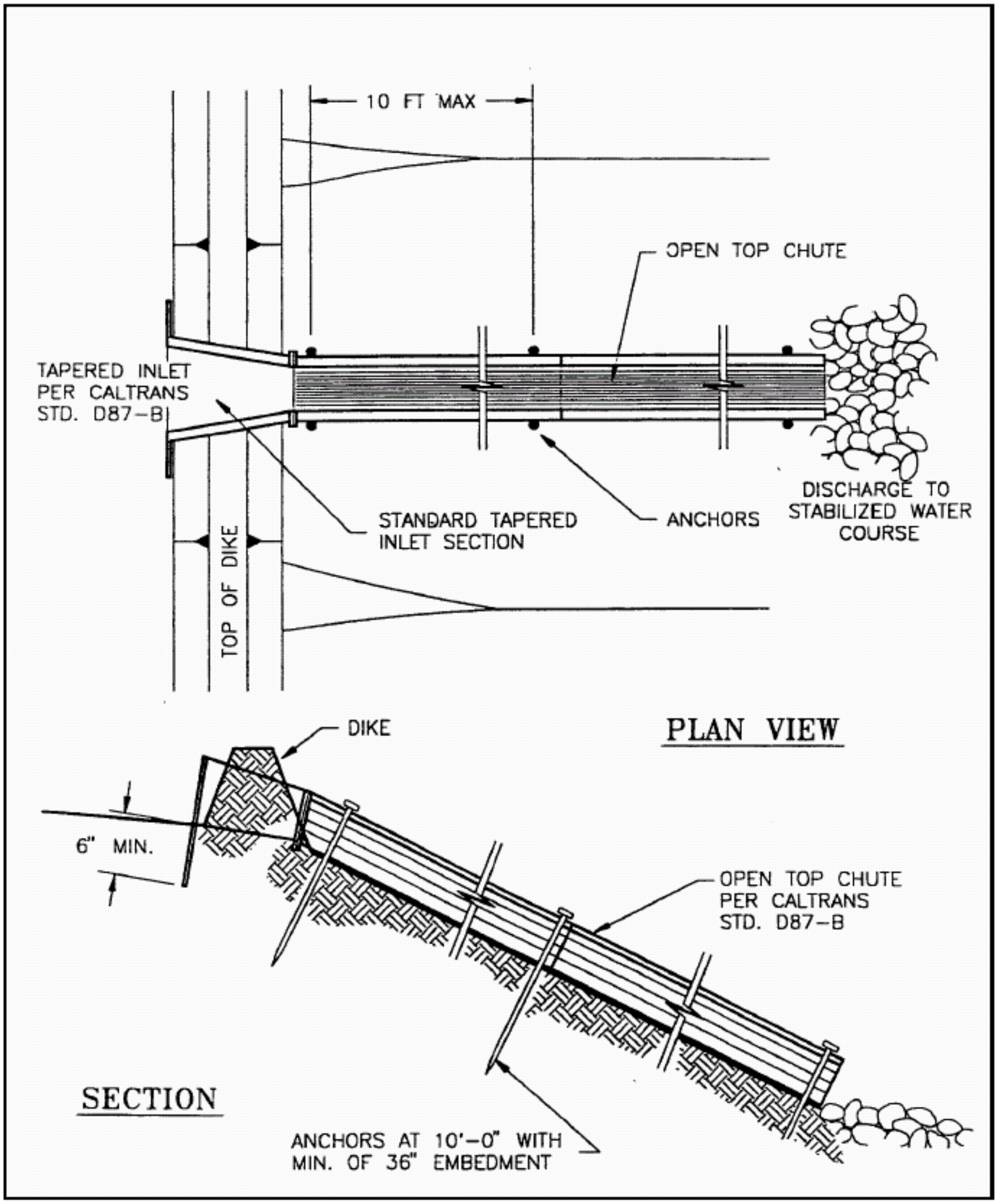
BMP MAINTENANCE

- ✓ Check connections, inlet and outfall areas frequently for signs of distress to prevent slope drain failure.
- ✓ Inspect drains before and after rainfall or heavy use for signs of erosion or scour. Additional energy dissipaters or reduced flow may be necessary to accommodate flow.
- ✓ Remove sediment accumulation. If necessary, flush out debris from pipe and trap sediment before it enters a waterway.

BMP REMOVAL

- ✓ N/A

SLOPE DRAIN - OVERSIDE



Source: McCullah, J. 1992. Erosion and Sediment Control Standards Design Manual – County of Shasta. Prepared for the Western Shasta RCD. Redding CA. 187 p.

✓

BMP – SLOPE DRAIN –SWALE

DESCRIPTION
A constructed water channel excavated into a side hill or built with an earthen dike. Typically built nearly parallel to the hillslope contour with a 2% or greater flowline grade.

APPLICATIONS
Swales or ditches are used to divert and convey surface run-on away from the work site or unstable area, into a stable area in order to prevent erosion. Also used below steep grades where runoff begins to concentrate, at the top of slopes, and as slope breaks.

LIMITATIONS
- ✓ Not suitable as sediment trapping devices
- ✓ May be necessary to use other soil stabilization and sediment controls such as check dams, erosion control blankets, turf reinforcement mat, or rock to prevent scour and erosion in newly graded swales.

CONSTRUCTION GUIDELINES

1) Slope drain swales must be correctly sized to accommodate the flows of the contributing watershed.

2) Conveyances must be stabilized by compaction, vegetation, matting and/or hard armor depending on the calculated flow velocity.

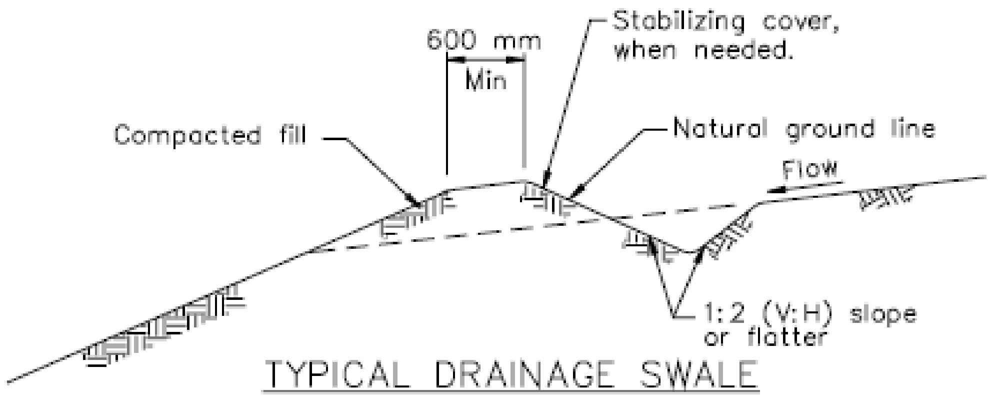
3) Water should be outlet back to the natural watercourse as soon as possible and not diverted into another watershed if possible.

4) Provide stabilized outlets.

BMP MAINTENANCE
- ✓ Inspect newly constructed swales prior to the rainy season, after rainfall events, and regularly during the rainy season.
- ✓ Replace lost riprap, lining, or soil stabilizers as needed.
- ✓ Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment, and repair linings and embankments as needed.

BMP REMOVAL
- ✓ If temporary, remove as soon as the surrounding drainage area has been stabilized, recontour the slope, seed and mulch bare areas.

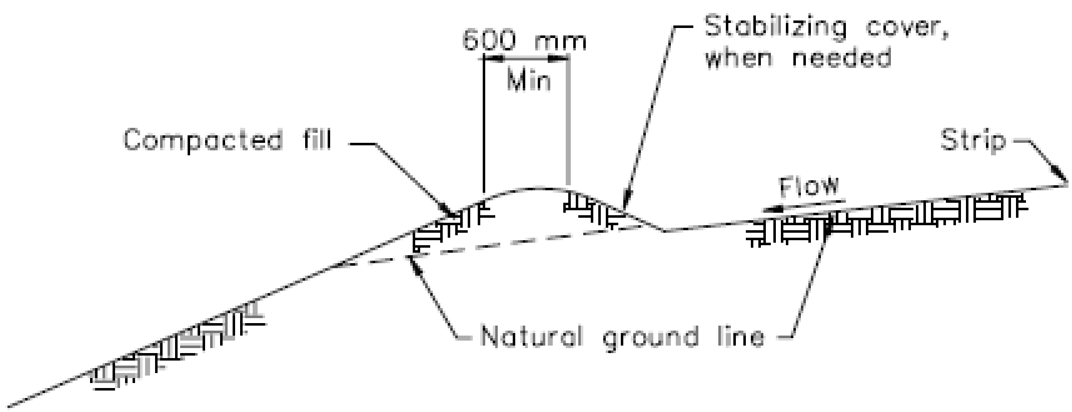
Source: FishNet4C



TYPICAL DRAINAGE SWALE
NOT TO SCALE

NOTES:

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



TYPICAL EARTH DIKE
NOT TO SCALE

Source: Caltrans Storm Water Qaulity Handbooks: Construction Site Best Management Practices Manual. March 2003. Section 3, SS-9.

BMP - STREAM BYPASS (WATER DIVERSION)

DESCRIPTION

A stream diversion is a temporary bypass through a pipe, flume, or excavated channel that carries water flow around work areas.

APPLICATIONS

Commonly used for culvert installation or replacement. Where possible, a stream diversion should be the first choice to control erosion and sediment during the construction of culverts or other instream structures.
Maintaining a live channel is always the utmost priority. Therefore, we recommend a partial bypass. [BL: New NOAA comment. Also, NOAA says “Pumps should not be used” and “Stream diversions should not be used”. I’m obviously missing something - They’re not asking to remove this entire BMP, are they?]

LIMITATIONS

The stream diversion technique you use depends upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project.

Advantages of a pumped diversion include:

- ✓ Downstream sediment transport can almost be eliminated.
- ✓ De-watering of the work area is possible.
- ✓ Pipes can be moved about to allow construction operations.
- ✓ The dams can serve as temporary access.
- ✓ Increased flows can be managed by adding more pumping capacity.

Some disadvantages of a pumped diversion are:

- ✓ Flow volume is limited by pump capacity.
- ✓ Requires 24-hour monitoring of pumps.
- ✓ Sudden rain could overtop dams
- ✓ Creates in-stream disturbance to install and remove dams.

Source: FishNet4C

Advantages of excavated channels and flumes are:

- ✓ Isolates work from water flow and allows dewatering
- ✓ Can handle larger flows than pumps.

Disadvantages of excavated channels and flumes are:

- ✓ Bypass channel or flume must be sized to handle flows, including possible floods.
- ✓ Channels must be protected from erosion.
- ✓ Flow diversion and then re-direction with small dams causes in-stream disturbance and sediment.

Do *not* use stream diversions;

- ✓ without identifying potential impacts to the stream channel.
- ✓ until all necessary permits have been obtained. A stream bypass is a potentially serious "taking" issue and is not a routine road maintenance BMP (for information on incidental take permits for fish habitats, see Chapter 2-Permits).

CONSTRUCTION GUIDELINES

1) Guidelines vary based on existing site conditions.

2) The preferred option is a partial bypass, which maintains a live stream channel.

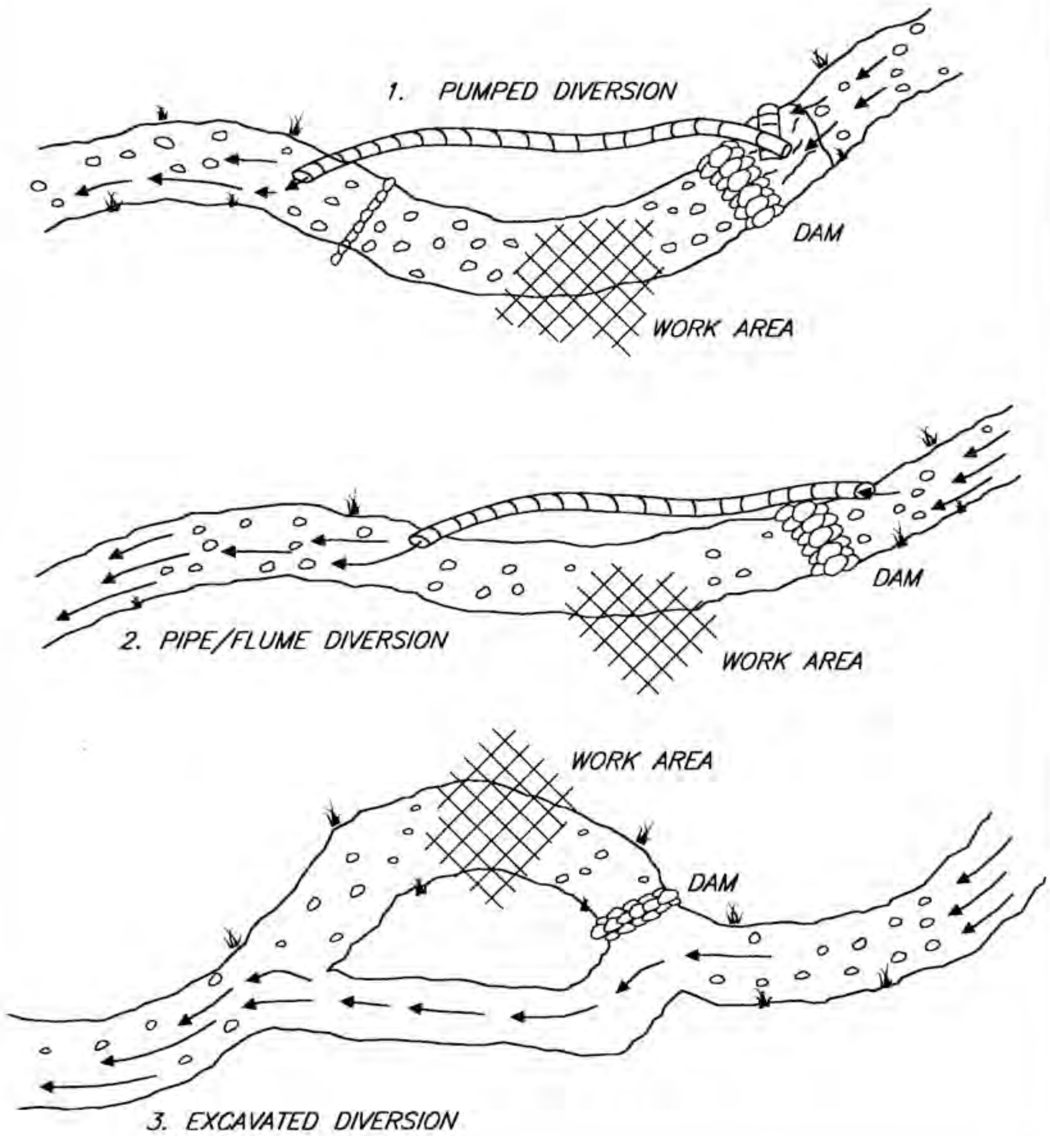
3) Size pipes adequately to allow fish passage.

BMP MAINTENANCE

- ✓ Closely monitor and maintain all stream diversions
- ✓ Pumped diversions require 24-hour monitoring of pumps

BMP REMOVAL

- ✓ Once the work is completed, remove the stream diversion and redirect the flow through the new culvert or back into the original stream channel.



TYPICAL STREAM DIVERSION TECHNIQUES

FILE: Stream Diversion

Source: FishNet4C

STREAMBANK PROTECTION BIOTECHNICAL BMPS

Source: FishNet4C

BMP – BRUSH MATTRESS

DESCRIPTION

A brush mattress or brush mat is a revegetation technique that provides a protective covering to a slope or streambank as soon as it is installed. A brush mattress is typically constructed using live willow branches or other species that root easily from cuttings, but can also be constructed with any brushy, woody branches in order to provide immediate and effective slope protection.

Brush mattresses quickly stabilize a slope or streambank by providing a dense network of branches, which prevent superficial erosion, while also collecting soil and native seeds. The overlapping branches provide an ideal environment for native seeds to germinate and establish. As the live branches root and grow, the soil is reinforced with an underground matrix of spreading roots. If used on streambanks, a brush mat traps sediments during high water, and eventually the plant growth on the stabilized streambank provides aquatic habitat. Brush mattresses work well for stabilizing reconstructed stream channels, as they provide immediate cover for fish and instant bank protection, even before they become established and grow.

Of all the streambank biotechnical practices, brush mattresses can withstand the highest velocities. Studies conducted by Christoph Gerstgraser, (Universitat fur Bodenkultur, Vienna, Austria), demonstrated that brush mattresses stabilized the bank in a test flume against velocities exceeding 7 mps (20 f/s), while other techniques, even rock riprap, failed.

APPLICATIONS

Brush mattresses are ideal for eroding streambank slopes where immediate protection is needed. Installing a brush mattress along an eroding reach can rapidly stabilize streambanks in danger of being scoured due to high erosive forces.. The mattress's dense layer of brush helps deflect water from the bank and protect it from scouring, while also providing habitat directly along the water's edge.
Brush mattresses also work well for shoreline protection. The mat's density breaks the impact of waves and instantly provides a thick protective layer of brush along the shoreline.
If the desire is to stabilize and revegetate an eroding streambank or shoreline and discourage foot trails along sensitive areas, brush mats work well as impenetrable barriers, giving time for vegetation to become established. On slopes, brush mattressing provides rapid protection against superficial erosion. Brush mats are often combined with other soil stabilization techniques such as vegetated riprap, wattles, live facines, root wads, live siltation, or coir logs, which may be needed to secure the toe of the slope. The brush mattress technique is usually most effective on slopes no steeper than 2H:1V.

For gully repair on steeper slopes, see *Sediment Control- Brush Packing*.

LIMITATIONS

- ✓ A brush mattress requires large numbers of cuttings, probably more than any other biotechnical method. Carefully evaluate availability of plant material before including this technique in a revegetation design.
- ✓ Brush mat installation is a labor-intensive construction method.
- ✓ In areas with little rainfall, brush mattresses installed on dry slopes may not survive long, as this technique does not entrench the branches deeply into the soil.
- ✓ If constructing a brush mattress on a streambank, do not leave loose overhanging branches. They may catch on material floating down the stream channel and the mattress may be ripped from the streambank.
- ✓

CONSTRUCTION GUIDELINES

1) Use wooden construction stakes and/or live stakes (such as willow). The length of stakes will vary based on soil conditions. Biodegradable natural fiber rope is usually preferable to wire.

2) Prepare the slope or streambank by clearing away large debris, and grading the slope so that branches will lie flat on the bank. Do not disturb the slope or bank any more than necessary.

