Final Report: 1999 South Fork Garcia River Watershed Erosion Control and Prevention Project, SB271 Road Upgrading and Decommissioning Project

prepared for:

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Mendocino Redwood Company,
&
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Final Report
1999 South Fork Garcia River Watershed Erosion Control and Prevention Project

CDF&G State Contract #P9985019

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Background

The South Fork Garcia River Watershed Restoration Project is the pilot implementation project for Trout Unlimited's much larger scale program intended to address factors and issues affecting coho salmon recovery in northern California coastal watersheds. The South Fork Garcia River (SFGR) Watershed Restoration Project is a cooperative coho salmon and steelhead restoration effort that brings together 6 cooperators to first address upland sediment sources and then address instream spawning and rearing habitat needs.

The cooperators are:

1) Trout Unlimited, a national coldwater fisheries conservation organization,
2) Mendocino Redwood Company, the largest timberland owner in Mendocino County,
3) Craig Bell, a local restoration expert,
4) Pacific Watershed Associates, a renowned watershed consulting firm,
5) the California Department of Fish and Game,
6) the Mendocino County Resource Conservation District,
7) the National Fish and Wildlife Foundation, and
8) the National Oceanic and Atmospheric Administration.

In the fall of 1998, Trout Unlimited (TU) retained Pacific Watershed Associates (PWA), of Arcata, CA. to conduct an upland sediment source assessment and develop an implementation plan for controlling erosion and sediment delivery from all 8.0 mi^2 of land in the SFGR owned and managed by Mendocino Redwood Company (see map 1). PWA completed the field investigation and prepared an Action Plan which included specific erosion control tasks to perform, estimates of "sediment savings", needed equipment and labor hours to complete the work, material costs, and a cost estimate to perform the work. The assessment mapped 148 individual sites, where sediment was or had the risk of being delivered to stream channels, along 22 different road segments totaling nearly 25 miles in the SFGR. The assessment documented a total of 39,700 yds^3 of future sediment delivery if no efforts were made to correct road conditions in the SFGR.

Concurrently with the PWA upslope planning process Craig Bell of TU was identifying the locations for and types of potential instream habitat improvements that were designed to improve the complexity of instream habitat. Fifteen suitable work locations were identified and classified as either a "structure site" or "channel maintenance site." Each was intended to either increase the frequency, depth and volume of available pool habitat in the SFGR, or to increase the area of available spawning habitat in the basin.

In May 1999, TU submitted a proposal to the California Department of Fish & Game (CDF&G) S.B. 271 Grant Program to implement and treat seven road segments in the SFGR totaling 8.75 miles in length (36% of the total inventoried road miles). The project proposed to treat 82 of the inventoried sites (55% of the total), and prevent over 28,800 yds^3 of sediment from being delivered to the SFGR (72% of the estimated total sediment delivery). The instream component of the project proposed to construct the 10 instream structures along a mile of the main stem SFGR.

The State accepted the project for funding, and TU received a signed contract with the State to commence the project on September 19, 1999. During the winter and spring 2000, CEQA and the 1603 permit were completed while TU, the Mendocino Redwoods Company (MRC) and PWA finalized details of the project.

Location

The SFGR, a tributary to the Garcia River, is located in coastal Mendocino County. The SFGR sub-basin is found on the Gualala USGS 7.5 minute topographic map. It is further identified by township 12 north and range 15 west, sections 29 through 34, and T 11 N, R l5 W, sections 3 through 5 (see location map).

Access to the SFGR, from either the north or south, is via U.S. Route 1. Approximately 8 miles north of the town of Gualala, or 4 miles south of the town of Point Arena, turn east onto Iverson Road. Follow Iverson Road to the ridge top and then go south on the ridge to Fish Rock Road. Turn left (go east) down Fish Rock Road to the bottom of a long steep hill just past the county dump. When the pavement ends, turn left onto an obvious dirt road with a gate about 250 feet from Fish Rock Road. This gate belongs to MRC and is the primary access into their SFGR property.

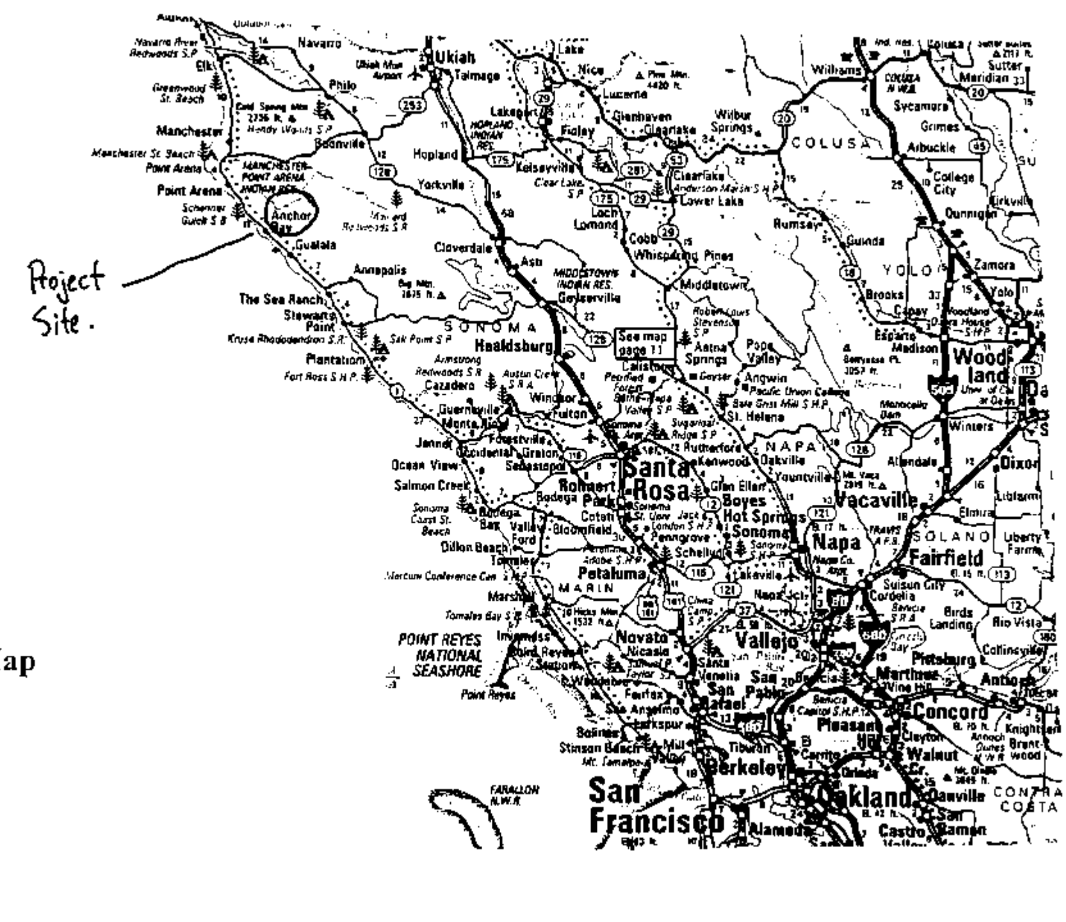


Figure 1: Location Map

Project Objectives

The project was designed to address and implement both upslope and instream restoration prescriptions recommended by PWA and TU, respectively. The upslope or road upgrading project was designed to protect and improve salmonid habitat through controlling and preventing road-related erosion and sediment delivery to streams in the SFGR, as well as to lower, long term, road maintenance costs for MRC. The primary objective of the project was to implement cost-effective erosion control and erosion prevention work on roads that were identified as a part of the comprehensive watershed assessment and inventory project for the sub-basin.

The implementation of erosion control and erosion prevention work is perhaps the most important step to protecting and restoring watersheds and their anadromous fisheries (especially where sediment input is a limiting or potentially limiting factor to fisheries production, as is thought to be the case for the SFGR). Unlike many watershed improvement and restoration activities, erosion prevention and "storm-proofing" has an immediate benefit to the streams and aquatic habitat of the basin. It helps ensure that the biological productivity of the watershed's streams is not impacted by future human-caused erosion, and that future storm runoff can cleanse the streams of accumulated coarse and fine sediment, rather than depositing additional sediment from managed areas. The road upgrading and decommissioning work completed on this project is a significant step toward realization of long term salmon habitat protection and improvement in the Garcia River watershed.

The second objective was to improve instream habitat. TU recognizes that the reduction of upslope sediment sources is the necessary first step in recovering a sub-basin, and thus has placed greater emphasis on that portion of the project. Instream work is specifically designed to complement and build upon the foundation laid by the stabilization of upslope areas. The instream structures are calculated to provide rapid and permanent enhancement of the existing spawning and rearing habitat in the basin.