3) Excavate a horizontal trench, 8 to 12 inches deep, at the toe of the streambank or at the base of applicable area on the slope. The basal ends of the branches should extend into moist soil.

4) Lay the cuttings flat against the graded slope, slightly crisscrossed, with the basal ends placed as deeply into the trench as possible. Continue to lay the cuttings along the face of the bank or slope until about 80% groundcover is achieved (about 6-12 inches thick).

5) If the cuttings are shorter than the slope or bank,, stagger and overlap the cuttings so the entire area has adequate coverage.

6) You may plant rooted plants within the brush mattress, before the branches are laid. It is too difficult to plant through the mattress afterward.

7) Pound in a grid of 24 to 36 inch long stakes into the mattress at 3 to 4 foot centers (see typical drawing: Brush Mattress). Do not pound the stakes completely in, as this will be done after tying. Use longer stakes in less cohesive (sandy) soil.

8) Secure the brush mattress by using cord, rope, or 10-12 gauge-galvanized wire tied in a diamond pattern between each row of stakes. (Tie the cord or wire to the stakes in such a manner that if it breaks, the integrity of the remaining cord or wire is still maintained). Notching or drilling stakes may make securing cord or wire to stakes easier, but is not necessary.

9) After networking the mattress with cord or wire, drive the stakes in further to compress the mattress tightly against the slope.

10) Secure the toe of the mattress using the technique best suitable for the site conditions. To secure the toe of the mattress using a willow wattle, first construct a wattle the length of the area to be treated (see wattle technique). Make sure the wattle is tied together tightly. Place the wattle in the trench over the cut ends of the brush mattress. Secure the wattle with 18 to 48 inch long wedge-shaped wooden stakes every 3-4 feet. In some cases, such as small streams or gentle slopes, simply placing large locally collected rocks around and on top of the basal ends of the cuttings is enough to secure the toe of the mattress. Other techniques that may be used include vegetated riprap, wattles, live facines, rootwad revetments, live siltation, or coir logs.

11) Backfill around and in between the branches of the mattress by using material excavated from the trench, working the soil in well. Buckets of water will help to wash the soil down into the stems. It is most important for the thicker, basal ends of the mattress to get good soil cover for rooting, but generally cover at least 1/4 of the depth of the mattress with soil. If installed along a stream, make sure the upstream end of the mattress and wattle is keyed into the streambank to prevent high flows from scouring behind the mattress. It is also a good idea to protect this area with some revetment, large rocks, or tree trunks. If possible, tie the mattress to existing vegetation or roots on the bank for extra security.

12) Cover entire mattress with a thin layer (1 to 1.5 inches) of fine dirt.

BMP MAINTENANCE

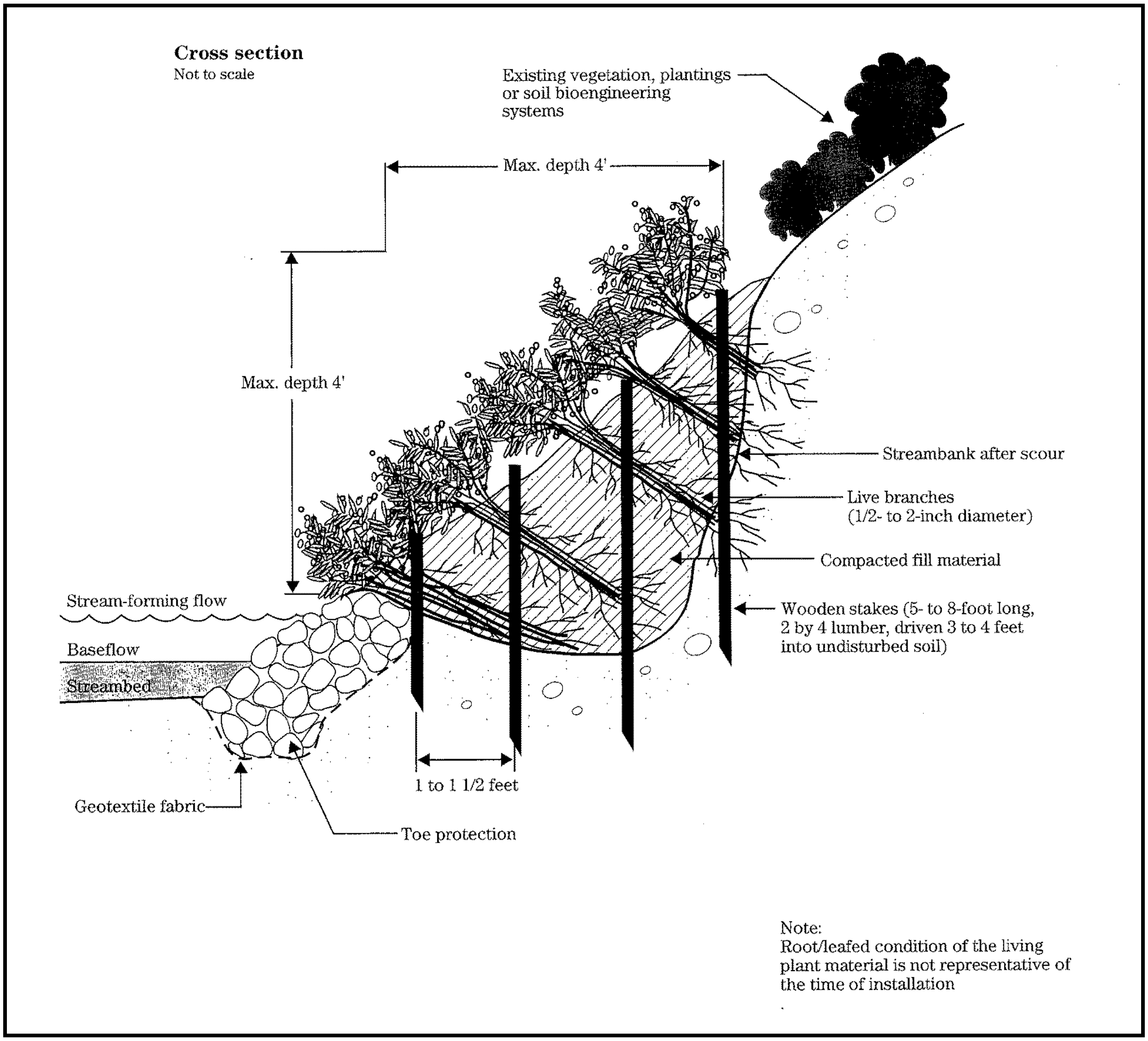
✓ Make sure you periodically monitor the brush mattress after it has been installed. This will provide valuable insight into the stabilization process and for future biotechnical projects. If the willow does not grow, the mattress will still provide stability, especially if it is backfilled and seeded with native grasses, sedges, or rushes.

✓ Periodic maintenance includes making sure the stakes and cord/wire are still securing the mattress to the streambank. Carefully check the upstream end to make sure flows are not getting behind the mattress.

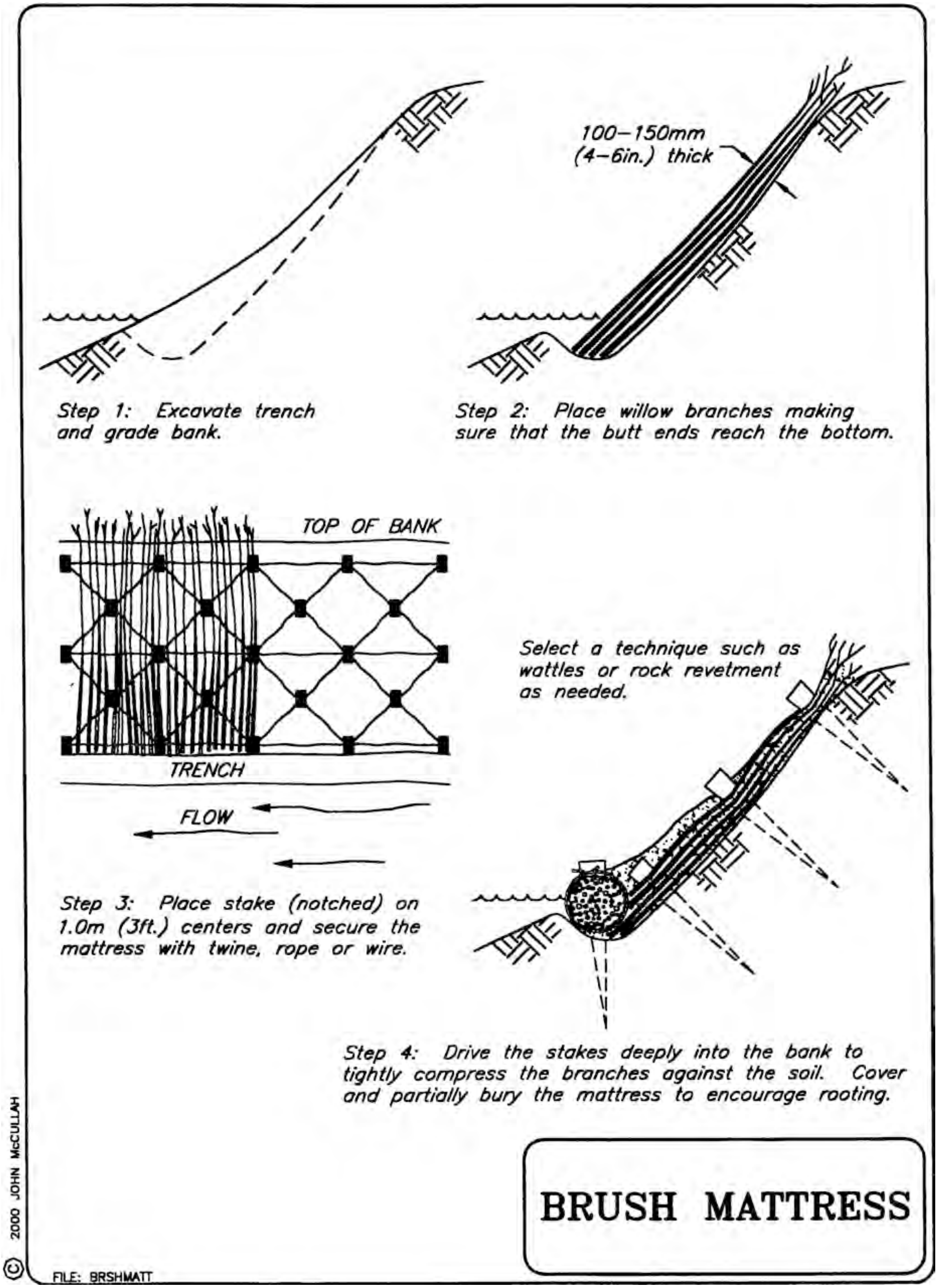
✓ Irrigate through first two growing seasons.

BMP REMOVAL

✓ BMP removal is not necessary.



Note: CDFG encourages planting to below bankfull elevation and the addition of large woody debris (see B-7.4). Source: USDA Natural Resources Conservation Service. 1996. Engineering Field Handbook – Streambank and Shoreline Protection. Part 650, Chapter 16.



Source: FishNet4C

BMP - HARVESTING AND HANDLING OF WOODY CUTTINGS

DESCRIPTION

Proper harvesting and handling of live woody cuttings is essential to plant growth establishment. Cuttings must be harvested at optimum times of the year and safely transported without drying out. Willow and cottonwood species are typically used. See also BMP – Planting; BMP – Fabric Reinforced Earth Fill with Brush Layering (Vegetated Geodrid).

APPLICATIONS

Live woody cuttings are used in riparian plantings for habitat enhancement and streambank stabilization projects using soil bioengineering.

LIMITATIONS

- ✓ There may be limited quantities of harvestable cutting within a reasonable distance from the project site. Native cutting should ideally be from the watershed in which the project is implemented.
- ✓ There is a limited period during which cuttings can be collected and planted. The ideal time in Northern coastal California is October through January, although cuttings may be taken as early as August if the planting site is properly irrigated.
- ✓ Planting woody cuttings in the spring is not recommended as the plant's energy goes primarily to leaf production with an accompanying high evapo-transpiration demand at that time, especially on south facing slopes with coarse textured soils.
- ✓ Site conditions must be conducive to growth of the selected species: soil texture, moisture, and site aspect must be considered.

CONSTRUCTION GUIDELINES

1) Choose the right species from either the *Salix* (willow) or *Populus* (cottonwood) genus, depending upon what is growing naturally in the area. Plant form or structure (tree or shrub) may be an important criteria depending on the project goals (e.g., willowfly catcher habitat = shrubby vs. flood conveyance = tall, over-arching, shading). The willow genus includes low-growing, multiple stem shrubby species (arroyo, sandbar willow) and taller single stem forms (red, black, and yellow).

2) Hardwood cuttings are generally divided into three categories: Sprigs (or stakes) that are 0.75 to 1.5 inches in diameter and 36 to 48 inches long; Poles that are 1.5 to 3 inches in diameter and 5 to 8 feet long; and Branch Cuttings or Weavers which are no thinner than 1/2 inch and 6 to 12 feet long depending on the application (wattles, layering, willow wall revetments).

3) A good source of willow is along road right-of-ways. Another possible source is along drainage or irrigation canals. Donor trees or areas of trees from which cuttings are taken shall be pre-approved by project manager or biologist. No more than 50% of an existing cottonwood or willow clump shall be removed, unless the clump is scheduled to be removed by grading. Try to remove cuttings from inside the crown of the existing plant and spread the harvesting activity throughout the stand to minimize visual impact. No cuttings shall be taken from within 40 feet of a willow or cottonwood with an active bird nest in it.

4) Cuttings shall be cut clean with sharp hand saws or loppers. Branches of sprigs and poles shall be pruned off with sharp shears close to the main stem but just outside the branch collar. Some side branches may be left on the branch cuttings intended for brush layering and fascines. Trim the terminal bud (the bud at the growing tip) so the plant energy will be rerouted to the lateral buds and adventitious tissue. Cuttings with swelling, scar tissue, boring insects, or disease shall be rejected. Cuttings shall be cut from live healthy materials. The bottom end of the pole shall be cut at a 45° angle (approximately) and the top shall be cut flat, straight across (90° to the length of the pole).

5) <u>Transportation</u>: During cutting and transportation, keep cutting moist and in the shade by using wet burlap or wet sawdust and tarps. Never let the cuttings dry out or be exposed to sunlight until planted.!

6) <u>Storage</u>: Ideally, cuttings should be planted within 48 hours of harvest. Between time of harvest and planting, the bottom ends of the cuttings must be submerged and the tops kept moist. They should be soaked in a pond or river backwater and kept in the shade.

7) <u>Installation</u>: In most cases, a 1.5 foot radius area around the planting spot should be bare mineral soil. A planting hole may be prepared using an auger, water-jet, or by pounding a foundation stake into the ground (depending on planting depth). When the stake is pounded, the top should be protected with a cap or wire wraps, and any splits should be cut off. Ideally, the cutting should be long enough to extend into the capillary fringe of the water table. A minimum of two-thirds of the cutting should be below the ground surface.

BMP - LARGE WOODY DEBRIS REVETMENT

DESCRIPTION

Large woody debris (LWD) is any large piece of woody material generally defined as 6 inches and larger in diameter and at least 10 feet long, including the trunk and root mass, including stumps or rootwads.

APPLICATIONS

When incorporating woody material into projects, it is necessary to identify the desired performance and habitat benefits. Each project must be specifically tailored to meet the objectives identified for the habitat and any structures to be protected. It can be used in combination with other BMPs.

LWD in coastal streams creates exceptional habitat for salmonids and should be properly sized at 1.5 times channel width.

LIMITATIONS

Do *not* use this BMP:

- ✓ without identifying potential impacts to upstream and downstream banks, structures and facilities.
- ✓ when specific design requirements and desired habitat benefits have not been identified.
- ✓ in or adjacent to water bodies until all necessary permits have been obtained.

CONSTRUCTION GUIDELINES

1) Guidelines will vary based on existing site conditions, size and shape of the wood, forces exerted by moving water, etc.

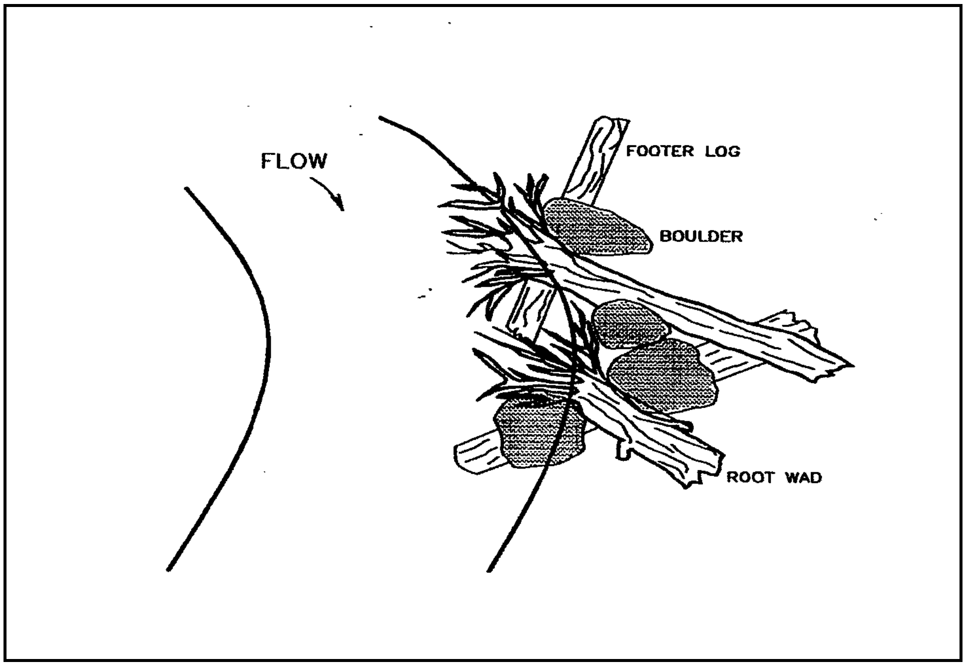
2) Construct in accordance with design and permit conditions.

BMP MAINTENANCE

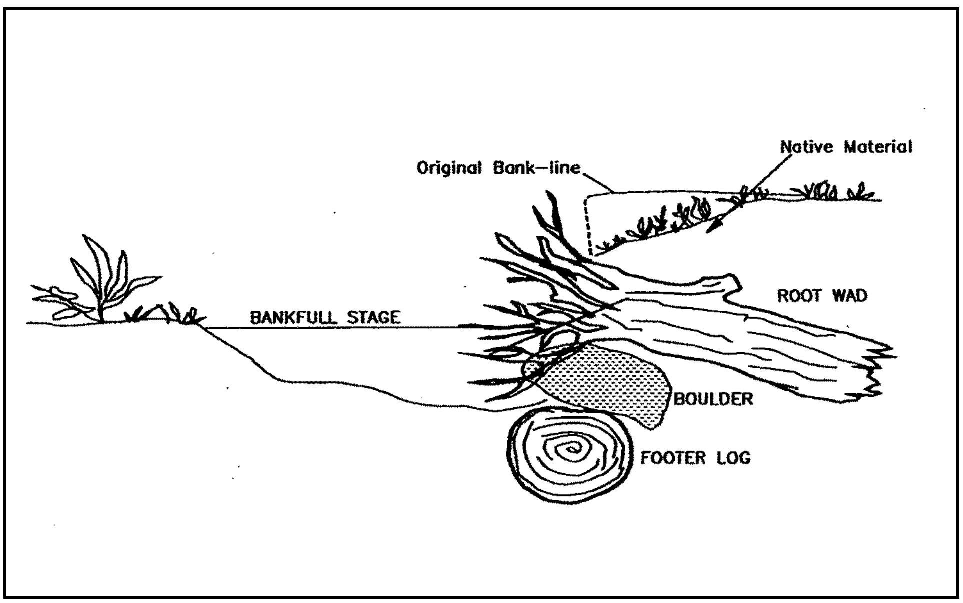
- ✓ Monitor large woody debris installed to ensure it remains as built. Consult as necessary for adjustments and/or modifications to large woody debris installations.

Source: FishNet4C

Large Woody Debris Revetment

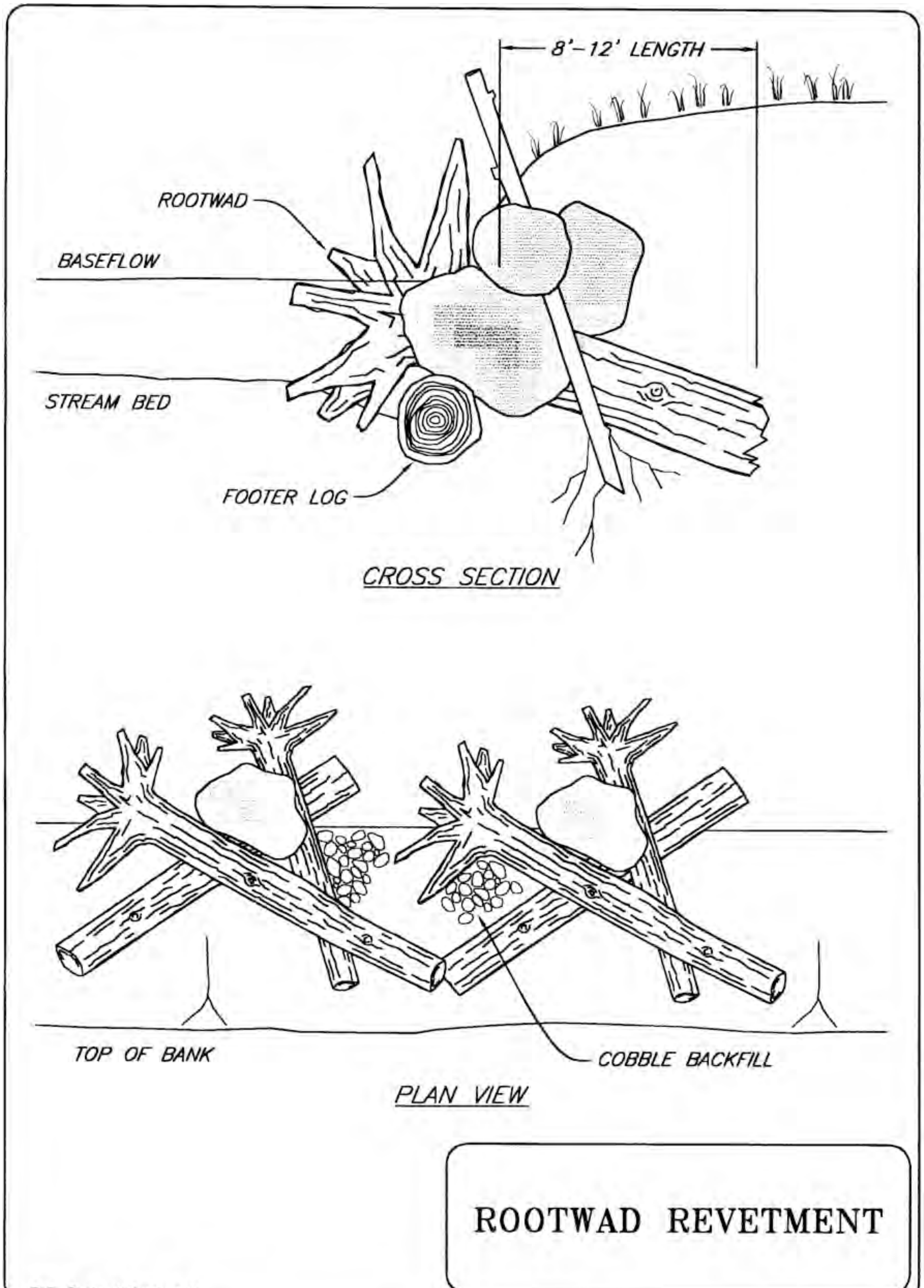


Native material revetment – Plan View. (After Rosgen, 1993)

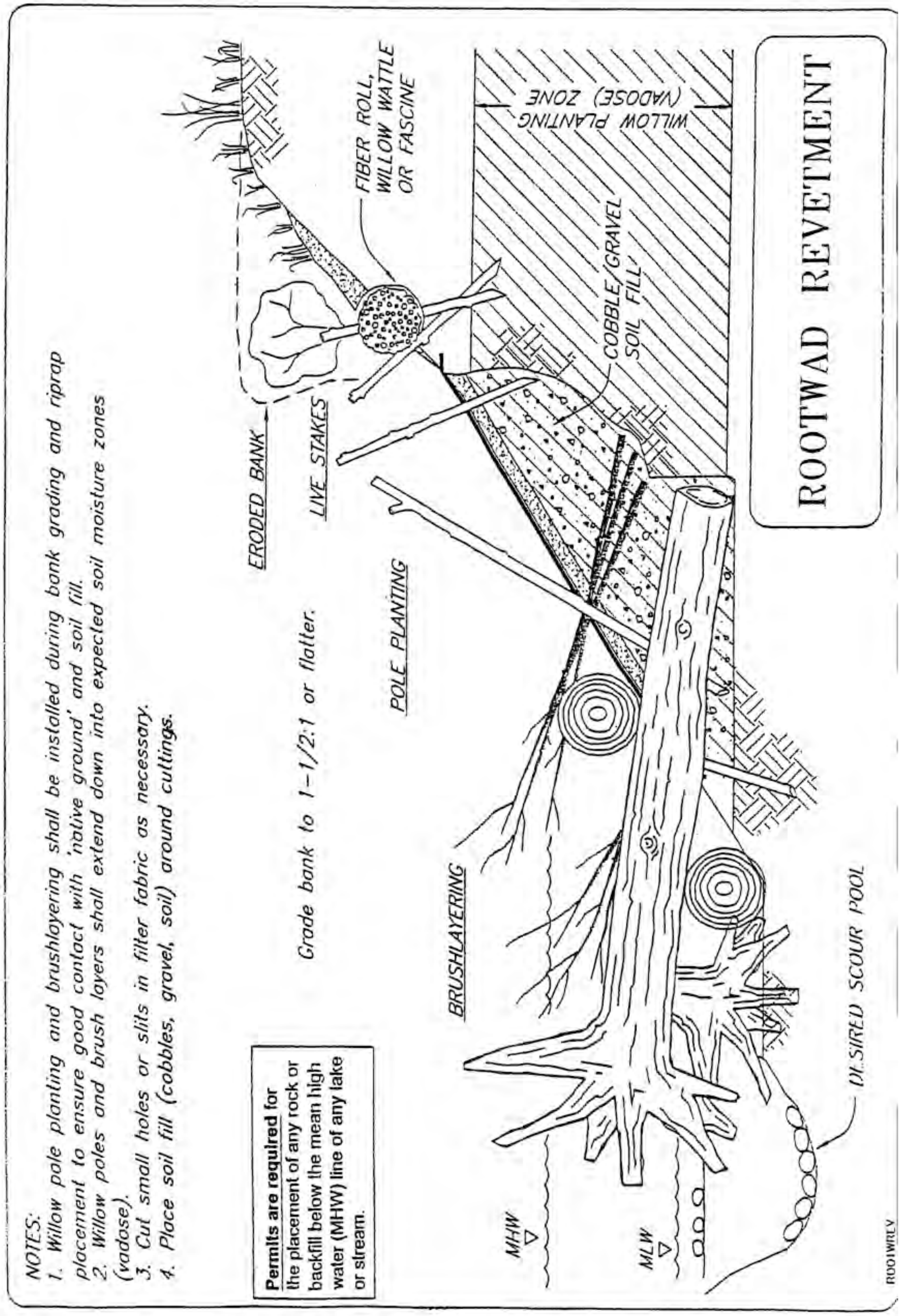


Native material revetment – Side View. (After Rosgen, 1993).

Source: California Dept. of Fish and Game (CDFG). 1998. California Salmonid Stream Habitat
Restoration Manual. By Gary Flosi, et al. 3rd edition. Sacramento, CA.



Source: FishNet4C



Source: FishNet4C

BMP – WILLOW WALL REVETMENT

DESCRIPTION

A living revetment built along an eroding stream bank to rebuild the bank and protect it from further erosion.

APPLICATIONS

Useful for stream bank protection and re-construction in small to medium river systems. As a living system, the roots grow into the fill soil forming a flexible, porous structure. Provides valuable stream bank habitat for aquatic and terrestrial species.

LIMITATIONS

- ✓ Not suitable for deeply slumped, landslide areas.
- ✓ Drainage areas should be relatively small (generally less than 2,000 acres) with stable streambeds.
- ✓ The system must be built during low flow conditions. May need to divert water around the site and/or dewater.
- ✓ Live cuttings should be taken no earlier than the end of August and kept moist until the rainy season.
- ✓ Willows require nearly full sun conditions to be vigorous. Not to be used in heavy shade. Check to see if willows are growing in the area to confirm if this technique can be used.
- ✓ Maximum height of revetment is three feet, but can be constructed in multiple stair-step under the right moisture regime.
- ✓ Not to be used in a down-cutting stream.

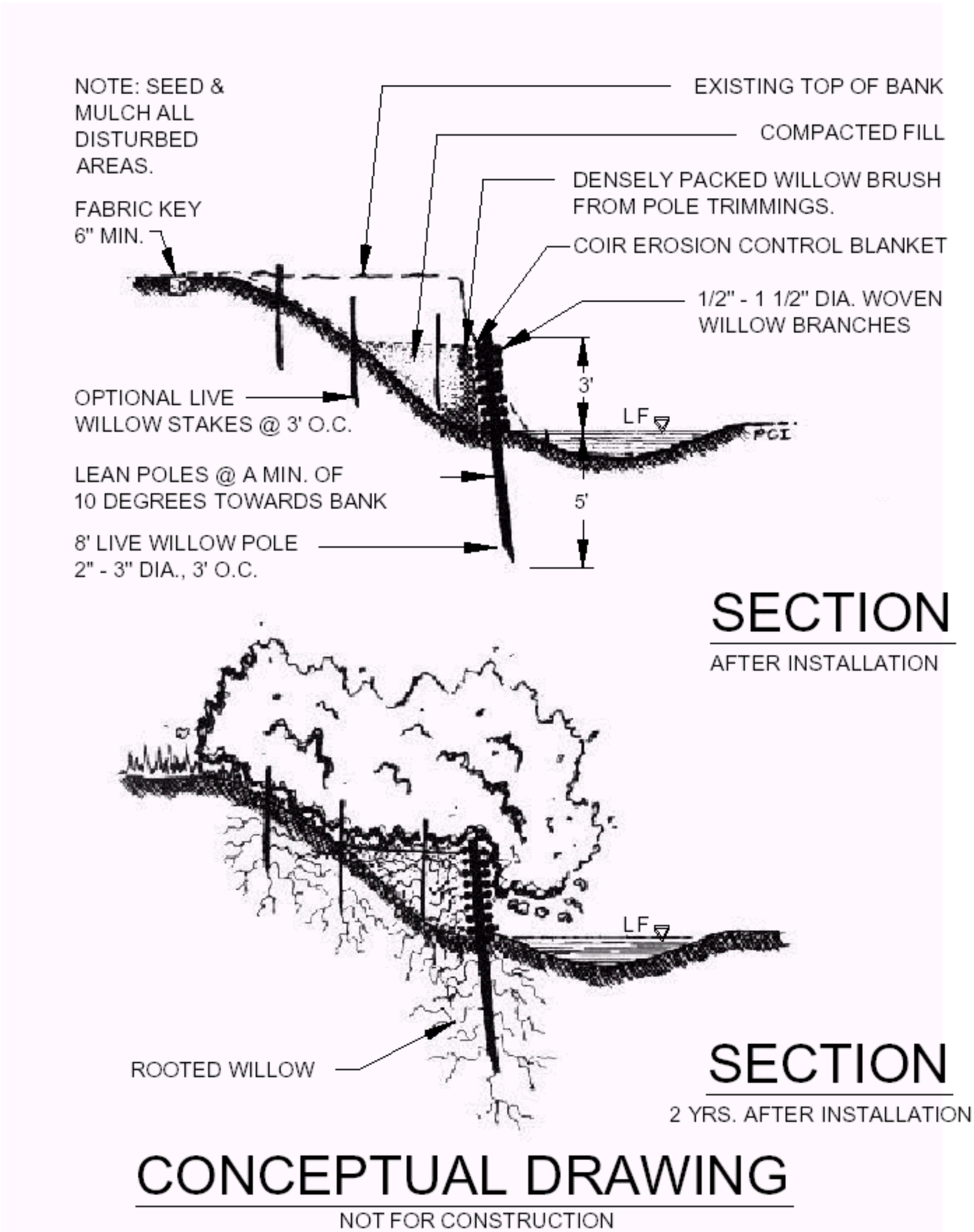
CONSTRUCTION GUIDELINES

1) See drawing for details.
2) Toe of wall starts between the low flow and bank full level. Lay out post positions at 3-foot intervals to conform to bank. Upstream and downstream ends must be tucked into a stable bank feature or keyed with rock.
3) If toe scour is an issue, a boulder toe may be required.

Source: FishNet4C

BMP MAINTENANCE

- ✓ Keep soil and live cuttings moist by overhead irrigation until the rainy season begins.
- ✓ Keep livestock away from the live cuttings. If possible protect from deer for the first year.



Source:
©Prunuske Chatham, Inc.
Occidental, CA

WILLOW WALL REVETMENT

BMP - LIVE POLE DRAIN

DESCRIPTION

A live pole drain is a biotechnical and reclamation technique intended to drain excess moisture away from an unstable site. The plants used to construct the bundles (willow) will sprout and grow, with the moisture continuing to drain from the lower end. The bundles of cuttings are usually placed in shallow trenches in a manner that they intersect and collect excessive slope moisture. That excess water is then allowed to drain onto a stabilized area.

APPLICATIONS

This BMP may be used on unstable slopes, landslide repairs, and small slumping gullies.

LIMITATIONS

- ✓ Live pole drains are not effective in larger, well defined channels with concentrated flows, as the pole drains will simply plug the channel and cause more erosion as the channel adjusts to maintain capacity.
- ✓ Installation should be conducted at times of the year when weather conditions are cool and moist and the plant material is dormant.

CONSTRUCTION GUIDELINES

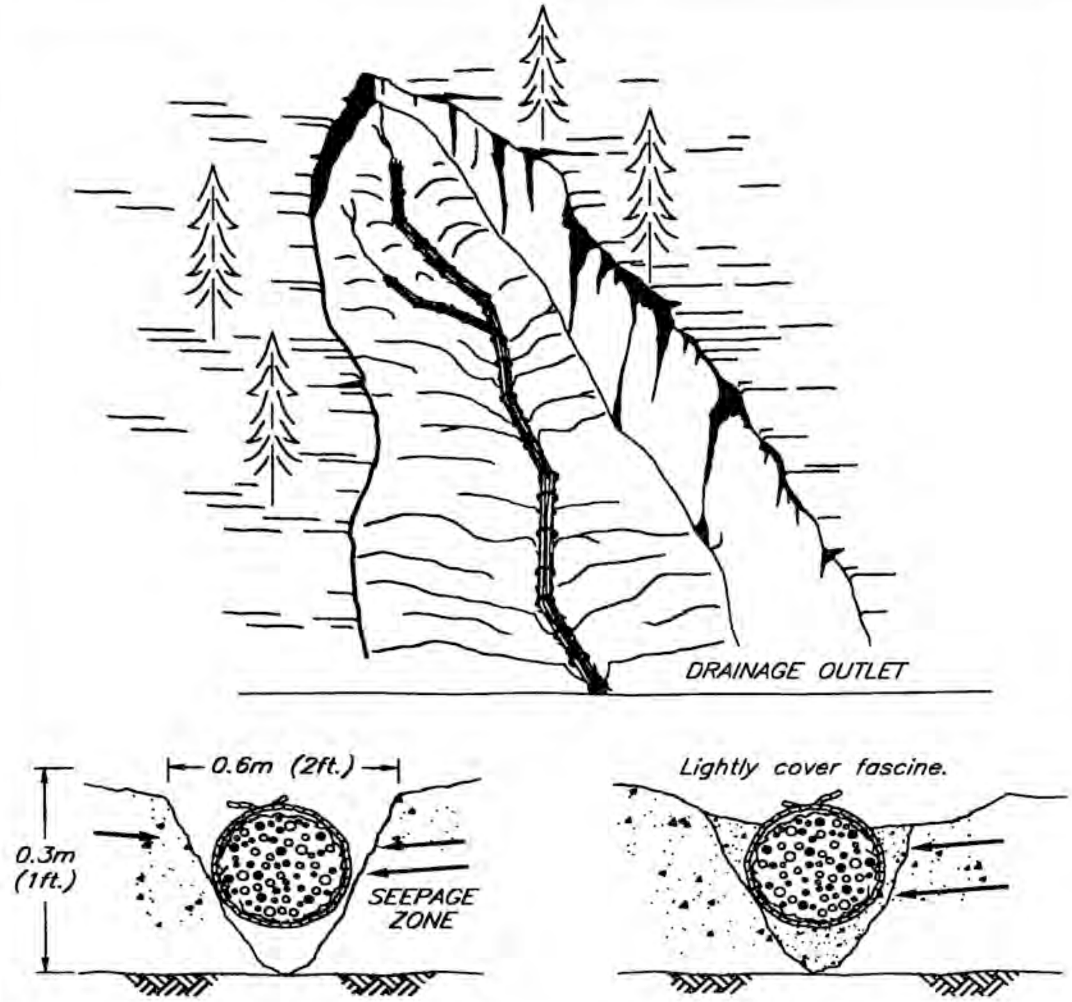
1) Install the drains in the areas of seepage, either by excavating a shallow trench or utilizing an existing drainage gully, so the drains intercept and control the excess moisture. Use wattle/fascine techniques to construct the bundles. The bundles should be tied tightly with twine or rope. Place the bundle of cuttings in the trench. Construct side drains as needed. Key the bundles into each other by jamming the ends firmly together.