Project Description

The project, as funded by CDF&G, was initially designed to 1) lower the risk of culvert failure and subsequent sediment delivery at 42 stream crossings, 2) prevent fill failure landsliding at 36 sites, and 3) improving road bed drainage by disconnecting the road bed from stream crossings or gullies through the construction of rolling dips, berm removal, outsloping the road, etc. along 7,250 feet of road, and treating 4 separate "other site" locations, mostly gullies, along the roads **(Attachment #1: South Fork Garcia River site map).**

During the winter and spring 2000, numerous meetings were held between MRC, PWA, and TU to finalize all the proposed road treatments. All proposed work sites and reaches of road to be treated were re-flagged and re-evaluated in the field **(Table 1: Proposed & Installed Treatments).**

Treatment prescriptions for all sites were finalized, including the list of needed culverts, road or rip-rap sized rock, seed and mulch. For road reaches, the specific locations where road shapes were to be changed from insloped to outsloped, or have berms removed or receive rolling dips were also determined and flagged in the field. A Road Log was developed which described all proposed work items, by mile post, along with explanations of subtle differences in the treatment or construction details. At the same time, specific Technical Specifications were developed, along with typical construction drawing for each major category of work items (see **Attachment #2: Conceptual Diagrams).**

Once PWA produced the Road Log, pre-work field trips were scheduled in early July 2000 for William T. Piper Logging, Manchester, CA., the heavy equipment contractor, MRC foresters, TU, and PWA. The required culverts arrived in the SFGR on July 10, 2000 and work commenced by first distributing a large majority of the culverts to a designated work site. Heavy equipment work and associated grass seeding, straw mulching and tree planting occurred over a two-year period. All road upgrading and decommissioning work was performed on the G-008 road, G-006 road, G-005-01 and the B Line between July and late October 2000. The remaining roads (the G-005-03, G-003 and the Q Line) were treated during September and October 2001. In general, all treatments to prevent surface erosion (i.e. seeding and mulching) were immediately applied to a site as soon as the construction was completed. MRC donated young conifers and hardwoods and TU coordinated tree planting at most treated sites during the winter months.

All instream structures to improve habitat were installed by TU during July and August, 2000. MRC provided large root wads and heavy equipment to assist with getting the materials close to the intended placement location.

At least 8 different field trips for public and agency personnel were conducted in the SFGR during the contracting period. These included 2 separate field reviews of completed work with Steve Cannata, our CDF&G contract manager. There was a two-day workshop for all MRC contractors and foresters in 2000. There were also field trips for 25 Regional Water Quality Control Board staff, for 16 contractors and heavy equipment operators as part of a Bodega Bay Marine Lab sponsored workshop, for 35 equipment operators and large property managers sponsored by the Salmonid Restoration Federation, and 4 different, much smaller field trips for NOAA, NMFS, National Fish and Wildlife Foundation, and Water Quality personnel. During the project, TU arranged for photograph shoots and contacted reporters, efforts that led to newspaper coverage and articles in *Trout* and *California Fly Fisher* magazines discussing the project goals and the unique and successful partnership between a conservation group, a timber company, expert consultants, and state, county and federal agencies. Copies of both articles have been included in **Attachment #5.**

The final invoice and a final report was prepared and sent to CDF&G on April 12, 2002.

Project Implementation

Upslope work

Piper Logging used either one or two excavators, 2 dozer tractors, a front end loader, dump trucks, a water truck, and a motor grader to treat all the recommended sites and road reaches. The equipment worked in various combinations depending on whether a culvert, armored crossing, or road reach was being treated. Likewise, the installation of a large number of armored crossings required a lot of loader and dump truck time to stage rock armor materials along the road at designated sites.

The CDF&G funded plan called for hydrological closure or "decommissioning" 4 roads (the G-003, G-005-01, G-005-03 and the Q Line) which totaled 4.83 miles in length, while the remaining 3 roads (the B Line, G-006 and the G-008) which totaled 3.92 miles were to be upgraded or "storm-proofed" (see **Attachment** #1). During the finalization of treatment prescriptions and the development of the Road Log, a few specific erosion control and erosion prevention measures were altered at some sites. This was the result of changes in site conditions at several sites since the plan was developed in 1999, and also long term transportation planning by MRC. **Table 1: Proposed versus Installed Treatments for the South Fork Garcia River Project** itemizes the number of proposed treatment types versus the actual "as built" numbers.

Table 1: Proposed versus Installed Treatments for South Fork Garcia River Project.

Treatment Type	Proposed No.	Installed No.
Install Culvert	3	4
Replace Culvert	10	10
Install Bridge	0	2
Install Armor Crossing	0	10
Decommission Crossing	26	19
Install Trash Rack	1	1
Critical Dip	9	9
Excavate Soil	70	70
Install Rolling Dips	25	65
Outslope road	505LF	16,250 LF
Remove berm	320LF	1,025 LF
Remove Ditch	200LF	875 LF
Other (mainly gully treatments)	4	2

Forty five (45) stream crossings were re-constructed or decommissioned to accommodate the 100 year flood flow along the 8.75 miles of treated road. This included installing or replacing culverts at 14 stream crossings, removing culverts and installing armored fill crossings at 10 stream crossings, installing 2 flatcar bridges at crossings that were originally slated for new culverts, and completely excavating or decommissioning 19 stream crossings on abandoned roads. Many of the newly culverted stream crossings had 9 critical dips installed on the down road hinge line to prevent stream diversions in the event that a culvert does plug with sediment and debris, and one stream crossing had a trash rack installed to reduce the risk of the culvert plugging.

A total of seventy (70) sites had soil, fill material, or channel sediment stored above culvert inlets excavated and disposed of in a proper manner. This generally involved using the excavated material to change road shapes and improve road drainage by using the material to outslope the road bed. Nineteen (19) of the sites are decommissioned stream crossings, 2 are stream crossing fills which were excavated to accommodate the two new bridges, 6 are stream crossings which had stored sediment above the culvert inlet, and 43 sites are potential fill or landing failure which were excavated (3 additional potential fill slope failures were excavated along the G-005-01 and G005-03 roads during the decommissioning operations).

Road bed drainage improvements consisted of constructing 65 rolling dips along the road at 200 to 300 foot spacings. The excavated material was used to eliminate or fill nearly 16,250 linear feet of inboard ditch to further improve the road outslope. In addition to the above treatments to improve and disperse road drainage, heavy equipment also independently removed 1,025 feet of berm and 875 feet of ditch, at various locations, along the outside and inside edge of the road, respectively. The Other sites listed in Table 2 are locations where hill slope gullies were de-watered.

The principal changes in the plan were associated with upgrading instead of decommissioning, as planned, along the first sections of the G-003 road, the G-005-01 and the G-005-03 roads. In reviewing the plan, the sections of road all lacked major stream crossings, and by excavating all the unstable fills and improved the road drainage, each section could be reconstructed to provide a stable, low risk road route. Altering the plan for these sections of road from decommissioning to upgrade caused cost over-runs, but MRC increased their matching funds to accommodate for the changes in prescribed treatments. As can be seen in Table 2, there were a total of eight small streams along the G-005-01 and G005-03 roads which were constructed with rock armored fill crossings, and 2 sites along the G-003 road which received over-sized new culverts designed to accommodate a storm flow greater than the 100 year storm.

Finally, some roads assessed by PWA in 1998 were left untreated due to lack of funding. TU plans to work with Craig Bell to secure funding to restore these roads in conjunction with MRC and PWA. The highest priorities are the F-005 and G-006-04. There area also a number of relatively minor sites along the G-006-06 that could be treated. A small number of additional sites remain untreated, typically scattered along ridgeline roads and of low priority in relation to the treated roads.

Instream work

Under the direction of Craig Bell, a total of 12 instream structures were installed within the main stem of the SFGR. They consisted of 7 complex and *5* simple log, root wad and boulder structures. Thanks to MRC's assistance, TU was able to install two additional structures over the 10 that had been budgeted for. All structures were constructed according to the recommendations of the California Salmonid Stream Habitat Restoration Manual published by the CDF&G. **Attachment 4** describes the location and type of structures installed in the SFGR.

Table 2. Number of "Planned" versus "As Built" sites along roads in the South Fork Garcia River, Mendocino County, California

Road	**As Planned**				**As Built**				**Volume "saved" (yds^3)**
	Upgrade sites (#)		Decommission sites (#)		Upgrade sites (#)		Decommission sites (#)		
	Xing	*Slide(l)*	*Xing*	*Slide (1)*	*Xing*	*Slide (1)*	*Xing*	*Slide (1)*	
B-line	5	1	0	0	5	1	0	0	10,337
G-006	3	8	0	0	4(2)	8	0	0	4,030
G-008	9	0	0	0	9	0	0	0	2,008
G-003	0	0	3	2	2	0	1	2	2,349
G-005-01	0	0	10	11	4	0	6	12	5,219
G-005-03	0	0	8	15	4	0	4	16	3,175
Q-line	0	0	4	3	0	0	4	4	1,737
Totals:	**17**	**9**	**25**	**31**	**28**	**9**	**15**	**34**	**28,855**

[1] The slide category includes the 4 other sites identified in the original proposal. As stated earlier, 3 additional potential fill slope failures were excavated along the G-005-01 and G005-03 roads during the decommissioning operations.

[2] One the new flatcar bridges was installed at site#18 which was not part of the funded project. Funding from MRC and the Mendocino County Resource Conservation District permitted the removal of the undersized culvert and the installation of the bridge.

Budget

CDF&G funds were distributed to four recipients: MRC, PWA, Craig Bell, and TU. A final breakdown of the total figures per category with the line items from the original budget is provided below. All figures and line items are taken from Exhibit B (page 7) of the July 1, 1999 Standard Agreement (contract) between the CDF&G and TU.

Mendocino Redwood Company: $88,400. (Figure includes the following line items: Low Boy, D-7 Tractor, Excavator, Dump Truck, Compactor, Miscellaneous field supplies, 55 Bails Hay, 25 lbs. Seed/acre, Tools and instruments.)

Pacific Watershed Associates: $23,270. (Figure includes the following line items: Admin. Supervisor (PWA), Skilled Labor, Food/Lodging, Photographic Supplies, Transportation costs.)

Craig Bell: $4,000. (Figure includes the following line items: Construction materials (except Miscellaneous field supplies), Subcontractor, Liability insurance, Printing/duplicating/postage, Telephone.)