2) Use construction stakes and/or live stakes to hold the fascines in place. Insert the stakes adjacent to the rope ties for additional support. Stake the pole drains at 3-6 foot intervals. Lightly backfill the bundles with native soil. Some twigs and branches should be left above the ground as the willow material requires some sunlight exposure to grow.

BMP MAINTENANCE

- ✓ Conduct regular inspections and maintenance, particularly during the first year.
- ✓ Immediately correct and repair failures of fill or drainage structures.

Source: FishNet4C



Excavate a shallow trench or utilize existing "seepage gully" (small<2ft.²).

Place bundle of cuttings (fascine) in the trench and lightly backfill with native material.

NOTES:

1. Live pole drain is a biotechnical/reclamation technique which drains excess moisture from the site and provides an initial cover of woody vegetation.

2. The cuttings used to form the fascines are intended to sprout and grow while the excess moisture continues to drain from the lower end.

3. The key to successful live pole drain construction is to establish the drains in the area of seepage so they provide a controlled alternative for excess moisture to escape.

LIVE POLE DRAIN

© 2000 JOHN McCULLAH

FILE: LIVEPOLE

Source: FishNet4C

BMP - LIVE STAKES

DESCRIPTION

Live staking involves the insertion of live, vegetative cuttings into the ground in a manner that allows the cutting (stake) to take root and grow. This BMP is used to reduce the potential for soil to become water borne, to reduce water velocity and erosive forces, and to aid in habitat protection. Poles used in willow walls and through rip rap may be a structural application. Sprigs may be used in individual planting spots along a streambank. See *BMP- Harvesting and Handling of Woody Cuttings.*

APPLICATIONS

This BMP may be used to repair small slips and slumps, to reinforce or enhance stream banks, and to anchor and enhance the effectiveness of wattles, fascines, straw logs and other erosion control materials. It may also be used in conjunction with approved rip rap installations (vegetated rip rap).

LIMITATIONS

Do *not* use this BMP:

- ✓ where vegetation growth will interfere with maintenance or facility access.
- ✓ where vegetation growth will create safety issues.
- ✓ for immediate soil stabilization results.

CONSTRUCTION GUIDELINES

1) Before cutting and gathering materials, see *BMP Harvesting and Handling of Woody Cuttings* to ensure greatest success for plant material to sprout and grow.

2) Live staking must be implemented during the dormancy period of chosen plant species, late fall to winter (October through January is ideal in Northern Coastal California). If native willows or cottonwood are not found in the vicinity, live staking may not be a good option.

3) Hardwood cuttings are generally divided into three categories: Sprigs (or stakes) that are 0.75 to 1.5 inches in diameter and 36 to 48 inches long; Poles that are 1.5 to 3 inches in diameter and 5 to 8 feet long; and Branch Cuttings or Weavers which are no thinner than 1/2 inch and 6 to 12 feet long depending on the application (wattles, layering, willow wall revetments).

4) Don’t allow stakes to dry out. Soak all cuttings in water for a minimum of 24 hours. Soaking significantly increases the survival rate of the cuttings; however, they must be planted the same day they are removed from water.

5) Use an iron stake or bar to make a pilot hole in firm soil. Plant the stakes butt-ends into the ground, with the leaf bud scars or emerging buds always pointing up. Be careful not to damage the buds, strip the bark or split the stake during installation. Plant stakes at random in the most suitable places at a rate of 2-5 cuttings/square yard. Do not plant the stakes in rows or at regular intervals.

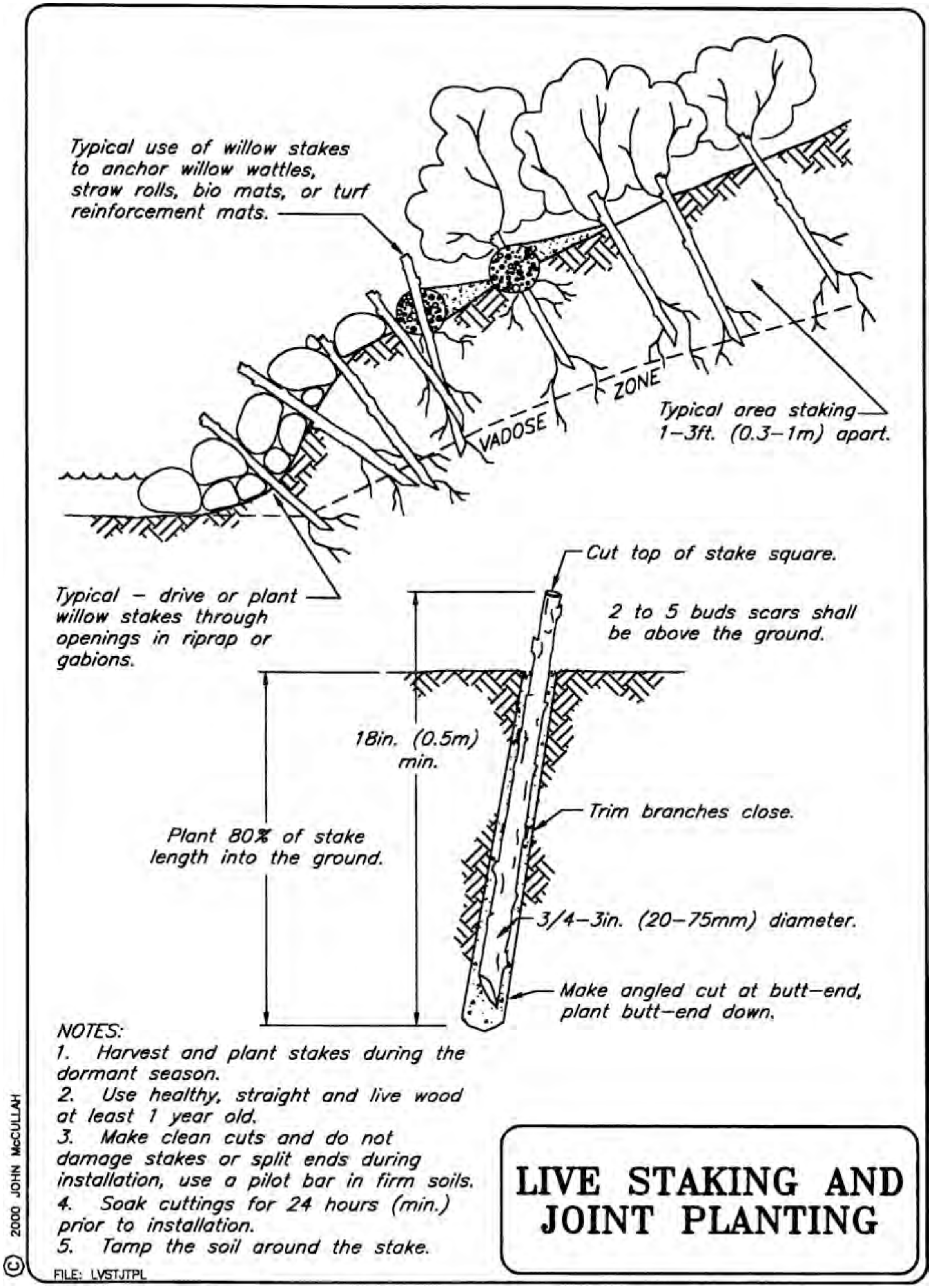
6) Set the stake as deep as possible into the soil, preferably with 80 percent of its length into the soil and in contact with mid-summer moist soils. The stake should protrude only to a maximum of one-quarter its length above the ground level to prevent it from drying. Stakes should be cut so that cutting extends above competing herbaceous vegetation. At least 2 buds and/or bud scars shall be above the ground after planting. It is essential to have good contact between the stake and soil for roots to sprout. Tamp the soil around the cutting. Do not fertilize.

BMP MAINTENANCE

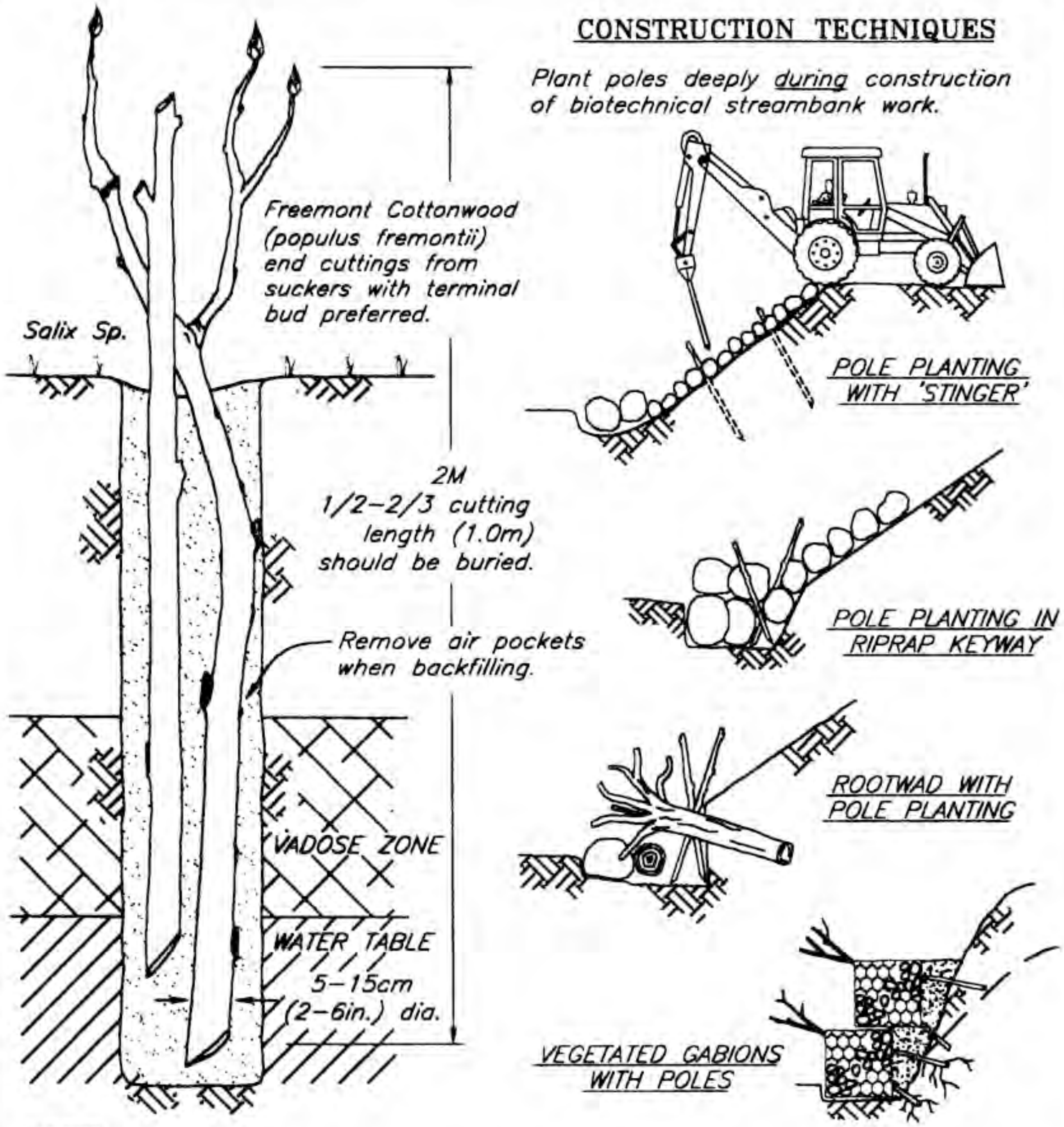
- ✓ Periodic inspection, repair and maintenance will be done in accordance with permit requirements. If no permits are required, vegetation will be monitored for the first two years or until the vegetation is established.
- ✓ Staked area may need to be watered during summer months.

BMP REMOVAL

- ✓ BMP removal is not necessary.



Source: FishNet4C



NOTES:

1. *Pole cuttings of willow or cottonwood are longer and have a larger diameter than branch cuttings or live stakes.*
2. *Larger diameter cuttings have a greater supply of stored energy (stored photosynthesis) than smaller diameter cuttings.*
3. *Pole cuttings are better suited for highly erodible areas and sites with fluctuating water levels.*
4. *The pole cuttings should extend through the vadose zone and into the permanent water table. At least 1/2 to 2/3 of the pole should be below the ground, at least 1.0m (3 ft.), and long enough to emerge above adjacent vegetation.*
5. *"Muddying" – filling the hole with water and then soil to make a mud slurry can remove air pockets.*

POLE PLANTING

© 2000 JOHN McCULLAH

POLEPLNT

Source: FishNet4C

FABRIC REINFORCED EARTH FILL WITH BRUSH LAYERING

DESCRIPTION

A constructed fill slope built with layers of live brush cuttings (usually willow) in between lifts of compacted soil, encapsulated with natural erosion control blankets or synthetic geogrids.

APPLICATIONS

Used for repairing steep slopes, slumps or stream banks above stream-forming flow conditions. Useful in restoring eroding stream banks on outside bends where laying back the bank is not feasible. Can be placed on slopes up to 1:1 or steeper with additional geotechnical analysis. Can help dry wet sites with seeps through transpiration. The willow brush helps reduce near bank stream velocities.

LIMITATIONS

- ✓ Drainage areas should be relatively small (generally less than 2,000 acres). If used on larger stream systems additional toe protection and analysis will be required.
- ✓ Stream system should not be degrading (downcutting) or the structure can be undermined.
- ✓ The system must be built during low flow conditions. May need to divert water around the site and/or dewater.
- ✓ Live cuttings should be taken no earlier than the end of August and kept moist until the rainy season.
- ✓ Willows require nearly full sun conditions to be vigorous. Not to be used in heavy shade. Check to see if willows are growing in the area to confirm if this technique can be used.
- ✓ In-stream construction requires permits from a number of regulatory agencies.

CONSTRUCTION GUIDELINES

1) The structure needs to be built on a competent rock or coarse gravel base with a 10:1 (H:V) back slope to counter lateral earth forces. Boulder toe protection should be installed if toe scour is a concern. Toe depth should be several feet below the thalweg of the streambed. Width of lifts will vary by site, however a minimum width of 4 feet should be used for adequate fabric and brush layer depth.

2) Beginning at the bankfull elevation, place 8 to 12 live branch cuttings per linear foot on top of the rock filled fabric lift with growing tips at right angles to the streamflow. Live willow cuttings should be 4 feet in length or longer. Place a few inches of select fill around willow between fabric lifts to ensure good soil contact with willow. Water in willow.

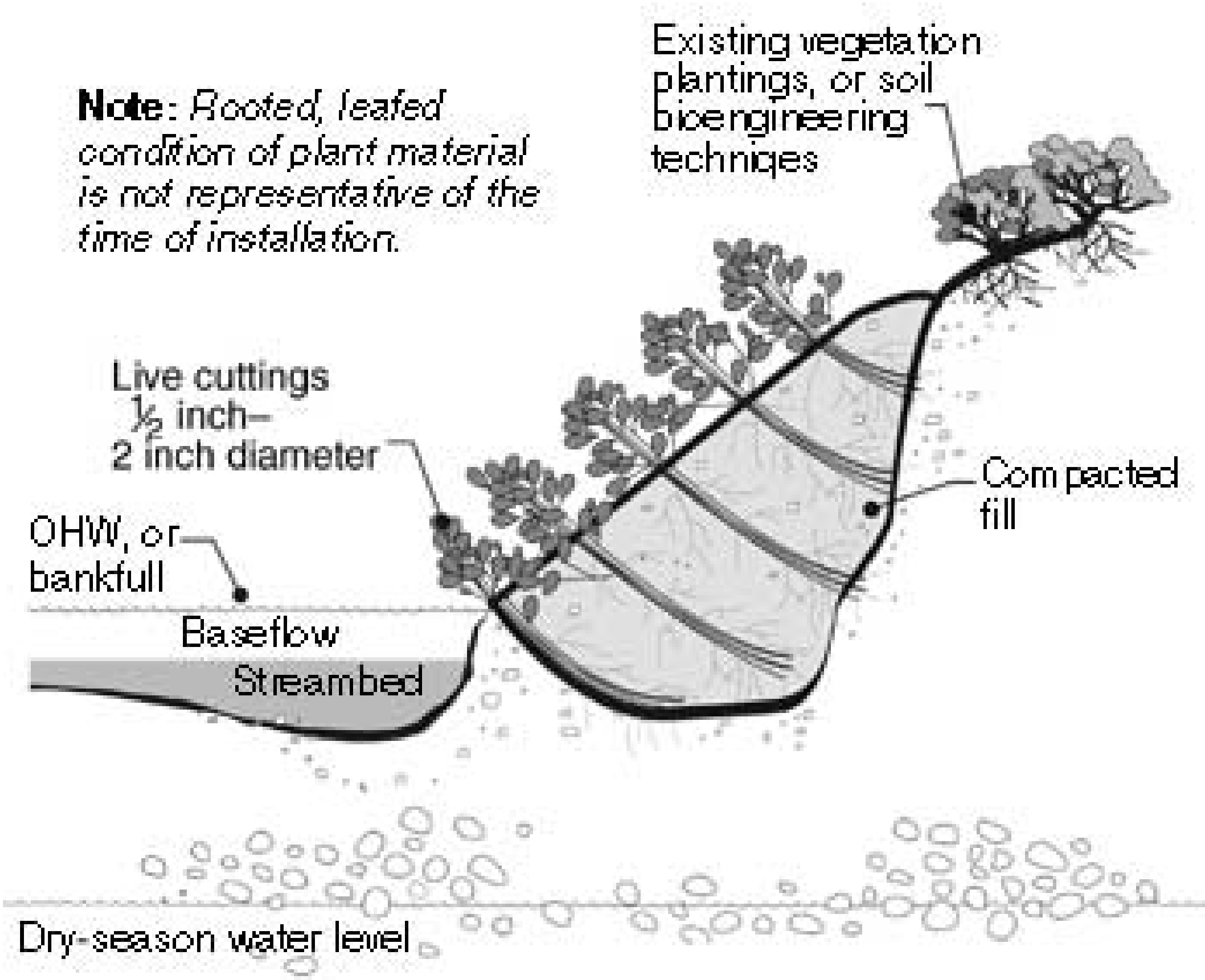
3) Cover this layer of cuttings with fabric leaving an overhang. Place a 12 to 24-inch layer of soil suitable for plant growth (in compacted 6” lifts) on top of the fabric. Wrap the overhanging portion of fabric over the compacted soil to encapsulate the soil in a wrap. Pull and tighten fabric toward slope and stake in place. The thickness of lifts will vary by soil type, stream shear stress, and velocity. Generally, 12-inch thick lifts are more stable than thicker lifts but are more expensive to build. Lifts typically range from 12-inch to 30-inch with 18-inch lifts being most common.