Trout Unlimited $12,667. (Figure includes the following line items: ACOE 404 permit, SRWQCB 401 permit, CDFG 1603 permit, Administrative Overhead.)

Total: $128,337.

A total of four invoices were submitted to the CDF&G. Those invoices were as follows:

27 October, 2000:

MRC: $42,628.50
PWA: $8,384.40
TU: $5,101.29

Total: $56,114.19

Withholdings@10%:

MRC: $4,736.50
PWA: $931.60
TU: $566.80

9 January, 2001:

MRC: $19,647.00
PWA: $3,189.60
TU: $2,283.30

Total: $25,119.90

Withholdings @ 10%:

MRC: $2,830.00
PWA: $354.40
TU: $253.70

17 October, 2001

MRC: $16,168.50
PWA: $3,189.60
TU: $1,935.90

Total: $21,294.00

Withholdings® 10%:

MRC: $1,796.50
PWA: $354.40
TU: $215.10

31 March, 2002

(Figures include 10% withholdings from previous invoices.)

MRC:	$9,956.00
PWA:	$8,506.40
Craig Bell:	$4,000.00
TU:	$3,346.51
Total:	**$25,808.91**

In the final invoice, some consolidation of budget line items occurred for the sake of simplicity and also to reflect cost adjustments made during the course of the project. For example, the Pacific Watershed Associates costs listed as "Project Supervision" and "Labor" included any remaining funds from line items Food/Lodging, Photographic Supplies, and Transportation costs. Costs incurred for the instream portion of the project were listed as "Instream structure component (materials and labor);" this category included all line items listed as Construction materials (with the exception of miscellaneous field supplies) as well as subcontractors, liability insurance, and administrative costs (printing/duplicating/postage and telephone), and also reflected cost adjustments made according to on-site needs as the project unfolded. Costs listed as "Administrative costs" reflected TU's administrative overhead costs; the figure also collected those funds allocated for ACOE 404 permit, SRWQCB 401 permit, and CDFG 1603 permit.

Significant match in addition to that specified in TU's original budget was raised in order to cover the cost of completing the upslope portion of this project. TU's overall 1998 funding request to the CDF&G was for $192,280.24. TU received $128,337.00. The final project cost of the upslope component (not including PWA supervision) was $240,852.29. The CDF&G allocated $88,400 to MRC for upslope work; MRC was committed to $38,595 in matching funds. After the CDF&G funding decision was made TU raised additional funding from the Mendocino County Resource Conservation District ($35,000.00) and from the National Oceanic and Atmospheric Administration ($29,000.00) to cover project costs beyond those allocated to the upslope portion by the CDF&G. All remaining costs were donated by MRC.

Finally, Craig Bell raised an uncalculated but extraordinary amount of match in the form of donated labor and donated tree seedlings from MRC. Bell organized numerous volunteer tree planting expeditions throughout the SFGR, with special focus on reseeding the decommissioned road sections. Bell also generated enormous publicity for the project and its partners, especially in the local communities. These efforts have borne fruit in the form of new partnerships to restore coho salmon and steelhead habitat.

Monitoring

Before the project commenced, photo point stations were established for many of the project work sites. These photo points were used to document the work sites before, during and after the excavation. Examples of "before" and "after" photo point shots have been included in the report to depict re-constructed stream crossings, decommissioned stream crossings, rolling dips and outsloped roads in the SFGR (see **Attachment #5: Selected before and after photographs).** The photo points will provide long-term effectiveness monitoring in the future.

Conclusions

The expected benefit of completing erosion control and prevention work lies in the reduction of long term sediment delivery to the SFGR, an important salmonid stream. The purpose of this project was to permanently reduce the amount of sediment that could erode and be delivered to the South Fork and its tributaries. By storm-proofing or decommissioning 8.75 miles of logging roads in the SFGR, an estimated 28,855yds^3 of sediment was prevented from being delivered to streams within the watershed. This, coupled with implementing an instream structure component, makes this project a comprehensive effort at protecting and restoring watershed processes.

TU wishes to thank all of the project's partners for their generosity, their expertise, and for the tremendous efforts that they put forth in order to see this project through to completion. We look forward to many more projects in the future.

Attachment #1. Site Map

Legend:

Treated as part of CDF&G Project

Decommissioned roads:

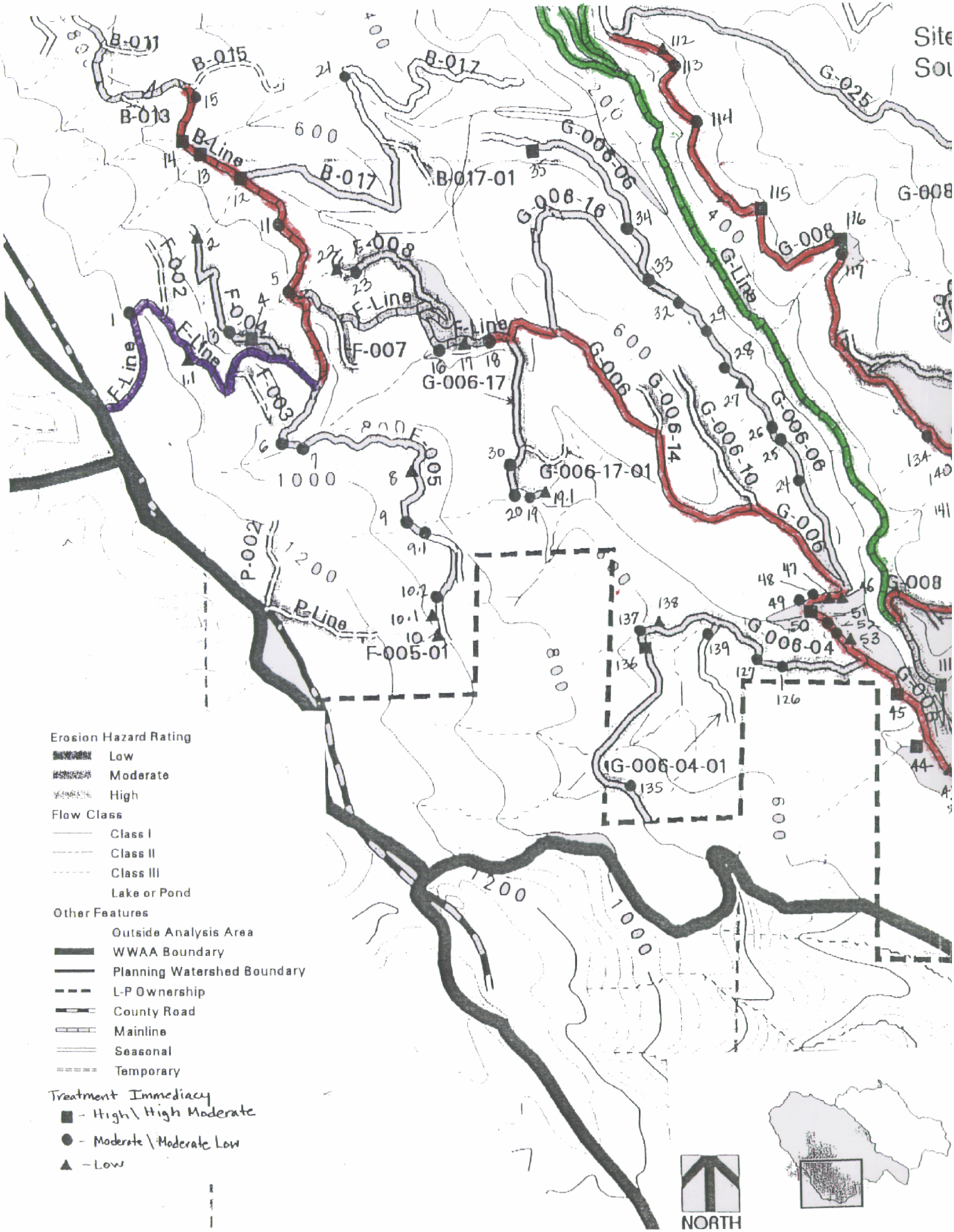
Upgraded roads:

Treated by MRC during TU/MRC operator/forester training session

Upgraded road:

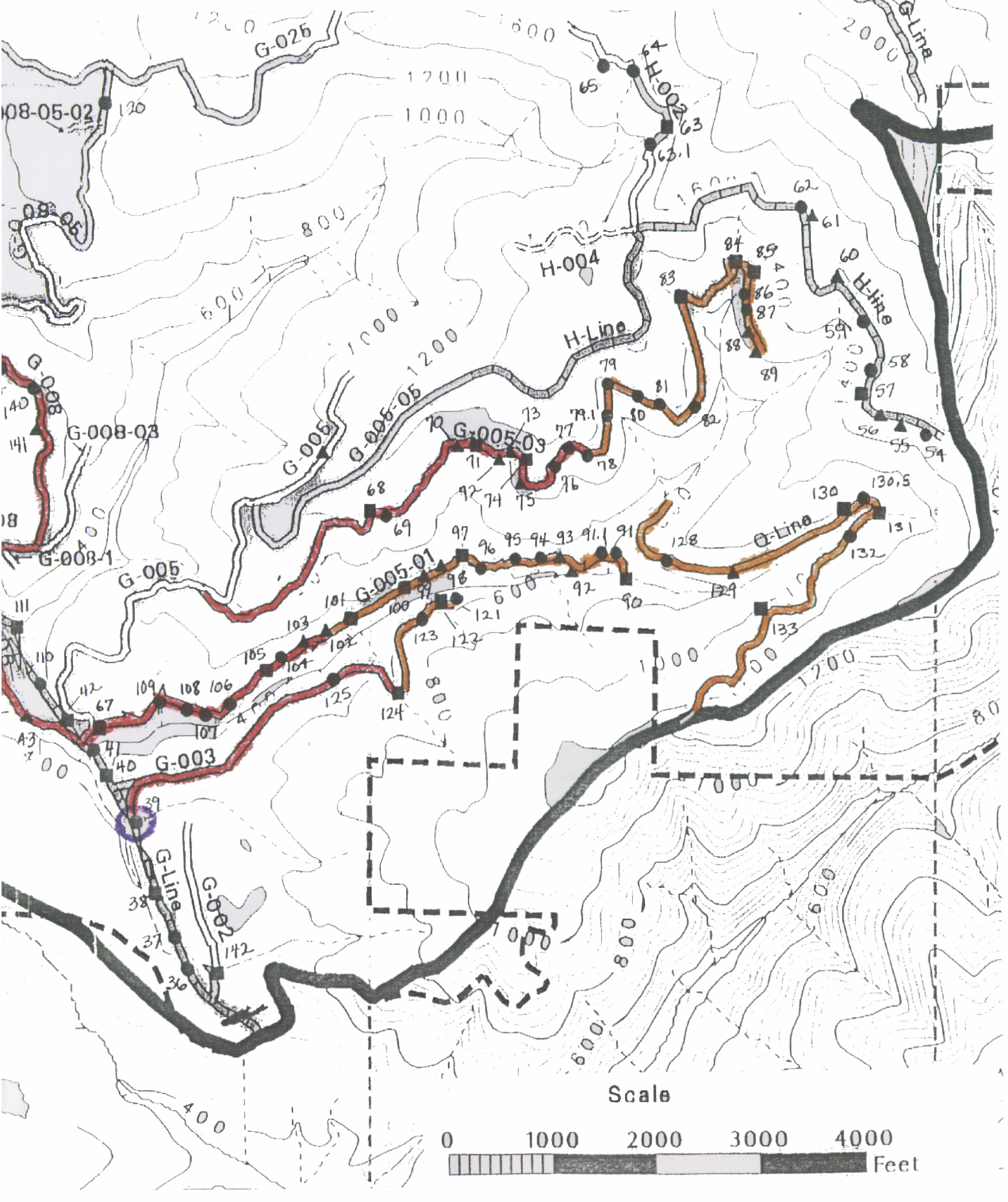
Treated by MRC as part of THP

Decommissioned road:



B-011
B-015
B-013
B-017
B-017-01
B-Line
F-002
F-004
F-003
F-Line
F-007
F-008
F-005
F-005-01
P-002
P-Line
G-006
G-006-06
G-006-16
G-006-17
G-006-17-01
G-006-14
G-006-10
G-006-08
G-006-04
G-006-04-01
G-008
G-025
G-Line
600
800
1000
1200
400
Erosion Hazard Rating
Low
Moderate
High
Flow Class
Class I
Class II
Class III
Lake or Pond
Other Features
Outside Analysis Area
WWAA Boundary
Planning Watershed Boundary
L-P Ownership
County Road
Mainline
Seasonal
Temporary
Treatment Immediacy
■ - High\ High Moderate
● - Moderate \ Moderate Low
▲ - Low
NORTH

Sites recommended for treatment by treatment immediacy, South Fork Garcia River, Mendocino County, California



Attachment #2.

Conceptual Drawing of Typical Road

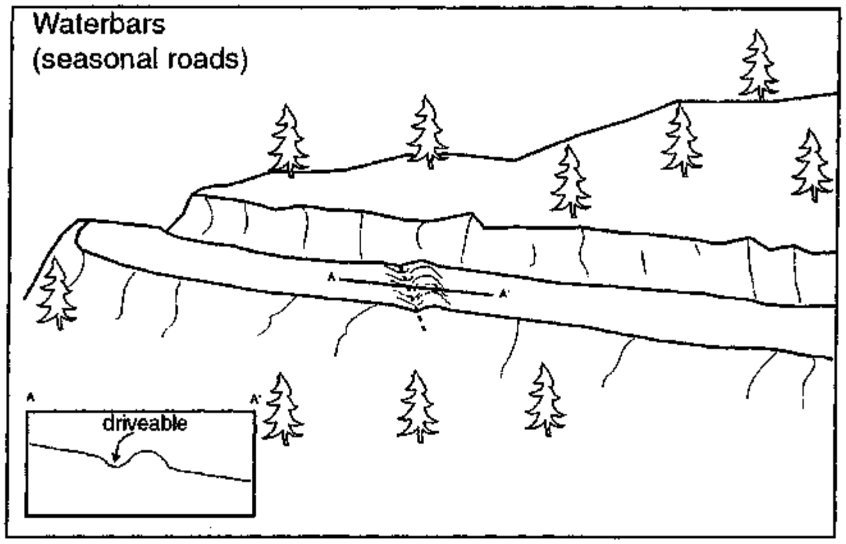
Upgrading and Decommissioning Treatments,

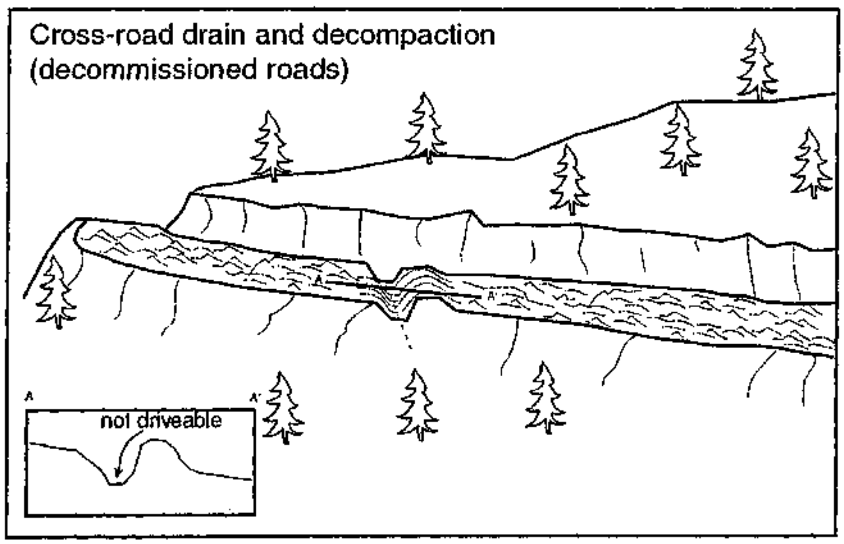
South Fork Garcia River,

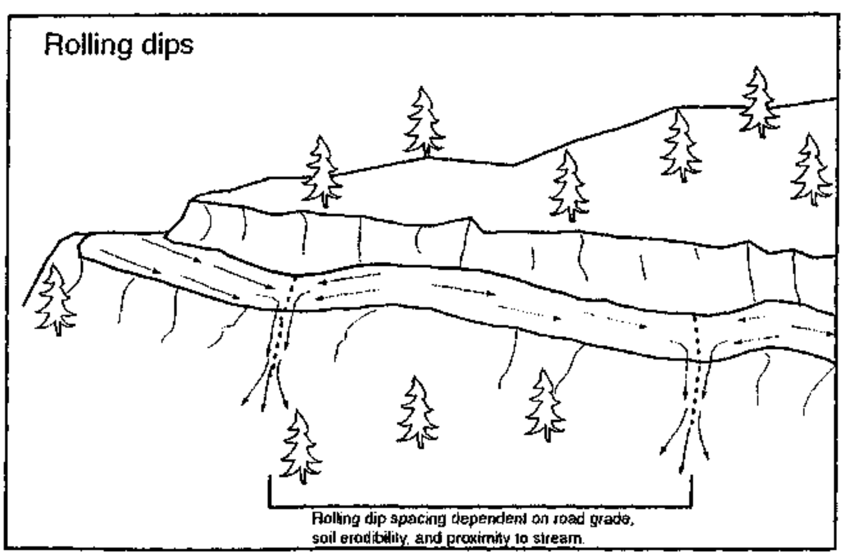
Mendocino County, California.

CDF&G State Contract #P9985019

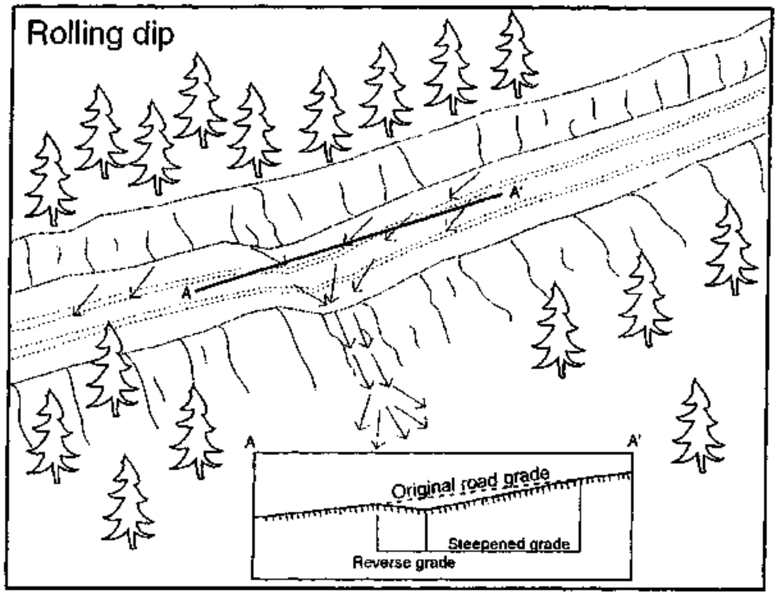
Dispersing road surface runoff







Road surface drainage by rolling dips



Rolling dip installation:

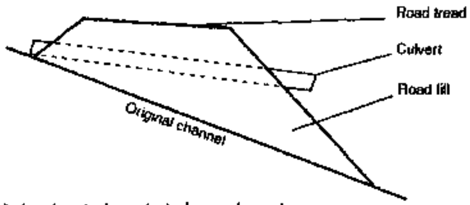
1)Rolling dips are installed in the road bed as needed to drain the road surface.
2)Rolling dips can be sloped either into the ditch or to the outside of the road edge as required to properly drain the road and disperse surface runoff.
3)Rolling dips are usually built directly across the road alignment with a cross grade of at least 1 percent greater than the grade of the road.
4)Excavation for the dips can be done with a medium size bulldozer (D-7 size) with rippers.
5)Excavation of the dips begins 50 to 100 feet up-road from where the axis of the dip is planned per guidelines established in the rolling dip dimensions table.
6)Material will be progressively excavated from the road bed, steepening the grade until the axis is reached.
7)The depth of the dip is determined by the grade of the road (see table).
8)On the down-road side of the rolling dip axis, a grade change should be installed to prevent runoff from continuing down the road (see figure).
9)The rise in grade should be carried for about 10-20 feet and then fall to the original slope.
10)The transition from axis to bottom, through rising grade to falling grade should be in a road-distance of at least 15 to 30 feet.