4) Continue this process with alternating layers of cuttings and compacted lifts wrapped in fabric until the bank is restored to its original height or meets desired grade.

5) Several fabric options can be used for creating the wraps. Coir twine mats (outside) with a high tensile strength can be used in conjunction with coir erosion control blanket (inside) with a dense weave to prevent soil migration through the blanket. At sites where capitol improvements are in jeopardy or higher shear stresses and velocities are calculated, synthetic geotextile materials can be used (geogrids). Willow roots will grow through the geogrid layers creating a dense matrix of willow roots bonding the structure into a single mass.

BMP MAINTENANCE

- ✓ Keep soil and live cuttings moist by overhead irrigation until the rainy season begins.
- ✓ Keep livestock away from the live cuttings. If possible protect from deer for the first year.



Brush Layering: Fill Method
Not to scale

Source: U.S.D.A. Forest Service.

BMP - WATTLES/FASCINES

DESCRIPTION

Wattles and fascines are live branch cuttings, usually willows, bound together into long, tubular bundles used to stabilize slopes and stream banks. Both wattles and live fascines are true biotechnical practices. The live branches and live stakes provide the biological element while the stems, rope ties and wedge shaped wooden stakes all combine to provide the structural elements. Fascines differ from wattles in that the branch cuttings all point in the same direction in fascines, where they may point in either direction in wattles. Wattles are typically aligned on contour, where fascines are angled slightly upslope and thus tend to produce more vigorous growth.

APPLICATIONS

Wattles/fascines may be used for long slopes, road fills, road cuts, gullies or slumped areas, eroded slopes or eroding stream banks. May be used to repair small earth slips and slumps or to protect slopes from shallow slides 1-2 feet deep. Wattles/fascines may be used to stabilize entire cut or fill slopes or localized gully areas of slopes, or may be installed on newly built slopes or as a remedial action on existing slopes. This technique is useful on slopes requiring other planting materials such as woody vegetation, transplants and grasses. Wattles/fascines enhance conditions for natural invasion and the establishment of other plants from the surrounding plant community.

LIMITATIONS

- ✓ Always perform plant material harvest and installation during the dormant season, late fall through early spring.
- ✓ Where increased infiltration may cause slope failures, use fascines instead of wattles to ensure positive drainage.

CONSTRUCTION GUIDELINES

1) Pre-soak wattles/fascines for 24 hours, or install on the same day they are harvested and prepared. Wattles/fascines must be stored in the shade and under cover, preferably in water. Use site reconnaissance to identify species and site conditions on adjacent sites and compare their conditions to the construction site.

Planting will be more successful as the soil, site conditions, and species selected match stable and vegetated nearby sites.

2) Tie cuttings together to form bundles, tapered at each end, 6-30 feet in length, depending on site conditions or limitations in handling. The completed bundles should be 6-12 inches in diameter. Stagger the cuttings in the bundles so that the tips are evenly distributed throughout the length of the bundle.

3) Compress and tightly tie wattle/fascine bundles with rope or twine of sufficient strength and durability. Bundles shall be tied 12-15 inches apart.

4) General Installation Guidelines

Slope (H:V)	*Slope Length Between Wattles/Fascines (feet)*
1:1 to 1.5:1	*3-4*
1.5:1 to 2:1	*4-5*
2:1 to 2.5:1	*5-6*
2.5:1 to 4:1	*6-8*
3.5:1 to 4:1	*8-12*
4.5:1 to 5:1	*10-20*

5) Perform any slope repairs prior to wattle/fascine installation.

6) Beginning at the base of the slope, dig a trench on contour. The trench shall be shallow, about ½ : what fraction? Check printout] the diameter of the wattle. The trench width will vary from 12-18 inches depending on the slope angle. Place the wattles immediately after trenching to reduce desiccation of the exposed soil. Wattles shall be staked firmly in place with one row of construction stakes on the downhill side of the wattling, not more than 3 feet apart. second row of stakes shall be placed through the wattles, near the ties, at not more than 5 feet apart. Overlap the tapered ends of adjacent wattles so the overall wattle thickness of the wattle is uniform. Two stakes shall be used at each bundle overlap such that a stake may be driven between the last two ties of each wattle.

7) Live stakes, if specified, are generally installed on the downslope side of the bundle. Drive the live stakes below and against the bundle between the previously installed construction stakes. Proper backfilling is essential to the successful rooting of the wattles. Backfill wattles with soil from the slope or trench above. The backfill shall be worked into the wattle interstices and compacted behind and below the bundle by walking on and working from its wattling terrace.

8) Repeat the preceding steps to the top of the slope. Place moist soil along the sides of the live bundle. The top of the bundle should be slightly visible when the installation is completed. Plant the slope as specified.

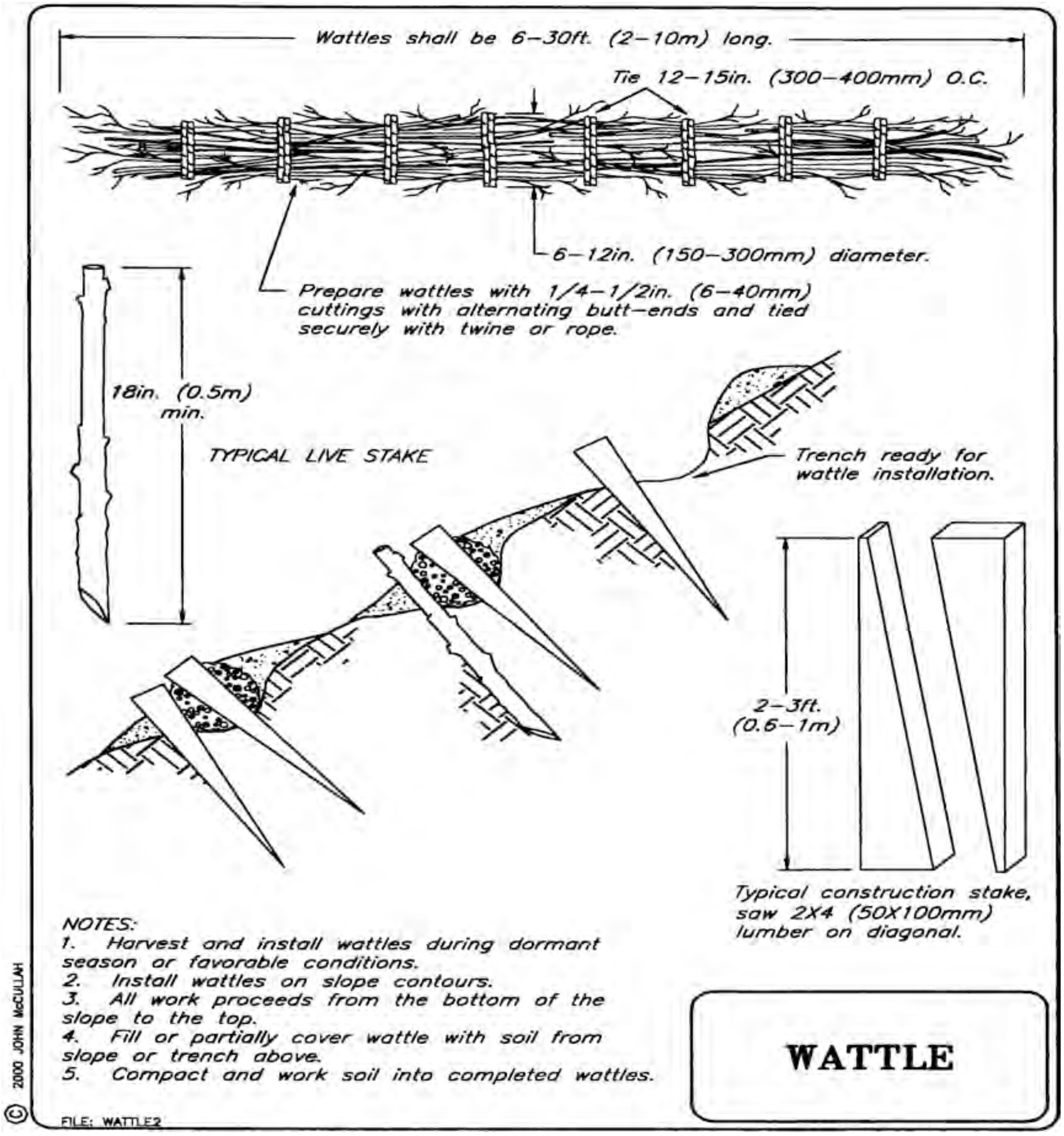
9) Seed and mulch slope, if specified. Shallow slopes, generally 3:1 or flatter may be seeded and mulched by hand. Steeper slopes can have seed applied hydraulically and the mulch should be anchored with tackifier or other approved methods.

BMP MAINTENANCE

- ✓ Conduct regular inspections and maintenance of wattle installations, particularly during the first year.
- ✓ Staked area may need to be watered during summer months.
- ✓ Immediately repair rills and gullies around or under wattles.

BMP REMOVAL

- ✓ BMP removal is not necessary.



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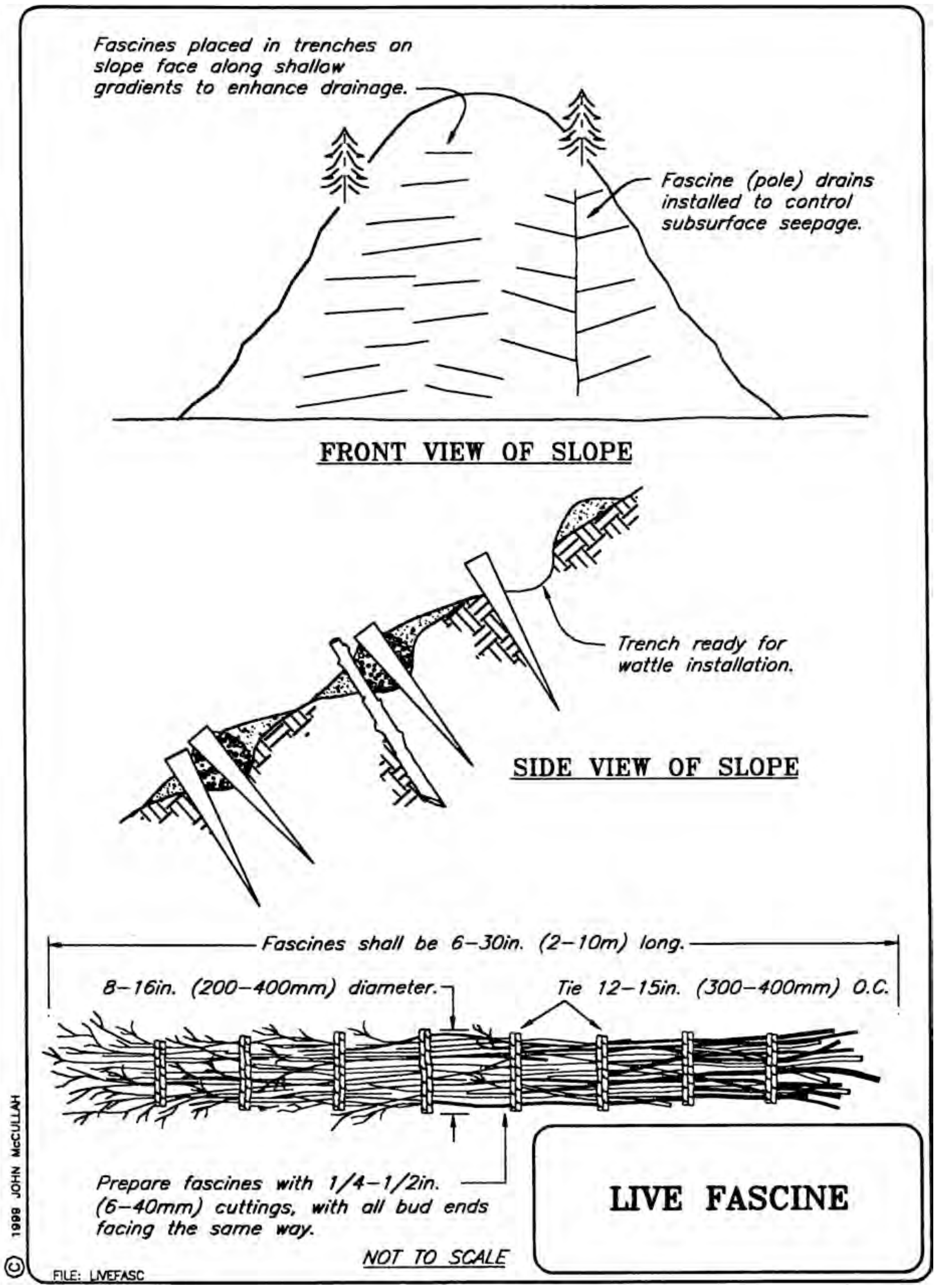


Source: FishNet4C

STREAMBANK PROTECTION HARDSCAPE BMPS

BMP - BOULDER/RIPRAP

DESCRIPTION

Riprap is a structural method appropriate for supporting slopes and/or reducing erosion in areas where biotechnical methods are unsuitable and where engineered retaining structures are unnecessary.

APPLICATIONS

Riprap may be used to stabilize steep slopes with seepage problems and/or unstable soils that need armoring to prevent sloughing. This BMP should only be used as a last resort in locations where planting or other stabilizing methods are impracticable. Riprap may also be used in combination with biotechnical BMPs. Rip rapped areas should be evaluated for finishing with topsoil and re-vegetation to improve the drainage capacity of the fill and the stability of the riprap matrix.

LIMITATIONS

- ✓ Do not use riprap as a stand-alone method of streambank stabilization.
- ✓ Obtain permits from appropriate agencies before placing any riprap below the mean high water line of any water body, or in other sensitive areas. For example, placing rock riprap in pools at the bottom of culverts is a regulated activity. Road crews frequently fill pools this way, and it is mistakenly believed to have little or no impact. Filling these pools can have a substantial impact!

CONSTRUCTION GUIDELINES

1) Perform live staking or pole planting during riprap placement as much as possible.

2) Plant native trees during construction (not after) while there is no soil in the riprap interstitial spaces.

10) Schedule topsoil and revegetation finish work at an appropriate time of year. Ideally install riprap when soil is moist enough to support the vegetation you plan to incorporate. Often vegetated riprap projects fail due to low soil moisture. Maintain soil moisture during prolonged dry periods to support plant growth and ensure success.

3) Key the toe of the riprap slope to a stable foundation at its base, and below scour

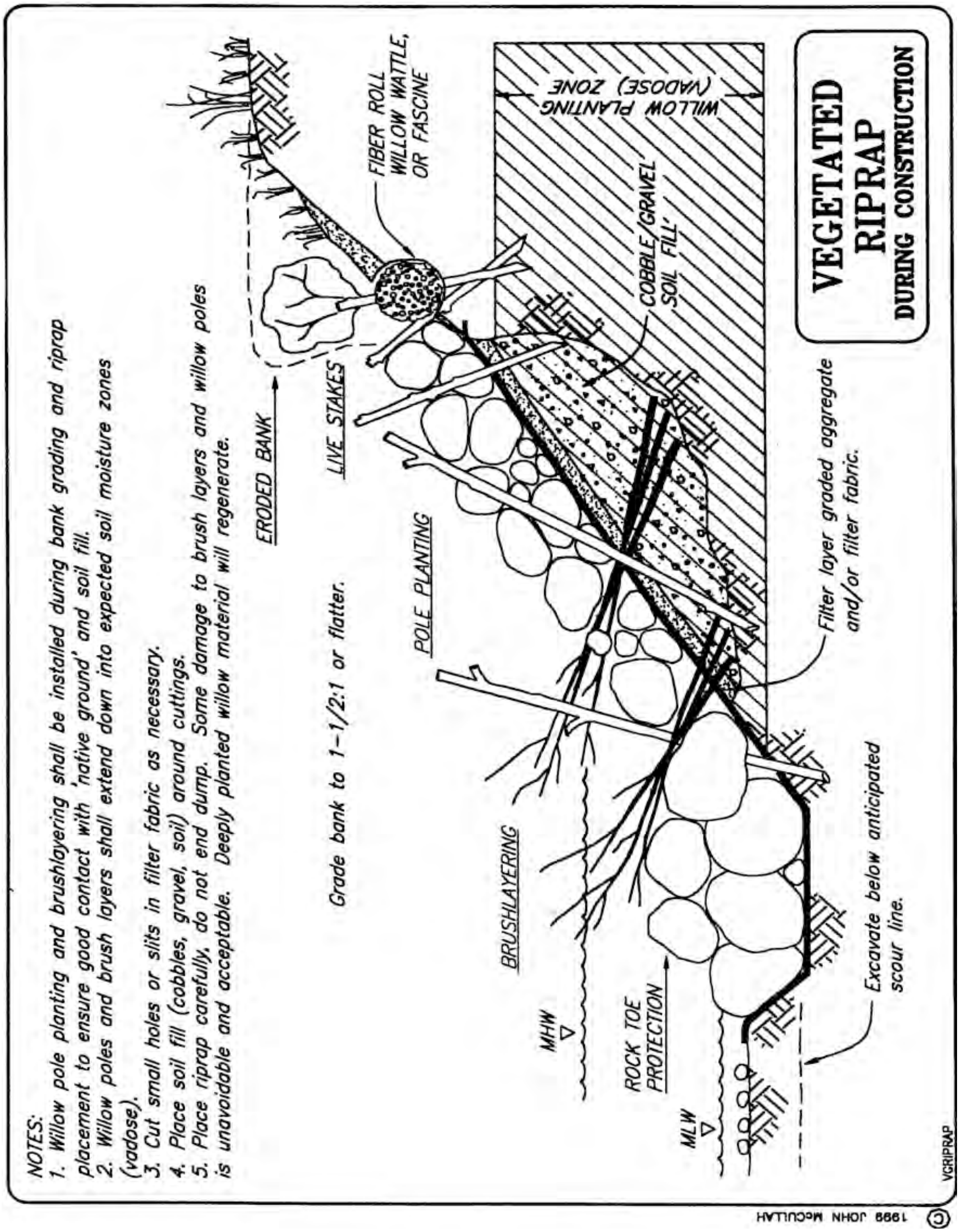
11) Size for 100-year event.