Table of rolling dip dimensions

Road grade	Upslope approach (distance from up-road start of rolling dip to	Reverse grade (Distance from trough to crest)	Depth below average road grade at discharge end of	Depth below average road grade at upslope end of trough. (ft)
<6	55	15-20	0.9	0.3
8	65	15-20	1.0	0.2
10	75	15-20	1.1	.01
12	85	20-25	1.2	.01
>12	100	20-25	1.3	.01

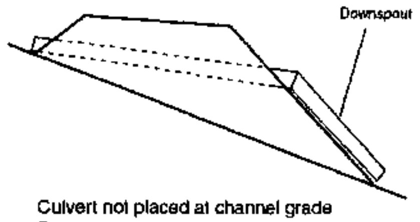
Typical design of non-fish bearing culverted stream crossings

Existing



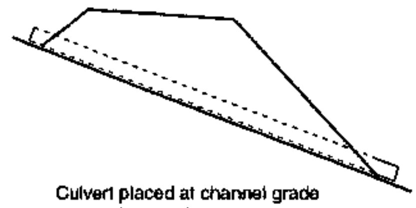
Culvert not placed at channel grade
Culvert outlet does not extend past base of road fill

Upgraded



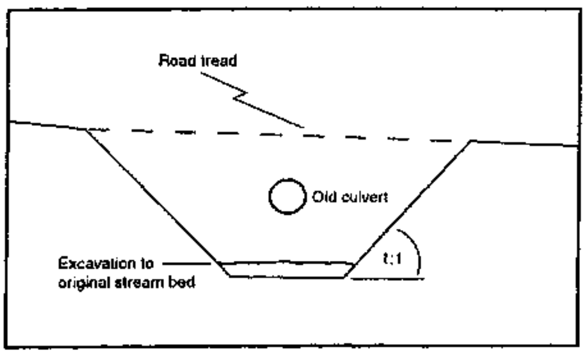
Culvert not placed at channel grade
Downspout added to extend outlet past road fill

Upgraded (preferred design option)

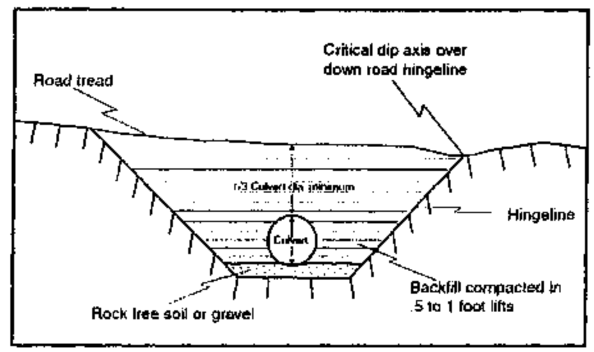


Culvert placed at channel grade
Culvert inlet and outlet resting on or partially in the original stream bed

Excavation in preparation for upgrading culverted stream crossing



Upgraded stream crossing culvert installation



Typical installation of non-fish bearing culverted stream crossings

Road upgrading tasks typically include upgrading stream crossings by installing larger culverts and inlet protection (trash barriers) to prevent plugging. Culvert sizing for the 100-year flood flow should be determined by both field observation and calculations using a procedure such as the Rational Formula.

Stream crossing culvert installation:

1) Culverts should be aligned with natural stream channels to ensure proper function, prevent bank erosion and debris plugging problems.
2) Culverts should be placed at the base of the fill and at the grade of the original streambed or downspouted past the base of the fill where ever possible.
3) Culverts should be set slightly below the original stream grade so that the water drops several inches as it enters the pipe.
4) Culvert beds should be composed of rock free soil or gravel, evenly distributed under the length of the pipe.
5) To allow for sagging after burial, an upward camber should be between 1.5 to 3 inches per 10 feet culvert pipe length.
6) Backfill material should be free of rocks, limbs or other debris that could dent or puncture the pipe or allow water to seep around pipe.
7) One end of the culvert pipe should be covered then the other end. Once the ends have been secured, the center will be covered.
8) Backfill material should be tamped and compacted throughout the entire process. -Base and side wall material will be compacted before the pipe is placed in its bed. -Backfill compacting will be done in 0.5 -1 ft lifts until! 1/3 of the diameter of the culvert has been covered. A gas powered tamper should be used for this work.
9) Inlets and outlets should be armored with rock or mulched and seeded with grass as needed. Routine armoring is generally not needed.
10) Trash protectors should be installed just upstream from the culvert inlet where there is a hazard of floating debris plugging the culvert
11) Layers of fill will be pushed over the crossing until the final, design road grade is achieved, at a minimum of 1/3 to 1/2 the culvert diameter.

Erosion control measures for culvert replacement:

Both mechanical and vegetative measures can be employed to minimize accelerated erosion from stream crossing and ditch relief culvert upgrading. Erosion control measures that are implemented will be evaluated on a site by site basis. Erosion control measures that can be employed may include, but are not limited to:

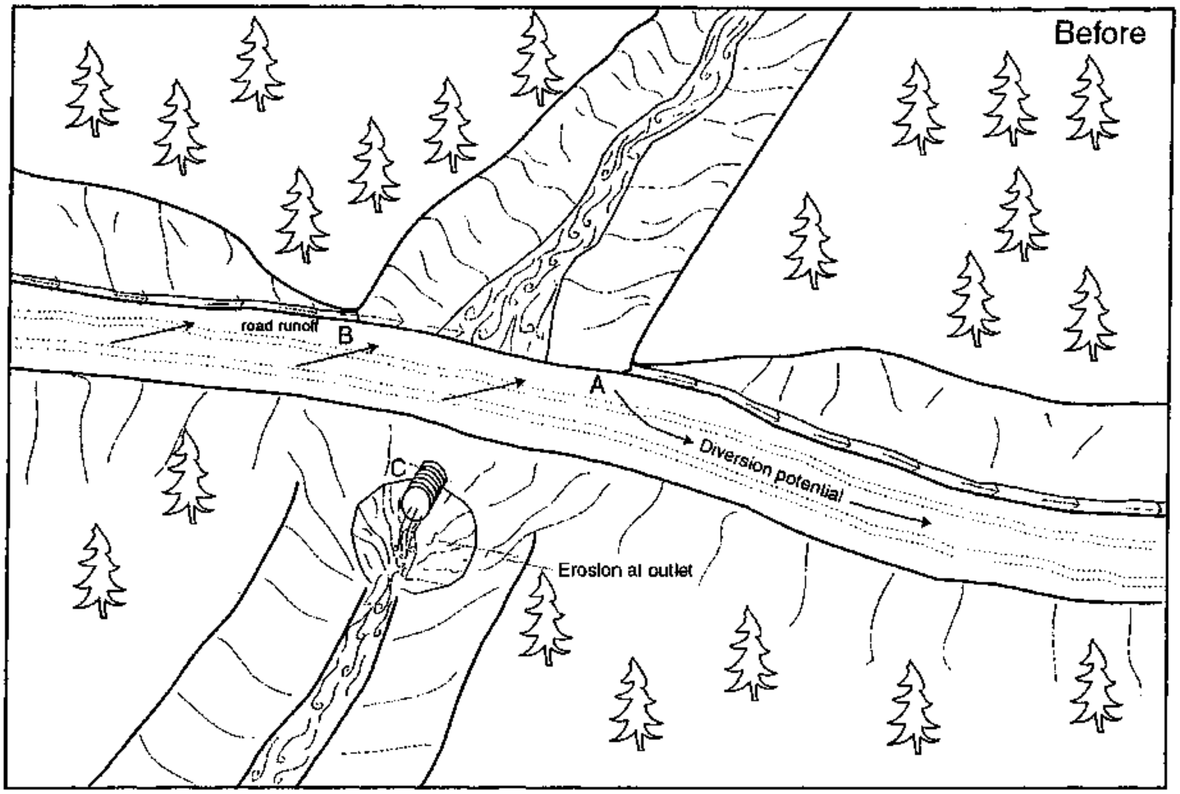
1) Minimizing soil exposure by limiting excavation areas and heavy equipment disturbance.
2) Installing filter windrows of slash at the base of the road fill to minimize the movement of eroded soil to downslope areas and stream channels.
3) Inslope the road prism to minimize fill slope erosion by road runoff.
4) Bare slopes created by construction operations will be protected until vegetation can stabilize the surface. Surface erosion on exposed cuts and fills will be minimized by mulching, seeding, planting, compacting, armoring and/or benching prior to the first fall rains.
5) Extra or unusable soil will be stored in long term spoils disposal locations that are not limited by factors such as excessive moisture, steep slopes, archeology potential, listed species or proximity to a watercoarse.
6) On running streams, water will be pumped or diverted past the crossing and into the down stream channel during the construction process.
7) Straw bales and/or silt fencing will be employed where necessary to control runoff and sediment delivery within the construction zone.

Common problems

A - Diversion potential

B - Road surface and ditch flows drain to stream

C - Undersized culvert high in fill with outlet erosion

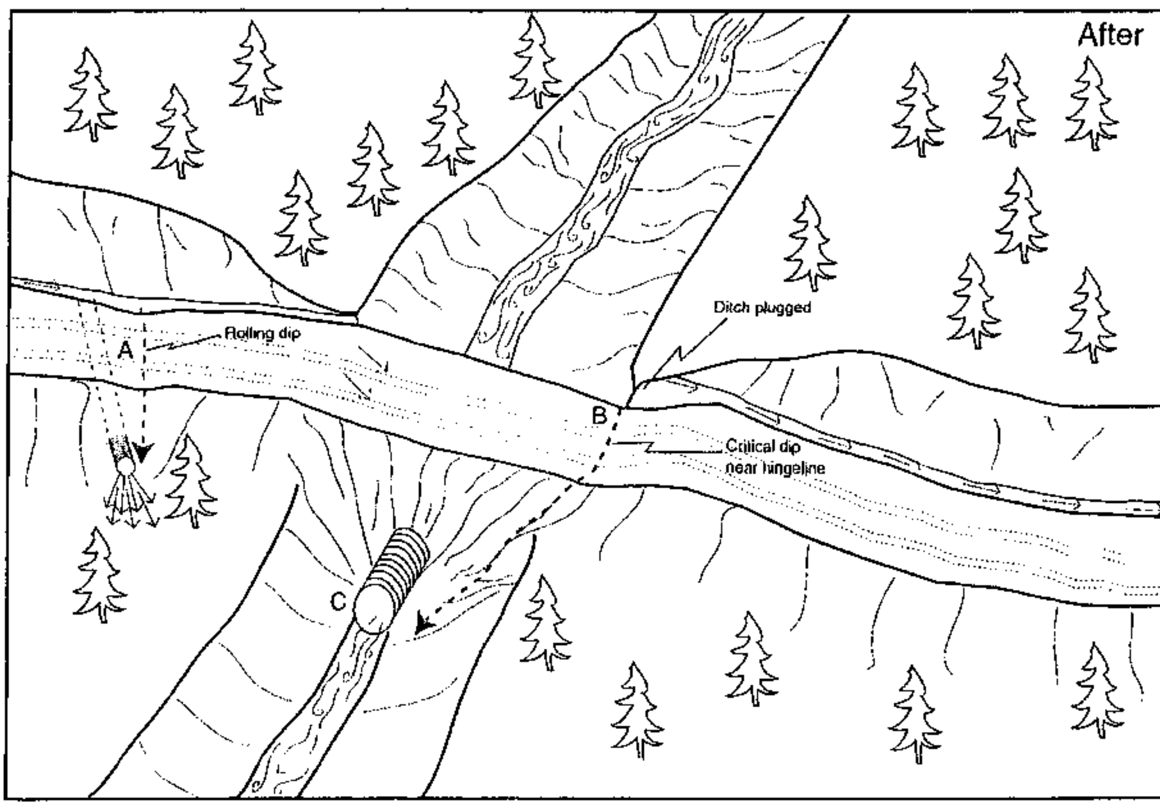


General Standards

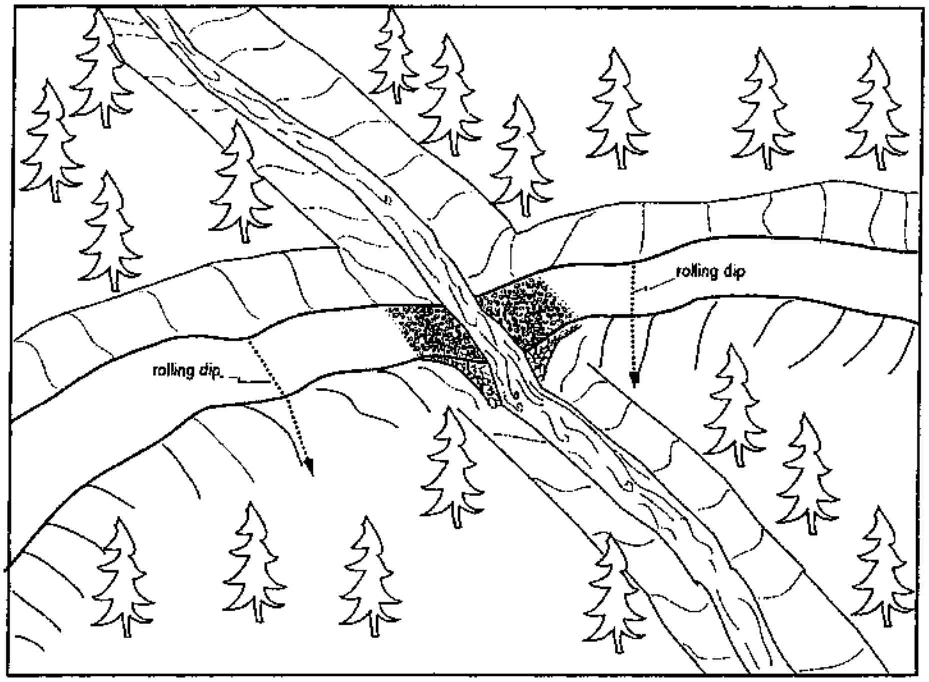
A - Road surface and ditch "disconnected" from stream

B- No diversion potential

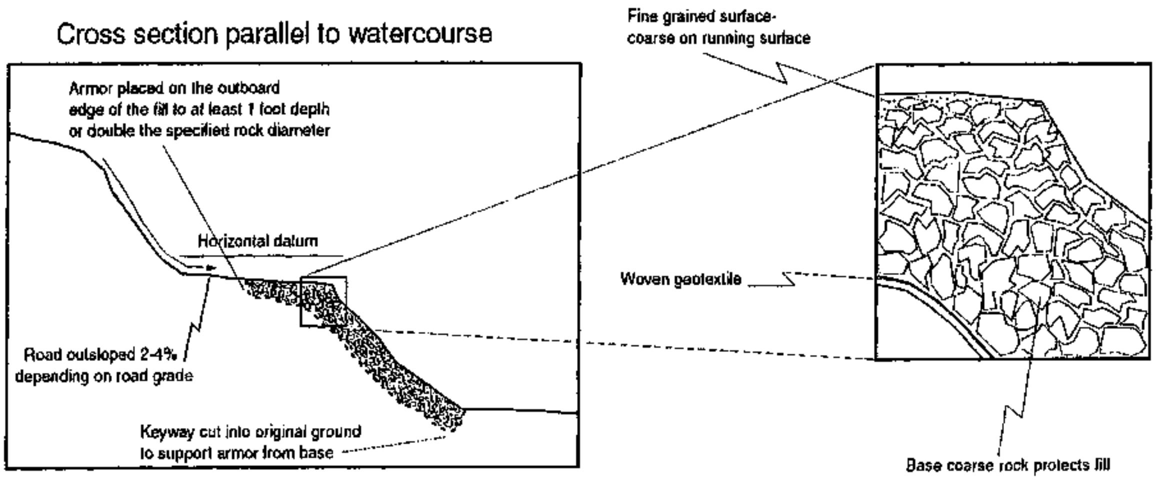
C - 100 year culvert set at base of fill



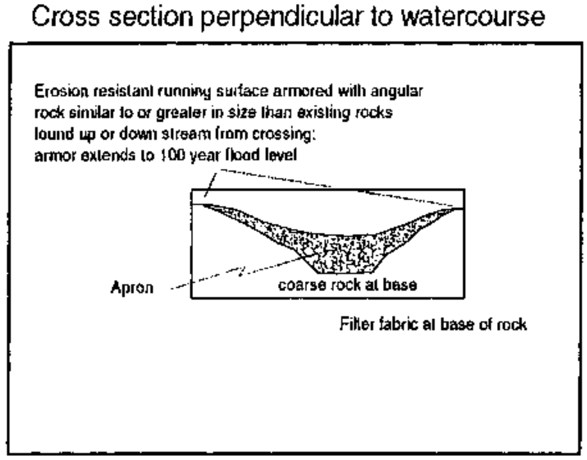
Typical armored fill crossing installation