BMP MAINTENANCE

- ✓ Inspect riprap inspected periodically for scour or dislodged stones and repair immediately.

BMP REMOVAL

- ✓ BMP removal should not be necessary.



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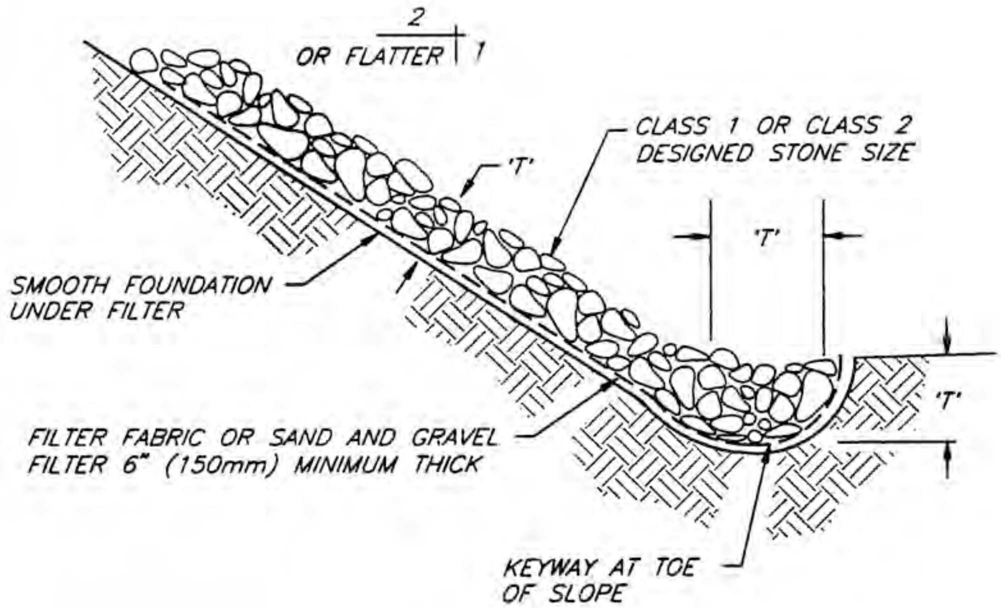


TYPICAL SECTION

NOTE:
'T' = THICKNESS: THICKNESS SHALL BE DETERMINED BY THE ENGINEER.

MINIMUM THICKNESS SHALL BE 1.5x THE MAXIMUM STONE DIAMETER, NEVER LESS THAN 6" (150mm).

RIPRAP PROTECTION

© 1994 JOHN McCULLAH

FILE: RIPRAP

Source: FishNet4C

BMP – STREAMBED GRAVEL

DESCRIPTION

Streambed gravel is clean, alluvial river-run, non-angular (smooth) gravel of variable sizes used for in-stream habitat protection and maintenance, or sometimes in a culvert.

APPLICATIONS

Streambed gravel can be used to provide a natural substrate for fish and for minimizing siltation in ditches and/or stormwater facilities.

LIMITATIONS

- ✓ Placing gravel in streams constitutes fill and must be permitted by the appropriate agencies.
- ✓ Gravel tends to move from the site, downstream, during winter storm run-off.
- ✓ When used as a bedding underneath a culvert, gravel may allow piping of water under the culvert.
- ✓ In some regions, river-run alluvial gravel can be difficult to acquire.

CONSTRUCTION GUIDELINES

1) Place gravel in accordance with applicable design and permit conditions.
2) Check gravel gradation to ensure it meets design specifications.
3) If gravel has excessive fines, wash gravel off-site (at a location where washed water cannot enter watercourses, streams or wetlands) until it runs clear.
4) Haul material in clean truck bed.
5) Dump cleaned rock onto tarped area on-site.
6) Place a cover and berm around clean rock stockpiles. Re-wash rock before using if it becomes dirty.

BMP MAINTENANCE

- ✓ Replace as needed

Source: FishNet4C

BMP - VEGETATED CONCRETE CRIBWALL

DESCRIPTION

A vegetated concrete cribwall consists of a hollow, box-like interlocking arrangement of concrete beams filled with suitable backfill material and layers of live branch cuttings that root inside the crib. The roots of the cuttings will eventually behave as a coherent gravity structure itself.

APPLICATIONS

Vegetated concrete cribwalls are used for the stabilization of embankments and road cuts. They are helpful at the base of slopes where a low toe-wall can be used to reduce the steepness of a slope and stabilize the toe. Vegetation incorporated within the cribwalls has a more natural appearance and is less visually intrusive than a structural treatment alone. Vegetated cribwalls also minimize problems with graffiti and defacement of retaining walls, and they avoid encroachment on limited rights-of-way by use of a more vertical structure.

LIMITATIONS

- ✓ Design and construction of very high cribwalls should be approved by a qualified geotechnical engineer.
- ✓ Place crib walls below scour.
- ✓ Engineer for at least a 100-year event.

CONSTRUCTION GUIDELINES

1) Vegetated concrete crib walls must be designed to withstand expected lateral earth forces and must satisfy external stability requirements, as well as meet internal stability from shear stress, bending, and compression. Commercial crib wall systems and standard designs should satisfy these requirements.

BMP MAINTENANCE

- ✓ Check cribwalls periodically to ensure slope stability.
- ✓ Vegetation may need to be periodically trimmed.

BMP REMOVAL

- ✓ Removal is not necessary.

ADDITIONAL RESOURCES

Evergreen Wall, TEC-TON Enterprises, PO BOX 218, E. Pembroke, NY 14056-0218, (716) 762-8314, www.evergreenwall.com

Source: FishNet4C

PLANNING AND PREVENTION BMPS

BMP – SEASONAL PLANNING

DESCRIPTION

The purpose is to protect aquatic resources and fisheries to the greatest extent possible through scheduling and sequencing of construction activities with the implementation of erosion and sediment control measures. Minimize the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking.

APPLICATIONS

All projects involving land-disturbing activities. Sequencing to minimize land disturbance during the rainy season.

CONSTRUCTION GUIDELINES

1) Obtain all required permits well before beginning of construction as unforeseen permitting delays and requirements may require drastic delays in scheduling.
2) Create a timetable incorporating water quality and erosion control measures into construction plans.
3) Avoid working between October 15 and April 1st to limit impacts during critical periods for aquatic species during the wet season.
4) Schedule work to minimize the extent of site disturbance at any one time. Where appropriate, incorporate staged revegetation of graded slopes as work progresses.
5) Schedule establishment of permanent vegetation including appropriate planting time and maintenance.
6) Maintain year-round sediment control practices even during dry months when unexpected changes in weather could cause a discharge into waterways.
7) Plan enough time before rainfall to allow for effective use of vegetation or other soil stabilization methods.

BMP MAINTENANCE

- ✓ During construction, check the schedule frequently and change the schedule to accommodate changes to the work plan.
- ✓ Monitor the weather forecast for rainfall and adjust the construction schedule to allow the implementation of soil stabilization and sediment controls prior to the onset of rain.
- ✓ Be prepared year-round to deploy soil stabilization and sediment control practices. Keep the site stabilized year-round, retain and maintain rainy season sediment trapping devices in operational condition.

Source: FishNet4C

SEASONAL RESTRICTIONS BY SPECIES Taken from Mitigation Measures, Monitoring and Reporting Program for the 2005 Fisheries Restoration Grant Program –Appendix B; Dept. of Fish and Game Regional General Permit/Neg. Dec. for Fisheries Restoration Grant projects.

1) To avoid impacts to aquatic habitat the activities carried out in the restoration program typically occur during the summer dry season.

   a) Work around streams is restricted to the period of June 15 through November 1 or the first rainfall. This is to take advantage of low stream flow and avoid the spawning and egg/alevin incubation period of salmon and steelhead.

   b) Upslope work generally occurs during the same period as stream work. Road decommissioning and other sediment reduction activities are dependent on soil moisture content. Upslope projects do not have seasonal restrictions in the Incidental Take Statement but work may be restricted at some sites to allow soils to dry out adequately. In some areas equipment access and effectiveness is constrained by wet conditions.

   c) The permissible work window for individual work sites will be further constrained as necessary to avoid the nesting or breeding seasons of birds and terrestrial animals. At most sites with potential for raptor (including northern spotted owls) and migratory bird nesting, if work is conditioned to start after July 31, potential impacts will be avoided and no surveys will be required. For work sites that might contain nesting marbled murrelets, the starting date will be September 15 in the absence of surveys. The work window at individual work sites could be advanced if surveys determine that nesting birds will not be impacted.

   d) For restoration work that could affect swallow nesting habitat (such as removal of culverts showing evidence of past swallow nesting), construction will occur after August 31 to avoid the swallow nesting period. Alternatively, the suitable bridge nesting habitat will be netted before initiation of the breeding season to prevent nesting. Netting must be installed before any nesting activity begins, generally prior to March 1. Swallows must be excluded from areas where construction activities cause nest damage or abandonment.

   e) Planting of seedlings shall begin after December 1, or when sufficient rainfall has occurred to ensure the best chance of survival of the seedlings, but in no case after April 1.

Coho Salmon (*Oncorhynchus kisutch*), Chinook Salmon (*Oncorhynchus tshawytscha*), Steelhead (*Oncorhynchus mykiss*), and Coast Cutthroat Trout (*Oncorhynchus clarki clarki*)

1) Project work within the wetted stream shall be limited to the period between June 15 and November 1, or the first significant fall rainfall. This is to take advantage of low stream flows and to avoid the spawning and egg/alevin incubation period of salmon and steelhead. Whenever possible, the work period at individual sites shall be further limited to entirely avoid periods when salmonids are present (for example, in a seasonal creek, work will be confined to the period when the stream is dry).

California Red-Legged Frog (*Rana aurora draytonii*)

1) Ground disturbing activities in potential red-legged frog habitat will be restricted to the period between July 1 and October 15.

California Freshwater Shrimp (*Syncaris pacifica*)

1) Ground disturbing activities in potential shrimp habitat shall be restricted to the period between July 1 and November 1.

Least Bell's Vireo (*Vireo bellii pusillus*)

The potential exists for the noise from heavy equipment work and the harvesting of willow branches for revegetation at these sites to disrupt vireo nesting. To avoid this potential impact, the following mitigation measures will be implemented:

1) Work shall not begin within one quarter mile of any site with known or potential habitat for the Least Bell's Vireo until after September 15.

2) Harvest of willow branches at any site with potential habitat for the Least Bell's Vireo will not occur between March 1 and September 15.

3) The work window at individual work sites may be modified, if protocol surveys determine that nesting birds do not occur within 0.25 miles of the site during the breeding season.

Marbled Murrelet (*Brachyrampus marmoratus*)

The marbled murrelet is listed as endangered under CESA and threatened under ESA. Activities to protect and restore habitat will not remove or degrade suitable habitat for marbled murrelets, however nesting birds could be disturbed by the noise from heavy equipment required for projects such as culvert removal or placement of large woody debris.

1) Adverse effects can be avoided by limiting heavy equipment work within 0.25 mile of marbled murrelet habitat to the period between September 16 and March 23.

2) Work shall not begin within 0.25 mile of any site with occupied or un-surveyed suitable marbled murrelet habitat between March 24 and September 15.

3) The work window at individual work sites near suitable habitat may be modified, if protocol surveys determine that habitat quality is low and occupancy is very unlikely.

Northern Spotted Owl (*Strix occidentalis caurina*)

The northern spotted owl is listed as threatened under ESA. Restoration activities should not alter habitat for northern spotted owls, however nesting birds could be disturbed by the noise from heavy equipment during projects such as culvert removal or placement of large woody debris. Direct injury or mortality of owls is not an issue. The potential exists for heavy equipment work at these sites to disturb spotted owl nesting. To avoid this potential effect, the following mitigation measures will be implemented:

1) Disturbance can be avoided by limiting heavy equipment work within 0.25 miles of suitable spotted owl habitat to the period between August 1 and January 31.

2) Work at any site within 0.25 miles of suitable habitat for the northern spotted owl will not occur from February 1 to July 31.

3) The work window at individual work sites may be advanced prior to July 31, if protocol surveys determine that suitable habitat is unoccupied.

Willow Flycatcher (*Empidonax traillii*),

The potential exists to affect suitable habitat for the willow flycatcher by the harvesting of willow branches for riparian planting and construction of live willow mattresses and live willow walls. The potential also exists for the noise from heavy equipment work or harvesting of revegetation material at project sites to disrupt willow flycatcher nesting. To avoid this potential impact, the following mitigation measures will be implemented:

1) Heavy equipment work shall not begin within one quarter mile of any site with known or potential habitat for the *willow flycatcher* until after August 31. Heavy equipment work shall not begin within one quarter mile of any site with known or potential habitat for the *southwestern willow flycatcher* until after September 15.

2) Harvest of willow branches at any site with potential habitat for the willow flycatcher will not occur between May 1 and August 31. Harvest of willow branches at any site with potential habitat for the *southwestern willow flycatcher* will not occur between May 1 and September 15.

3) The work window at individual work sites may be modified, if protocol surveys determine that nesting birds do not occur within 0.25 miles of the site during the breeding season.

Least Bell's Vireo (*Vireo bellii pusillus*)

The potential exists for the noise from heavy equipment work and the harvesting of willow branches for revegetation at these sites to disrupt vireo nesting. To avoid this potential impact, the following mitigation measures will be implemented:

1) Work shall not begin within one quarter mile of any site with known or potential habitat for the Least Bell's Vireo until after September 15.

2) Harvest of willow branches at any site with potential habitat for the Least Bell's Vireo will not occur between March 1 and September 15.

3) The work window at individual work sites may be modified, if protocol surveys determine that nesting birds do not occur within 0.25 miles of the site during the breeding season.

Point Arena Mountain Beaver (*Aplodontia rufa nigra*)

1) No operation of noise generating equipment (e.g. chainsaws) within 100 feet of active burrows during the breeding season (December 15 – June 30).

2) No operation of mechanical equipment (e.g. backhoes, excavators) within 100 feet of active burrows during the breeding season (December 15 – June 30), and within 50 feet the remainder of the year.

3) No ground disturbance (e.g. dumping of boulders) within 500 feet of active burrows during breeding season, and within 100 feet the remainder of the year. No severe ground disturbance (e.g. driving of bridge piles, blasting) within 500 feet of active burrows at any time.

BMP – SMALL SPILL KIT

DESCRIPTION

Commercial emergency response spill kits contain absorbent material to contain and clean up small chemical spills.

APPLICATIONS

Spill kits typically have the capacity to help clean up 6 to 14 gallon size spills. Use wherever petroleum products, concrete and chemical pollutants may spill. Around heavy machinery with hydraulic fluids and at any on-site designated refueling/servicing areas. Also used to clean up chemical fertilizers and pesticides.

LIMITATIONS

- ✓ Assess the needs of project to match the type and size of kits to ensure proper materials in case of emergency.
- ✓ For larger spills, see “Spill - Large” BMP. Large spills must be reported immediately.

CONSTRUCTION GUIDELINES

1) Kits may contain absorbent pads, socks, wattles, pillows, disposal bags, warning labels, and emergency response guidebook.
2) Use appropriate personal protective equipment.
3) Deploy materials to stop the flow into the ground or off-site. This may require constructing an emergency earthen berm.
4) Repair source of leak (containers or machinery) or remove from site.
5) Dispose of contaminated materials and soil in an approved location.
6) Report all significant spills.

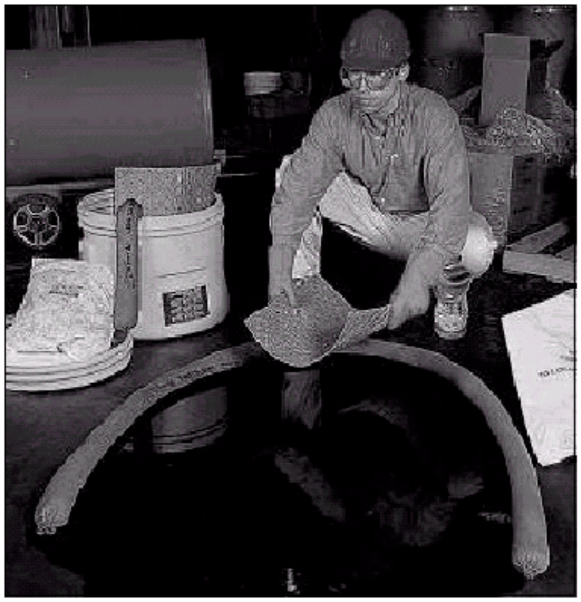
BMP MAINTENANCE

- ✓ Replace spill kits or parts of spill kits when used.

BMP REMOVAL

- ✓ Dispose of contaminated materials in an approved location.

Source: FishNet4C



UNIVERSAL NON-AGGRESSIVE 20-GALLON OVERPACK SPILL KIT

DESCRIPTION
1 20-gal Overpack Kit 25 lbs. Absorbs 14 gallons of Oil, Coolants, Solvents & Water, 1-3" x 10' Socks, 4-3" x 4' Socks, 2-18" x 18" Pillows, 15-16" x 20" Heavy-Wt. Pads, 5-Temporary Disposal Bags, 1-Emergency Response Guidebook, 3 Warning & Disposal Labels

Source:
www.dawginc.com/spill-kits/spill-kits.asp

SMALL SPILL KIT

Source: FishNet4C

BMP – LARGE SPILL KIT

DESCRIPTION

A palletized boxed spill kit capable of absorbing 148 gallons or more.