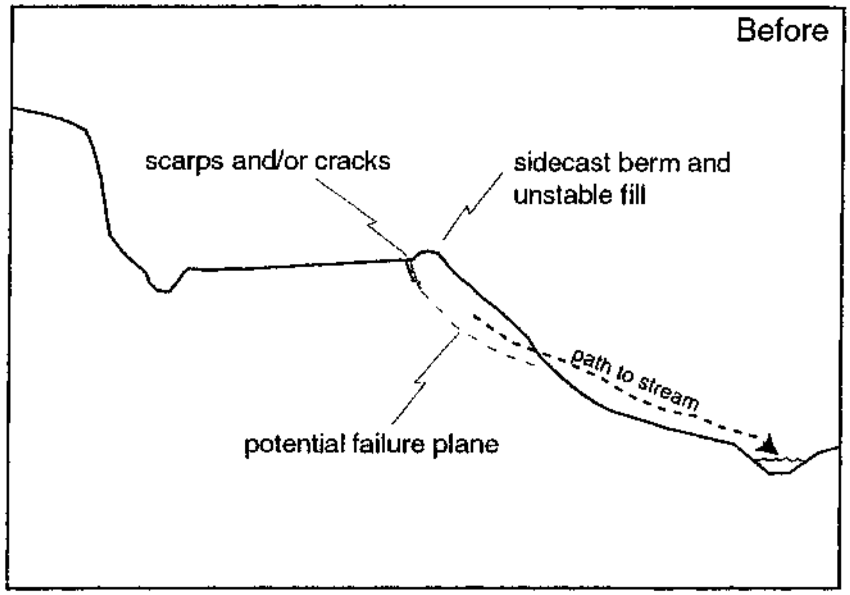
Cross section parallel to watercourse

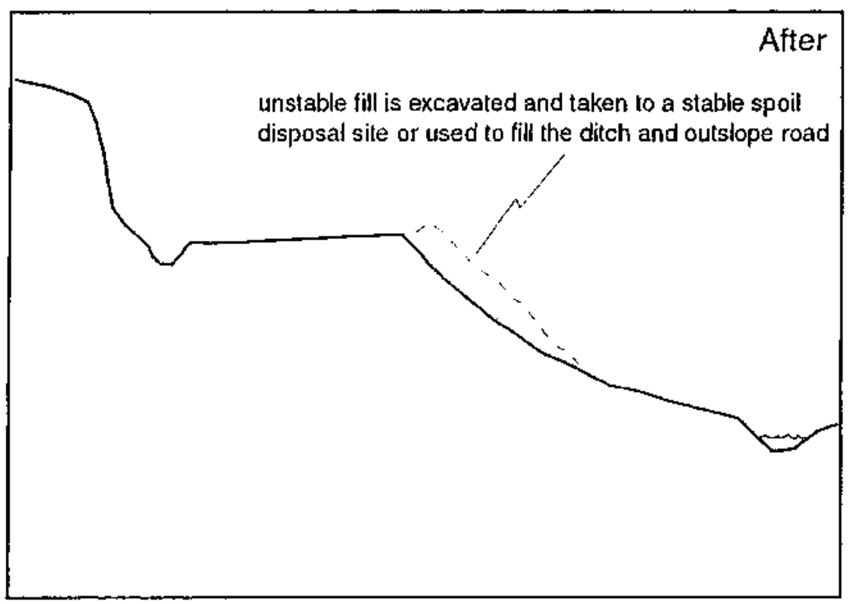


Cross section perpendicular to watercourse



Excavating unstable fill slope on maintained road

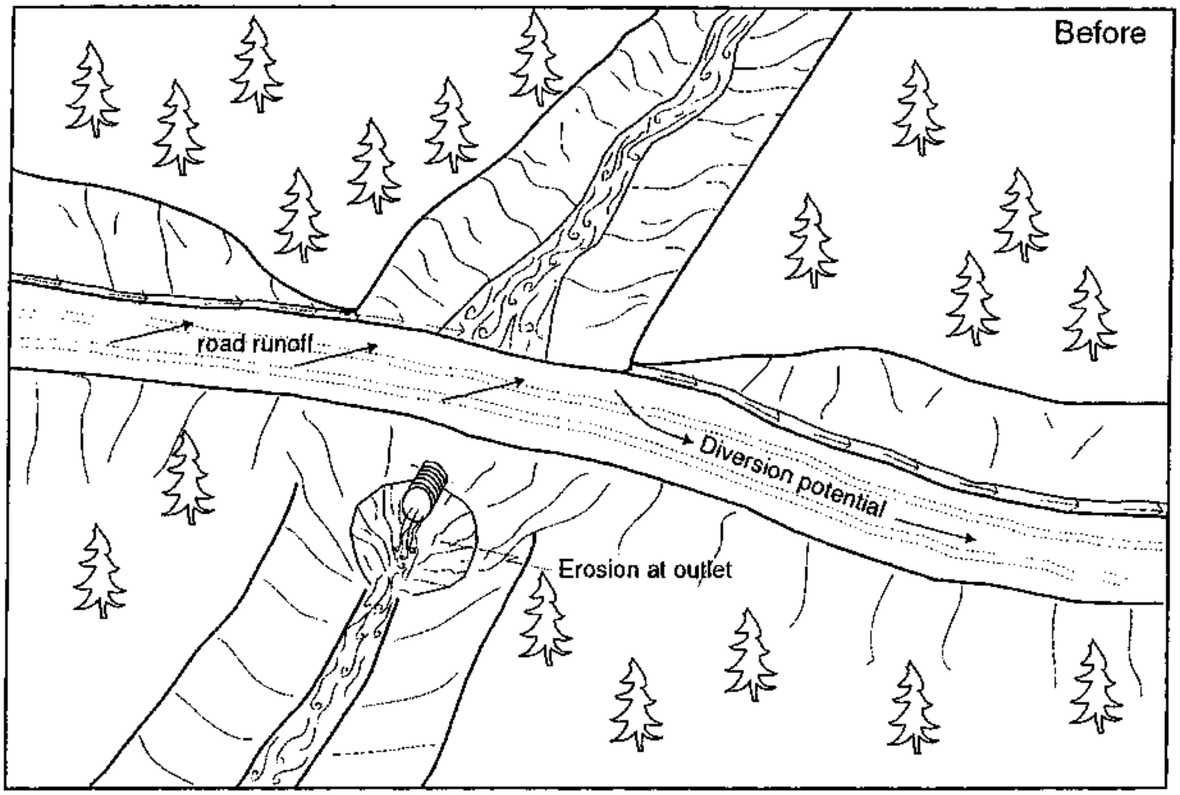




Typical stream crossing decommissioning

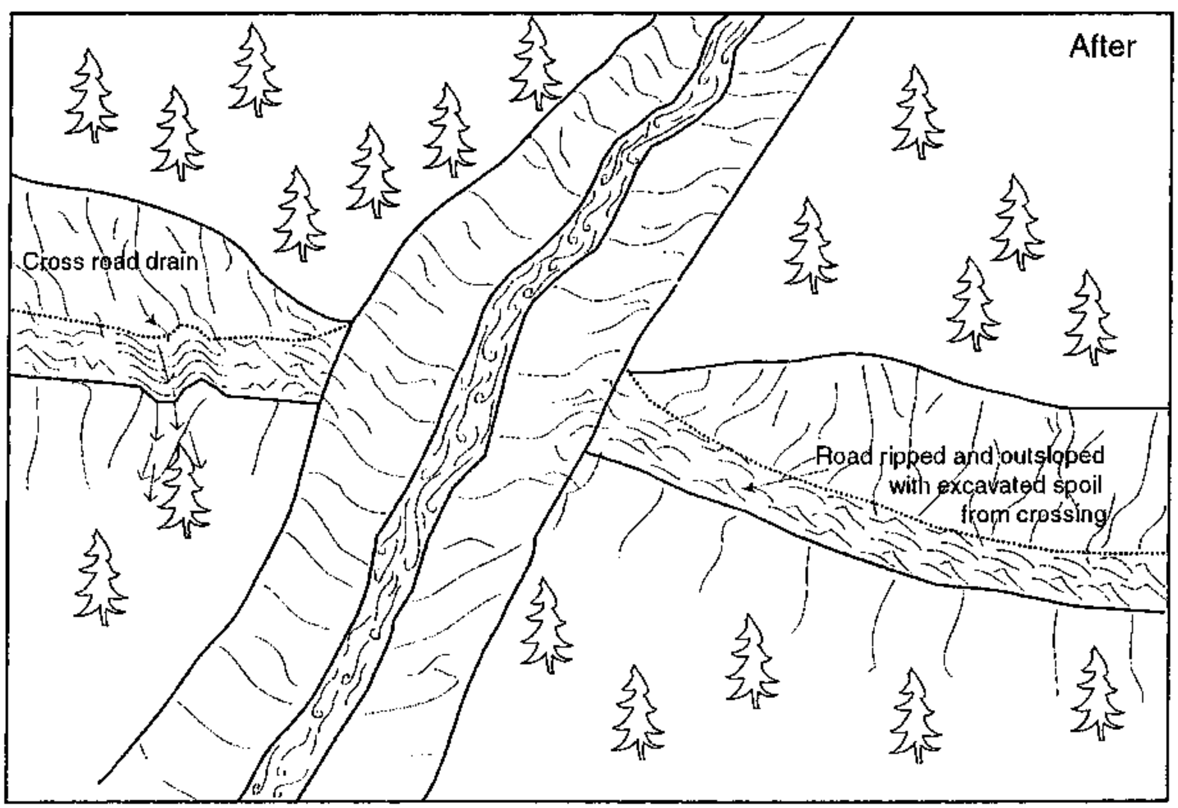
Condition

- Diversion potential
- Road surface and ditch flows drain to stream
- Undersized culvert high in fill with outlet erosion and elevated plugging potential