APPLICATIONS

Used as first line of defense on larger spills. Immediately notify local emergency response agency by dialing 911. Use wherever petroleum products and/or concrete and chemical pollutants may spill. Around heavy machinery with hydraulic fluids and at any on-site designated refueling/servicing areas. Also used to clean up chemical fertilizers and pesticides.

LIMITATIONS

- ✓ Assess the needs of project to match the type and size of kits to ensure proper materials in case of emergency.
- ✓ Determine whether or not materials are too hazardous to be contained by on site personnel. May require a certified HazMat team.

CONSTRUCTION GUIDELINES

1) Follow guidelines in the Stormwater Pollution Prevention Plan for the project.
2) Notify the local emergency response agency by dialing 911. Also notify other appropriate local officials. All necessary emergency telephone numbers should be available at the construction site.
3) Notify the Governor's Office of Emergency Services Warning Center at (800) 852-7550.
4) For spills of federal reportable quantities, notify the National Response Center at (800) 424-8802.
5) Notification should first be made by telephone and followed up with a written report as soon as possible.
6) If safe, stop the source of the spill and contain the spill's spread. Use appropriate personal protective equipment found in the spill kit (rubber gloves, safety glasses).
7) A spill cleanup contractor or HazMat team should be contacted immediately.
8) Construction personnel should not attempt to initiate cleanup until appropriate and qualified staff have arrived at the site.
9) Other agencies which may need to be consulted include local fire, police, and public works departments, the U.S. Coast Guard, the California Highway Patrol, the California Department of Toxic Substance Control, California Division of Oil and Gas, Cal/OSHA, etc.

Source: FishNet4C

BMP MAINTENANCE

✓ Replace spill kits or parts of spill kits when used.

BMP REMOVAL

✓ Dispose of contaminated materials in an approved location.

HEAVY DUTY CARDBOARD BOX SPILL KIT

DESCRIPTION
1 Kit Container 239 lbs. Absorbs 148 gallons of Oil, Coolants, Solvents & Water. Dawg Products: 20-3" x 10' Socks, 60-3" x 4' Socks, 16-18" x 18" Pillows, 200-16" x 20" Heavy Wt. Pads, 2 Suits, 2 Pr-Gloves, 2 Pr-Goggles, 30-Temporary Disposal Bags, 1-Emergency Response Guidebook, 168 Wipes, 1 Container Box (Dim: 36" Cube)

Source:
www.dawginc.com/spill-kits/
spill-kit-box-container.asp

LARGE SPILL KIT

Source: FishNet4C

APPENDIX B: GLOSSARY

Acronyms

Here is a list of the "alphabet soup" of agencies, laws, programs, and materials that may need translation.

ABAG	Association of Bay Area Governments
AC	Asphalt – concrete
BA	Biological Assessment (under ESA)
BASMAA	Bay Area Stormwater Management Agencies Association
BLM	Bureau of Land Management
BMP	Best Management Practice
BO	Biological Opinion (under ESA)
CAL-EPA	California Environmental Protection Agency
CCC	California Coastal Commission
CCCESU	Central California Coast Evolutionary Significant Unit
CDF	California Dept. of Forestry and Fire Protection
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CMA	Calcium Magnesium Acetate (for ice control)
CMP	Corrugated Metal Pipe culvert
COE	Corps of Engineers, U.S. Army
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DFG	California Dept. of Fish and Game
DOT	Department of Transportation (county, state or federal)
DRC	Ditch Relief Culvert
EIR	Environmental Impact Report (under State CEQA)
EIS	Environmental Impact Statement (under Federal NEPA)
EPA	U.S. Environmental Protection Agency
ERFO	Emergency Relief for Federally Owned Roads
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FHWA	Federal Highway Administration
HBRR	Highway Bridge Rehabilitation or Replacement
HCP	Habitat Conservation Plan
LCP	Local Coastal Plan
LOP	Limited Operating Period
LWD	Large Woody Debris
NFPA	National Fire Protection Association
NMFS	National Marine Fisheries Service (former name for NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Administration
NOAA FISHERIES-	The branch of NOAA responsible for fisheries protection and restoration
NPDES	National Pollution Discharge Elimination System

NRCS	Natural Resource Conservation Service
NWP	Nationwide General Permit (under CWA)
ODOT	Oregon Dept. of Transportation
RCD	Resource Conservation District
RGP	Regional General Permit (under CWA)
RWQCB	California Regional Water Quality Control Board
SHPO	State Historic Preservation Office
SLC	State Lands Commission
SMARA	Surface Mining and Reclamation Act (California)
SPCC	Spill Prevention Control and Countermeasure plan
STIP	State Transportation Improvement Project
SWP	Storm Water Permit
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load (under Clean Water Act)
USA	Underground Service Alert
USACE	U.S. Army Corps of Engineers (see COE)
USDOT	U.S Dept. of Transportation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WDR	Waste Discharge Requirements

Definition of Terms

Abandoned road – A road which is no longer maintained. An abandoned road may or may not still be driveable and may or may not be overgrown with vegetation. [See also R*oad abandonment*.]

Accelerated erosion – Erosion that has been caused directly or indirectly by human activities or land management. Typically thought of as erosion which is not “natural” or that which is in excess of that which would have naturally occurred.

Active channel width - See *Ordinary High Water Mark*. Term used by California DFG in its “Culvert Criteria for Fish Passage”.

Active road – A road that is part of the overall road network that needs to be actively inspected and maintained.

Adaptive management – Learning from experience by adapting management practices through the feedback received through monitoring.

Alevin – A juvenile salmonid fish in the early phase, recently emerging from the egg and still carrying a yolk sac.

Anadromous fish – (“*a-nad’-ro-mus*” ; to run upward) **-** fish that are born and rear in freshwater, move to the ocean to grow and mature, and return to freshwater to reproduce. Salmon, steelhead, and lamprey eel are examples.

Angle of repose – The steepest slope angle at which a material will freely stand without failing or sliding downslope. For material without cohesion, such as sand, the angle is about 33 degrees. It is steeper for cohesive materials. Slopes which are steeper than the angle of repose are likely to be unstable.

Armoring – Protective coverings or structures used to dissipate the erosive energy of water. Aprons and rip-rap are types of armoring.

Bankfull discharge – The stream discharge that just fills the stream to its banks, and which usually occurs approximately every two years on average.

Bearing surface – The driving surface of the road. Road rocking is a common method of increasing the load bearing capacity of the road surface if the subgrade soils are relatively weak.

Berm – A curb or dike constructed to control water and prevent roadway runoff waters from discharging onto roadside slopes and/or to provide material for subsequent road maintenance.

Best Management Practices (BMPs) – A technique, or series of techniques, which is the best known practice available to be effective in protecting water quality and stream habitat.

Borrow site – Locations on the landscape where sand, gravel, and/or rock is excavated for use in road construction activities elsewhere in the watershed.

Buffer strip – An area or strip of land adjacent to a stream containing relatively undisturbed vegetation that acts as a filter or buffer for erosion and runoff from upslope roads or other land management activities.

Check dam (straw bale) – A temporary structure used to contain eroded soil from leaving a disturbed or construction site. Straw bale dams quickly decompose and will usually not provide sediment storage or protection for more than a single season.

Chinook salmon – An anadromous fish species also known as “king salmon”.

CMP – Corrugated metal pipe culvert, often used synonymously with culvert. Metal culverts are typically made from galvanized steel or aluminum.

Coho salmon – An anadromous fish species also known as “silver salmon”.

Controllable – Erosion that would reasonably respond to cost-effective mitigation.

Cross-drain – A culvert, rolling dip, water bar, or outslope area that drains water across a road from an inboard ditch or water collection area. Cross-road drains are more substantial and deeper than conventional waterbars used to drain forest and ranch roads, and are steeper and more abrupt than rolling dips. Well constructed cross-drains will often be deep enough to prevent vehicular access to an area and are typically installed on roads which are being closed permanently or for several years. Cross-road drains are typically constructed (excavated) using a tractor, an hydraulic excavator, or a backhoe.

Culvert – A transverse drain, usually a metal pipe, set beneath the road surface which drains water from the inside of the road to the outside of the road. Culverts are used to drain ditches, springs, and streams across the road alignment.

Cutslope (cutbank) – The artificial face or slope cut into soils or rock along the inside of a road.

Danger tree – Trees or snags, on or near the highway, that are found to be weakened, unsound, undermined, leaning, or exposed so they may fall across the road. When permission to remove the trees cannot be obtained, it is necessary to trim and do whatever else is reasonable to alleviate the hazard.

Debris flow – A rapidly moving mass of rock fragments, soil and mud, with more than half of the particles being larger than sand size. In contrast to debris slides, debris flows are usually saturated with water.

Debris slide – A slow to rapid slide, involving downslope translation of relatively dry and predominantly unconsolidated materials, with more than half of the particles being larger than sand size.

Debris torrent – Rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods. This action generally occurs in smaller, steep stream channels and results in scouring of the streambed.

Dewatering – The temporary diversion of water away from a work site to protect water quality and allow progression of work. Diversion is accomplished with coffer dams, pipes, or other means. Water is removed from the work site only, and not the entire stream or body of water.

Ditch relief culvert – A drainage structure or facility which will move water from an inside road ditch to an outside area, beyond the outer edge of the road fill.

Diversion potential - Road stream crossing that has the potential to divert flow from a plugged culvert down the length of the road surface, rather than directly across the culvert fill and into its natural drainage channel. This potential carries the risk of causing soil erosion and sediment delivery.

Downspout – A flume or trough attached to a culvert outlet to transport water beyond the erosive road fill to a stable, armored catchment area in order to prevent erosion. Culverts that are placed at the base of the road fill discharge directly into the natural channel or hillslope and usually do not require a downspout.

Drainage basin – See: *Watershed*.

Drainage structure – A structure installed to control, divert or to cross over water, including but not limited to culverts, bridges, ditch drains, fords, waterbreaks, outsloping, and rolling dips.

Drop inlet – A vertical riser on a culvert inlet, usually of the same diameter as the culvert, and often slotted to allow water to flow into the culvert as streamflow rises around the outside. Drop inlets are often used on stream or ditch relief culverts where sediment or debris would otherwise threaten to plug a traditional horizontal inlet.

Emergency – "A situation which would result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if corrective action requiring a permit is not undertaken within a time period less than the normal time needed to process the application under standard." (COE Regulations); "A situation involving an act of God, disasters, casualties, national defense or security emergencies, etc., and includes response activities that must be taken to prevent imminent loss of human life or property." (ESA rules, 50 CFR 402.05); "A sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property or essential public services. Emergency includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage." (CEQA 15359).

Emergency road maintenance – See: *Storm maintenance*.

Endangered Species – Any species which is in danger of extinction throughout all or a significant portion of its range; an official designation of the California and/or Federal Endangered Species Acts.

Endhauling – The removal and transportation of excavated material to prevent sidecast, and the storage of the material in a stable location where it cannot enter stream channels. Endhauling is usually accomplished using dump trucks, but on larger jobs may be performed by mobile scrapers.

Energy dissipator – A device or material (often rocks) used to reduce the energy of flowing water, typically used at and below culvert outlets and other drainage structures to prevent erosion.

Ephemeral streams - Streams that contain running water only sporadically, such as during and following storm events.

Equipment limitation / equipment exclusion – The terms used when the use of heavy equipment is to be limited or prohibited, respectively, for the protection of water quality, the beneficial uses of water, or aquatic habitat.

Erodible soils – Soils which are relatively prone to erosion by rain drop impact and surface runoff. Granular, noncohesive soils (such as soils derived from sand dunes or from decomposed granite (DG)) are known to be especially erodible.

Erosion – The wearing away of land surface primarily by wind or water. Erosion occurs naturally as a result of weather or runoff, but can be intensified by clearing, grading, or excavation of the land surface. Erosion usually refers to processes of surface erosion (rain drop erosion, rilling, gullying, and ravelling) and not to mass soil movement (landsliding).

Erosion control - The act of controlling on-going erosion caused by rain drop impact, rilling, gullying, ravelling, and other surface processes.

Erosion prevention – Preventing erosion before it has occurred. Erosion prevention is typically less expensive and more effective than erosion control.

Erosion-proof – The act of performing erosion control and erosion prevention activities which will protect a road, including its drainage structures and fills, from serious erosion during a large storm and flood.

Excess material – See *Spoil.*

Fail-safe – A term used to describe a stream crossing that has no diversion potential.

Fail soft – A fail-safe stream crossing where the dip or change in road grade occurs over the hinge line between the fill and the natural ground surface. With the road dip or low point in this location, overflow from a plugged culvert will likely result in the least possible amount of erosion. Roads which dip deeply as they cross a stream channel have smaller fills which can be eroded when culvert plugging occurs.

Fillslope – That part of a road fill between the outside edge of the road and the base of the fill, where it meets the natural ground surface.

Fill – The material that is placed in low areas, compacted, and built up to form the roadbed surface.

Filter fabric (geotextile) – A synthetic fabric manufactured and designed for use in, among others, subsurface and surface drainage applications. Filter fabric is especially useful in maintaining a separation between coarse aggregate and finer native soil particles. It comes in a number of different types (with different specifications and uses) and is used in a number of different road building settings. Manufacturer’s specifications should always be consulted before using a fabric for drainage or other engineering applications.

Filter strip – See *Buffer*.

Filter windrow – A row of slash and woody debris laid and pressed down along the base of a road fill or sidecast slope to contain soil eroded from the hillslope. Filter windrows are often used to contain erosion from fillslopes and sidecast areas where a road approaches and crosses a stream channel.

Flared inlet – A culvert inlet which is flared or widened to increase its capacity and reduce the chance of inlet plugging and damage. Mitred inlets, usually made by cutting a normal culvert at an angle, are also used on ditch relief culverts to decrease inlet erosion and improve culvert efficiency. Flared inlets are attached to the normal culvert inlet using a band or bolts.

Floodplain – The land area that is covered by water from the overflow of stream channels when their banks are full. The '100-year floodplain' represents the area potentially inundated for an unusual but possible flood event with the probability of occurring once every 100 years on the average.

Fluvial geomorphology – the study of water-shaped landforms. See also *Geomorphology.*

Ford (wet) – A rock, concrete or other hardened structure built on the bed of a live stream which allows vehicle passage during low flow periods.

Ford (dry) - A rock, concrete or other hardened structure built on the bed of a swale, gully or usually dry stream which allows vehicle passage during periods of low or no flow.

French drain – A trench with covered drain rock used to provide subsurface ground water transport from a wet area and discharge it in a safe and stable location. French drains are often lined with filter fabric to keep soil from plugging the drain.

Fry – A juvenile salmonid fish, between the alevin and the smolt phase, in fresh water.

Full bench road – Road construction technique where the road bench cut width equals the road running surface width and no fill is used.

Full fill road – Road construction technique in which no bench cut is made into the hillslope and the road prism is made entirely from imported fill. The ground surface must still be prepared (grubbed and bared) for the fill to bind to the underlying substrate.

Geomorphology - the study of the physical features of the surface of the earth, including their form, nature, origin, and development. See also *Fluvial geomorphology*.

Geotextile – See *Filter fabric*.

Grade-break – The location of a reversal in the slope (grade) of the road from climbing to falling, or from falling to climbing.

Grading – The act of excavating and moving soil along the road alignment to an established grade-line during road construction or reconstruction. Grading also refers to the mechanical smoothing of the road bed to maintain a free-draining, smooth traveling surface.

Ground cover – Matter that covers the soil surface, such as low growing plants, rock and rock fragments, and debris such as leaves and twigs.

Groundwater – The standing body of water beneath the surface of the ground, consisting largely of surface water that has seeped down into the earth.

Gully – An erosion channel formed by concentrated surface runoff which generally has a cross sectional area larger than one square foot (1’ deep by 1’ wide). Gullies often form where road surface or ditch runoff is directed onto unprotected slopes.

Habitat – The place where a plant or animal (including fish and other aquatic life) naturally or normally lives and grows.

Hazard Tree - Trees or snags on or near the highway that are found to be weakened, unsound, undermined, leaning, or exposed so they may fall across the highway, impair sight while driving, or damage structures.

Hazardous waste - A waste, or combination of wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics, may either cause or significantly contribute to an increase in serious irreversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Possesses at least one of four characteristics (ignitiability, corrosivity, reactivity, or toxicity), or appears on special EPA or state lists. Regulated under the federal Resource Conservation and Recovery Act and the California Health and Safety Code.

Headcut – The vertical break in slope at the uphill end (head) of a gully. Headcuts migrate uphill and elongate the gully.

Headwater swale – The swale or dip in the natural topography that is upslope from a stream, at its headwaters. There may or may not be any evidence of overland or surface flow of water in the headwater swale.

Hillslope – Sediment erosion site associated with areas above the riparian area.

Horizontal drains – Drains installed in cut slopes and beneath fills to remove subsurface water and guard against slides in problem areas. Typically, they consist of perforated metal or plastic pipes in drill holes that have been bored horizontally into the aquifer or water-bearing formation.

Hydrological connectivity – Degree to which water from a source site or unstable area is conveyed to the network of the natural watercourse of concern.

Hydrologically connected road - Any road segment that, during a design runoff event, has a continuous surface flowpath between any part of the road prism and a natural stream channel..

Hydro-seeding (hydraulic seeding) – An erosion control technique for applying a slurry of seed, fertilizer and mulch by hydraulically spraying the mixture on the ground surface. Hydro-seeding is typically performed on slopes that are too steep for dry seeding.

Impaired- The term used by the EPA and Regional Water Quality Control Boards to designate streams with water quality impacts such as high temperatures, levels of sediment, or other chemical pollutants. If a stream is officially listed as *impaired* under the CWA 303(d) listing, it triggers a requirement for TMDL (Total Maximum Daily Load) non-point source pollution limits to be set for that stream.

Inactive road – A road needed only infrequently, for fire control or other intermittent management activities. These roads remain largely unused for most of the year, or for several years in succession, but have drainage structures intact and require regular inspection and maintenance.

Inboard ditch – The drainage ditch on the inside of the road, usually at the foot of a cutbank.

Infiltration – The movement of water through the soil surface of the soil.

Inner gorge – A stream reach bounded by steep valley walls that terminate upslope into a more gently topography. Common in areas of rapid stream downcutting or uplift.

Insloped road – Road surface that is sloped in toward the cutbank. Insloped roads usually have an inboard ditch that collects runoff from the road surface and cutbank.