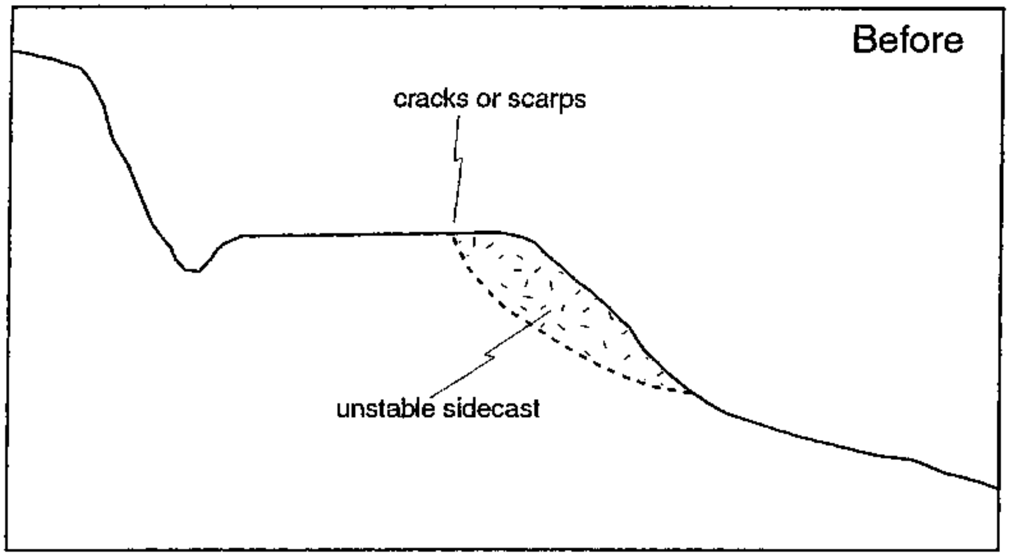


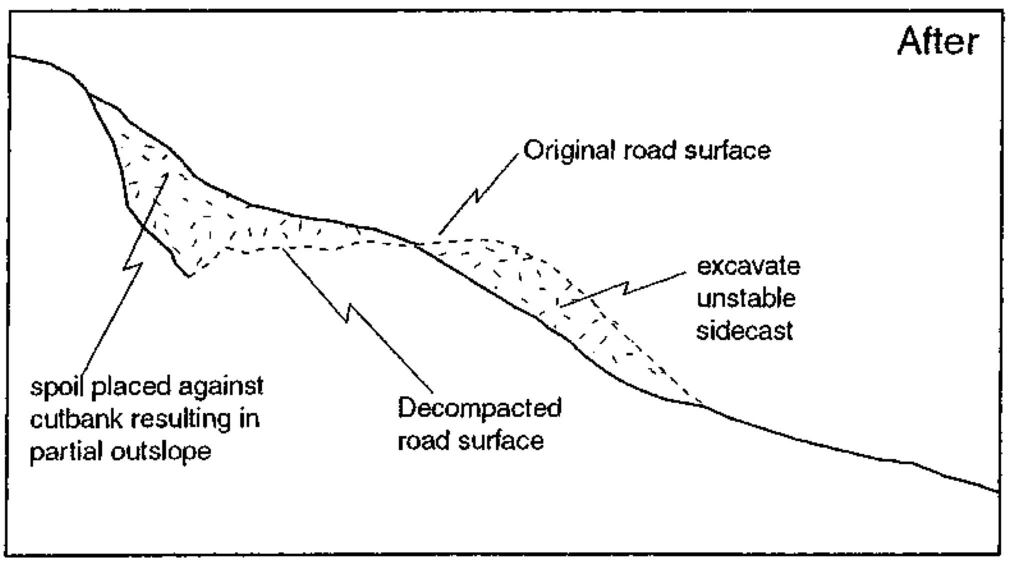
Treatment

- Road surface decompacted
- Cross road drains on old road
- Stream crossing fill completely excavated
- Excavated spoil used to outslope adjacent road



Excavation of unstable fill slope on decommissioned road





Attachment #3.

Copies of *Trout* and *California Fly Fisher*

Magazine Articles,

Referencing the:

South Fork Garcia River TU/CDF&G Project

are not available for online presentation.

Attachment #4. South Fork Garcia River Instream Structure Description and Locations.

Site #1. Located 0 .6 miles past locked gate South Fork Garcia access from Fish Rock Road (above first bridge). Complex structure, combining bank protection and future pool depth scour. 3 large logs, 3 large boulders.

Site #2. Located 185 feet below structure #1 (as measured by belt chain). Complex structure, combining bank protection and future pool scour, consisting of two large logs and two large boulders. (Note: additional fastening will be added in summer of 2002 to allow for settling of rocks and logs).

Site #3. Located 430 feet below structure #1. Complex structure, consisting of 1 large cross channel log, plus 1 large and 1 small root wad, with additional small hand placed rock, and limbs.

Site #4. Located 480 feet below structure #1. Complex structure, consisting of 1 large root wad, plus 1 large boulder, plus 1 large log.

Site #5. Located 570 feet below structure#l. Complex structure, consisting of 2 large cross channel logs.

Site #6. Located 720 feet below structure #1. Simple structure, consisting of 1 root wad, plus one boulder.

Site #7&#8. Located 855 feet below structure #1. Complex double structure, consisting of 4 large logs, 2 root wads, plus 4 boulders. Structure combines bank protection with future pool depth scour.

(At 1050 feet, cross under G-008 Road bridge.)

Site #9. Located 1160 feet below structure #1. Simple structure consisting of 1 large and 1 small log cabled to form scour pool.

Continue traveling downstream on access road until beginning of road decommissioning, marked by first pulled stream crossing.

Site #10. Located 250 feet (upstream) from pulled crossing. Simple structure consisting of large unfastened root wad dumped down bank into stream.

Site #11. From beginning of decommissioned road, walk past 4 pulled stream crossings. Simple structure #11 is 92 feet past 4th pulled crossing as road returns to stream grade. 1 large root wad cabled to form scour pool.

Site #12. Located 450 feet past 4th pulled crossing. Simple structure consisting of 1 large log cabled to large root wad to form scour pool.

Attachment #5.

Selected Before, During and After

Photo Point Photographs of

Completed Work in the South Fork Garcia River Watershed, Mendocino County, California.

Figure 1. Site 50, G-006 Road. Before photo of site conditions looking downstream across large plain of channel stored sediment, with undersized 6 foot diameter culvert under the roadway.

Figure 2. Site 50, G-006 Road. After photo looking downstream from the same location. All channel stored sediment and the culvert crossing have been excavated, and a flatcar bridge has been installed. The bridge was purchased with contributions from the MCRCD.

Figure 3. Site 13, B-Line. View looking down the road before erosion control efforts. The road bed in the middle portion of the photo between the cutbank and the twin redwoods in the distance has been constructed in a class 2 stream bed.

Figure 4. Site 13, B-Line. After treatment photo taken from the same location. The road bed has been decommissioned through this reach and a new 1000 foot section of no impact road has been constructed (not shown in the photo) to bypass this reach of road. The road was "put-to-bed" by excavating sidecast fill and outsloping the road. It the middle portion of the photo natural stream channel capacity has been re-established.

Figure 5. Site 13, B-Line. View upstream at the same reach of road seen in Figures 3 and 4. The truck in the distance is at the photo point where Figures 3 and 4 were taken. The natural stream channel flows toward the camera and is significantly constricted by introduced road fill and slash.

Figure 6. Site 13, B-Line. After treatment photo illustrating the application of in-place outsloping to remove a road. The natural stream channel has been reconstructed by removing all man introduced fill and slash, and now has a 6 foot wide channel bed designed to convey peak flood flows with minimal future erosion.

Figure 7. Site 94, G-005-01 Road. Before photo of road reach which exhibits unstable fill slopes between the orange flagging to beyond the person in the photo. A main fish bearing tributary to the South Fork Garcia is located 75 feet downslope of the road, and the potential fill failure was determined to have a risk of delivering some sediment to the stream.

Figure 8. Site 94, G-005-01 Road. After treatment photograph from the same location. The unstable fill slope has been excavated beyond the orange flagging and the spoil material has been placed on the stable portion of the road bed with a prominent outslope. Note how the spoil material now extends to the base of the small conifer on the cutbank in the middle of the photo (the spoil material is nearly 3 feet deep at the former inboard edge of the road). A sizable cross-road drain has been constructed in the foreground of the photo to disperse road runoff.

Figure 9. Site 100, G-005-01 Road. Before photo looking downstream at a large stream crossing to be decommissioned or properly pulled. Prior to opening the road to vehicular access, the road was completely overground with similarly sized alder as is visible in the photo. The crossing fill was eroding annual as a result of a plugged culvert. Future erosion at the site was estimated to be 525 yds^3.

Figure 10. Site 100, G-005-01 Road. After treatment photo looking downstream. Note the orange flagging, redwood branch and leaf litter in the foreground denote the same location. The excavation involved removing over 900 yds^3 of fill from the stream crossing. The formerly buried stump helped to define the fill verses native soil material boundary. The channel has a 5 foot wide stream bed and 2:1 sideslopes designed to accommodate peak flood flows.

Figure 11. Site 99, G-005-01 Road. After photograph of section of road which has had unstable fill material excavated and placed with an outslope along the base of the cutbank (i.e. in place outsloping). The unstable fill, which posed a risk of sediment delivery to a downslope stream, extended out to the top of the stump prior to the excavation. This stretch of road was decommissioned.

Figure 12. Site 106, G-005-01 Road. This after photograph exhibits the same treatment as in Figure 11 (i.e. excavating unstable fill material along the outside edge of the road), except for the road was not decommissioned but retained for future use. The fill material was excavated and loaded into dump trucks to be hauled to a stable location down the road for permanent storage. In upgrading the road, the road width was lessened, the inboard ditch was filled and eliminated, the road was re-shaped to exhibit a mild outslope with no berms, and periodic rolling dips were constructed along the road bed to ensure dispersed road runoff. Note the rolling dip about 60 feet behind the truck.