Intermittent stream – Any nonpermanent flowing drainage feature having a definable channel and evidence of scour and deposition. Intermittent streams flow in response to rainfall, and then for some period after the cessation of rainfall (being fed by groundwater discharge).

Landslide – The downslope movement of a mass of earth caused by gravity. Includes but is not limited to debris slides, torrents, rock falls, debris avalanches, and creep. It does not include dry ravel or surface erosion by running water. It may be caused by natural erosional processes, by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).

LWD – Large woody debris; portions of downed trees that collect in the stream and provide channel structure and habitat for aquatic animals.

Maintained road – A road which is regularly inspected and whose cutslopes, road surface, drainage structures and fillslopes are maintained to prevent erosion and deterioration.

Maintenance activities – Routine maintenance activities that may require clearing, grading, or excavation to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

Maintenance facilities – Facilities under County ownership or control that contain such areas as fueling areas, waste storage or disposal facilities, wash racks, equipment or vehicle storage, and materials storage areas.

Mass wasting – Downslope movement of soil mass under force of gravity; often used synonymously with “landslide”.

Mature tree - A tree with width greater than a 12-inch (30cm) diameter at breast height (dbh).

Mitigate – To offset or lessen real or potential negative environmental impacts or effects through the application of additional controls or actions.

Mulch – Material placed or spread on the surface of the ground to protect it from raindrop, rill and gully erosion. Mulches include wood chips, rock, straw, wood fiber, and a variety of other natural and synthetic materials.

Nonpoint source discharge – Discharge from a diffuse pollution source, that is one without a single point of origin or not introduced into a receiving stream from a specific outlet like a pipe.

Oil waste – Oil of any kind or in any form, including but not limited to petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged soil.

Ordinary High Water Mark – "That line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding area." [33 CFR 328.3(e)]

Organic matter – Material that is derived from living organisms, such as plants.

Outboard fill – The outside road edge fill material, usually generated by side cast road construction. This fill often comprises up to half the running surface width.

Outboard berm – A mounded earthen curb along the outboard edge of the road usually generated by periodic grading of the road. Berms trap water on the road.

Outfall – The discharge from a CMP, quantified by the vertical distance from the CMP outlet to its catchment basin.

Out-migration – The life cycle phase of anadromous salmonid fish, where juveniles move downstream from fresh water to the estuary and then the ocean for their salt water phase.

Outsloped road – Road surface that is sloped out away from the cutbank toward the road's fillslope. Outsloped roads may or may not have an inboard ditch.

Outsloping – The act of converting an insloped road to an outsloped road. Outsloping can also refer to the act of excavating the fill along the outside of the road and placing and grading it against the cutbank, thereby creating an outsloped surface where the roadbed once existed.

Partial bench – A partial bench road is one in which the road bed is part bench and part fill, somewhere between full bench and a full fill road.

Peak flow (flood flow) – The highest amount of stream or river flow occurring in a year or from a single storm event.

Perched outlet – A condition in which a culvert's outlet is suspended over the immediate downstream pool, requiring fish to leap into a culvert (DFG).

Perennial stream – A stream that typically has running water on a year-round basis.

Permanent road – A road which is planned and constructed to be part of a permanent all-season transportation system. These roads have a surface which is suitable of use throughout the entire winter period and have drainage structures, if any, at watercourse crossings which will accommodate the 50-year flood flow. Permanent roads receive regular and storm-period inspection and maintenance.

Permeable fill – See *Drainage blanket.*

Photopoint – Established point on the landscape used to conduct photographic monitoring.

Put-to-bed - The process of actively abandoning a road by eliminating all conceivable risks of sediment production until the road is again needed in future years. “Putting-to- bed” or road closure involves completely removing stream crossing fills and associated drainage structures and eliminating the risk of sediment production from roads. (See *Road closure*.)

Range finder – A hand-held field instrument used to measure distances less than about 1000 feet.

Ratio (slope) – A way of expressing slope gradient as a ration of horizontal distance to vertical rise, such as 3:1 (3 feet horizontal for every 1 foot vertical rise of fall).

Ravel (dry ravel) – Soil particles dislodging and rolling down a slope under the influence of gravity. Ravel occurs most rapidly when a cohesionless soil on a steep slope dries out. Ravelling is dramatically increased when frost acts on the exposed soil. Ravel on some steep, bare cutbanks can quickly fill ditches and supply sediment that is then eroded and moved to nearby ditch relief culverts or streams by concentrated ditch flow.

Rearing – The phase of a life cycle for a salmonid fish, where juveniles emerge from eggs and grow to large enough size to become adults or migrate to the ocean (for anadromous forms).

Redd – The nest depression, constructed by spawning salmonid fish in stream gravels, in which the eggs are laid.

Rill – A small erosion channel formed by concentrated surface runoff that is less than one square foot in cross sectional area. It typically forms where rainfall and surface runoff is concentrated on fillslopes, cutbanks, and ditches. Larger channels are called gullies.

Rip-rap – The large rock or other suitable material placed on the ground or along streambanks as an armoring device to prevent or reduce erosion.

Riparian – The banks and other lands adjacent to lakes, watercourse, estuaries, and wet areas. Often refers to water-loving vegetation along the water’s edge.

Riparian zone –Area alongside a stream that provides shade for water temperatures, streambed and flow modification by contributing large woody debris, filtration of organic and inorganic material, upslope stability, bank and channel stabilization and vegetative structure diversity for fish and wildlife habitat. (Source: California Forest Practice Rules, California Department of Forestry and Fire Protection Resource Management-Forest Practice Program, 2003.

River run rock – Aggregate (gravel) that is excavated from a river bed. It is usually well rounded and, unless screened, also contains sand.

Road abandonment – In the past, road abandonment was synonymous with blocking the road and letting it grow over with vegetation. Today, proper road abandonment involves a series of proactive steps and activities that essentially erosion-proof a road so that further maintenance will not be needed and significant erosion will not occur. (See also: *Road closure*)

Road closure – Also called “proactive road abandonment”, it is a method of closing a road so that regular maintenance is no longer needed and future erosion is largely prevented. The goal of road closure is to leave the road so that little or no maintenance is required for stability while the road is unused. Road closure usually involves erosion-proofing techniques including removing stream crossing fills, removing unstable road and landing fills, installing cross road drains for permanent road surface drainage and other erosion prevention and erosion control measures as needed. Proper road closure is not accomplished by blocking a road and walking away from it to let “nature reclaim the road”. (See also: *Road abandonment*)

Road failure – Damage to the roadbed (usually caused by a road bed slump, fill failure, stream crossing washout or major gully) which prevents vehicular passage, but does not usually mean minor cutbank or fill sloughing incidental to road settling.

Road fill excavation – Excavation and removal of unstable or potentially unstable fill and/or sidecast spoil from the outer edge of a road prism. Road fill excavations are performed as a preventive measure to guard against landsliding of unstable material into downslope stream channels.

Road grade – The slope of a road along its alignment.

Road maintenance – The actions taken to prevent erosion and/or the deterioration of a road, including the cutbank, the road surface, the fillslope and all drainage structures. Road maintenance activities include such tasks as grading, ditch cleaning, brushing and culvert cleaning.

Road network – The pattern of all the roads in an ownership, watershed, hillside or other defined area. The road network typically includes main trunk roads, secondary roads, and spur roads (in logging areas).

Road reconstruction – Repair or upgrading of those pre-existing roads that are to be restored or improved to make them useable for traffic. Reconstruction typically refers to road rebuilding when one or more road failures have occurred. (See: *Road failure*)

Road runoff – Surface runoff that collects on and is drained from the road surface, usually as a direct response to rainfall.

Rock armor – Coarse rock that is placed to protect a soil surface, usually from erosion caused by flowing or falling water. Rock armor is one type of material used for energy dissipation at culvert outfalls.

Rock pit – A large outcrop of bedrock that has been developed for aggregate uses, such as road surfacing material and/or larger rock armor. A borrow pit is an excavation from which material is removed for use in another location. (See also: *Borrow site*)

Rolling dip – Shallow, rounded dip in the road where road grade reverses for a short distance and surface runoff is directed in the dip or trough to the outside or inside of the road. Rolling dips are drainage facilities constructed to remain effective while allowing passage of motor vehicles at reduced road speed.

Runoff – Rainfall or snowmelt which flows overland across the surface or hillslopes and along roads and trails.

Rust line – The upper limit of rust inside a CMP which reflects the depth of sustained high water flows through the pipe.

Salmon, Chinook – A salmonid species, also called King Salmon in California.

Salmon, Coho – A salmonid fish species, also called Silver Salmon in California.

Salmonid – A species of fish that is a member of the salmon and trout family.

Sanitary sewer system – Underground pipes that carry off only domestic and industrial waste, not storm water.

Sediment – Organic or inorganic material that is carried or suspended in water and that settles out to form deposits in the storm drain system or receiving waters.

Sediment delivery – Material (usually referring to sediment) which is delivered to a stream channel. Sediment delivery often refers to the percent of material eroded from a site which actually gets delivered to a stream channel (as opposed to that which is stored on the hillslope).

Sheet erosion – The loss of thin layers of soil across a large surface area.

Shotgun culvert – A CMP that protrudes from the road fill with no down spout. The falling water often causes substantial erosion in the catchment area.

Sidecast – The excess earthen material pushed or dumped over the side of roads. Sidecasting usually refers to pushing loose dirt off the road down an embankment (as opposed to leaving loose dirt piled along the shoulder or roadside ditch after activities such as blading. This practice (in this manual) refers to relatively small quantities of soil created through activities such as blading the surface or road shoulders, not large quantities of soil from landslides or other mass wasting events.

Silt fence – A constructed barrier used to contain soil eroded from a construction site. The barrier is made from filter fabric stretched between fence posts placed on contour along a slope.

Slope ratio – See *Ratio*

Slope stability - The resistance of a natural or artificial slope or other inclined surface to failure by landsliding (mass movement).

Slump – An episodic, fast to very slow mass movement process involving the rotation of a block of hillslope or road along a broadly concave slip surface, often referred to as a rotational slide.

Smolt – A juvenile salmonid fish in the later phase of transitioning from fresh water to salt water, before migrating to the ocean.

Spawning – The phase of adult salmonid fish where redds (nests) are made and eggs are laid in gravels of streams.

Species of Special Concern – A designation used by California (CSC) and federal (FSC) agencies to refer to those species of animals (and sometimes plants) that have declining population levels, limited ranges, and/or continuing threats that have made them vulnerable to extinction. They may soon reach the point where they meet criteria for listing as threatened or endangered under the State and/or Federal Endangered Species Acts. No special legal protections are associated with this designation alone.

Spoil disposal site – The location where spoil material (woody debris and excavated soils) can be placed without the threat of accelerated erosion or of initiating slope instability. Stable spoil disposal sites include the cut portion of closed roads, the inside portion of turnouts, and flat or low gradient natural benches.

Spoil (spoil materials) – Material (soil and organic debris) that is not used or needed as a functional part of the road or a landing. Spoil material is generated during road construction, reconstruction, and maintenance activities.

Spur road – A side road off a main trunk road or a secondary road. Most spur roads are dead-end.

Steelhead – The anadromous form of the rainbow trout. Aside from their sea-going habits and large size at spawning, there is little to distinguish them from rainbow trout that are resident in the same streams that steelhead use for spawning.

Storm maintenance (emergency road maintenance) – Road inspection and maintenance that is performed during periods of high rainfall and runoff when drainage structures are most likely to plug, malfunction or fail.

Storm water – Rainfall runoff, snow melt runoff, surface runoff and drainage.

Storm water drainage system – Streets, gutters, conduits, artificial drains, channels and watercourses, or other facilities that are owned, operated, maintained, and used for the purpose of collecting, storing, transporting, or disposing of storm water.

Stream – A natural configuration in the land surface that transports water in a perennial, intermittent, or ephemeral circumstance.

Stream Class – A category of a watercourse based on the its *beneficial* use (based on California Board of Forestry regulations, 2000):

> Class I Watercourse: A stream (or lake) that is used for a domestic water supply (including springs) on the site and/or within 100 feet downstream of the operations area; and/or fish always or seasonally present onsite, including habitat to sustain fish migration and spawning. (It typically flows year round, but may flow seasonally.)
>
> Class II Watercourse: A stream (or lake) that has fish always or seasonally present offsite within 1000 feet downstream, and/or aquatic habitat for nonfish aquatic species; excludes Class III waters that are tributary to Class I waters. (These streams may flow year round or seasonally; many springs and wetlands are also included.)
>
> Class III Watercourse: A stream channel (or lake) with no aquatic life present but showing evidence of being capable of sediment transport to Class I or II waters under normal high water flow conditions.
>
> Class IV Watercourse: Man-made watercourses, usually downstream, for established domestic, agricultural, hydroelectric supply or other beneficial use.

Stream crossing – The location where a road crosses a stream channel. Drainage structures used in stream crossings include bridges, fords, culverts and a variety of temporary crossings.

Stream crossing excavation – The excavation of the fill material that was used to build (fill) a stream crossing, specifically a culverted crossing, a log crossing, or a temporary crossing. A stable steam crossing excavation must be dug down to the level of the original stream bed, with side slopes graded (excavated) back to a stable angle (usually 50% or less, depending on soil characteristics).

Subdrainage (subsurface drainage) – The flow of water beneath the surface of the ground. Along roads, specific construction techniques can be used to make sure subsurface drainage is not impeded by the road bed or road fill.

Surface erosion – The detachment and transport of soil particles by wind, water or gravity. Surface erosion can occur as the loss of soil in a uniform layer (sheet erosion), in many rills, gullies, or by dry ravel.

Surface runoff – Precipitation, snow-melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of non-point source pollutants.

Surfacing (surface course) – The top layer of the road surface, also called the wear course. Rock aggregate and paving are two types of surfacing used to weather-proof the road for winter use.

Swale – A channel-like linear depression or low spot on a hillslope which rarely carries runoff except during extreme rainfall events. Some swales may no longer carry surface runoff under the present climatic conditions.

Take - To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (as defined by the federal Endangered Species Act); to hunt, pursue, catch, capture, or kill, or to attempt to do any of these things (as defined by the California Endangered Species Act).

Threatened Species – Any species which is likely to become an endangered species within the foreseable future throughout all or a significant portion of its range; an official designation under the California and/or Federal Endangered Species Acts.

Through-cut (Double cut) – A road section that has a cutbank on each side of the road, both higher than the road elevation. This condition channels water down the road and usually creates an erosion source until a drainage opportunity occurs at a single cutbank section.

Through-fill – A road which is entirely composed of fill material and which has a berm along both sides of the road, thereby intentionally containing road surface runoff on the road and directing it to a single discharge point, usually a fabricated metal berm-drain. Through-fills are typically found at sensitive stream crossings where the fill is bermed on both sides of the road.

Total Maximum Daily Load (TMDL) – A process under the federal Clean Water Act that provides a tool for implementing State water quality standards and is based on the relationship between pollution sources and instream water quality conditions.

Trash rack – A debris grid built just over or upstream from a culvert inlet to trap floating woody debris before it plugs the culvert inlet.

Turbidity – Water that is cloudy or muddy usually due to sediment.

Unstable areas – Areas characterized by mass movement features or unstable soils, or by some or all of the following: hummocky topography consisting of rolling bumpy ground, frequent benches, and depressions; short irregular surface drainages which begin and end on the slope; visible tension cracks and head wall scarps; irregular slopes which may be slightly concave in upper half and convex in lower half as a result of previous slope failure; evidence of impaired ground water movement resulting in local zones of saturation including sag ponds with standing water, springs, or patches of wet ground; hydrophytic (wet site) vegetation; leaning, jackstrawed or split trees; pistol-butted trees with excessive sweep in areas of hummocky topography.

Unstable soils – These soils are indicated by the following characteristics: 1) unconsolidated, non-cohesive soils (coarser textured than loam) and colluvial debris including sands and gravels, rock fragments, or weathered granitics (e.g., decomposed granite or “DG”). Such soils are usually associated with a risk of shallow-seated landslides on slopes of 65% or more, having non-cohesive soils less than 5 feet deep in an area where precipitation exceeds 4 inches in 24 hours in a 5-year recurrence interval; 2) increase and decrease in volume as moisture content changes. During dry weather, these materials become hard and rock-like exhibiting a network of polygonal shrinkage cracks and a blocky structure resulting from dessication. Some cracks may be greater than 5 feet in depth. When wet, these materials are very sticky, dingy, shiny and easily molded.

Washed out stream crossing – A stream crossing fill that has been partially or completely eroded and “washed” downstream. Washouts usually occur when a culvert plugs and streamflow backs up and flows over the roadbed during flood events.

Waters of the U.S. – In nontidal waters, this federal legal jurisdiction extends: a) to the ordinary high water mark in the absence of adjacent wetlands; b) beyond the ordinary high water mark to the limit of the adjacent wetlands when present; c) to the limit of the wetland when only wetlands exist.

Waters of the State –Any surface water or groundwater, including saline waters, within the boundaries of the state (§13050(e) of the Porter-Cologne Water Quality Control Act).

Watercourse – Surface water bodies including streams, lakes, bays, estuaries, lagoons, reservoirs, and ponds. The term includes any well defined channel with distinguishable bed and bank showing evidence of having contained flowing water indicated by deposit of rock, sand or gravel.

Water quality – The chemical and biological characteristics of stream and lake water.

Watershed – The area or drainage basin contributing water, organic matter, dissolved nutrients and sediments to a stream or lake.

Wetlands – Areas that are inundated by surface water or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil conditions for growth and reproduction (Executive Order 11990). Wetlands generally include, but are not limited to, marshes, bogs and similar areas.

Winterize – To perform erosion prevention and erosion control work on a road in preparation for winter rains and flood flows.

Sources: Weaver & Hagans (1994); Caltrans (1998); Downie et al. (1998); Lewis et al. (2000); ODOT (1999); various state and federal statutes and regulations.

APPENDIX C: TECHNICAL REFERENCES

Technical References are available on-line and are not reproduced in this document.

1. Culvert Criteria for Fish Passage: California Salmonid Stream Habitat Restoration Manual, Appendix IX-A. California Department of Fish and Game, Flosi et. al., 2002.

2. Guidelines for Salmonid Passage at Stream Crossings, NOAA Fisheries. California Salmonid Stream Habitat Restoration Manual, Flosi et. al., 2002.

3. NOAA Fisheries Water Drafting Specifications. National Marine Fisheries Service, Southwest Region. August 2001.

4. Guidelines for Temporary Water Drafting from Watersheds Supporting Anadromous Salmonids. California Department of Fish and Game. Macedo. DRAFT November 2001.