

**Final Report:
1999 East Austin Creek
Watershed Erosion Control and Prevention Project,
SB271 Road Upgrading and Decommissioning Project**

prepared for:

**California Department of Fish and Game, &
California Department of Parks and Recreation,
East Austin Creek State Recreation Area**

by

Pacific Watershed Associates
Arcata, California,
(707) 839-5130

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Final Report
1999 East Austin Creek
Watershed Erosion Control and Prevention Project

CDF&G State Contract #P9985131

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Attachments:

1. East Austin Creek Site Plan
2. Portion of Road Log
3. Conceptual Diagrams of As-Builts
4. Selected before & after photo point photographs.

**Final Report
East Austin Creek Watershed
Erosion Control and Prevention Project**

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Background

During the winter and summer of 1996, the California Department of Fish & Game (CDFG) initiated a road inventory and sediment delivery assessment on 17.4 miles of road in the East Austin Creek and Fife Creek watersheds on lands managed by the California Department of Parks and Recreation (CDPR). The assessment was conducted by displaced salmon fisher-folks with funding from the U.S. Department of Commerce NEAP program, and was administered by the Sotoyome Resource Conservation District (SRCD). The SRCD and CDFG sponsored grant utilizing standardized protocols developed by Pacific Watershed Associates (PWA). In June 1998, PWA received an S.B. 271 grant and contract from the CDFG to review and finalize the field inventories conducted by displaced commercial salmon fishermen, and developed a prioritizing erosion control plan for all roads within the State Park.

During the fall and winter, 1998, 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 prepared a prioritized cost estimate to perform the work. The assessment mapped 118 individual sites, where sediment was or had the risk of being delivered to stream channels, along 7 different road segments totaling nearly 11.1 miles in the East Austin Creek assessment area. The assessment documented a total of 16,860 yds³ of future sediment delivery if no efforts were made to correct road conditions in East Austin Creek.

In May 1999, PWA in close cooperation with the CDPR submitted a proposal to the California Department of Fish & Game (CDFG) S.B. 271 Grant Program to implement and treat all sites along the 11.1 miles of road inventoried by the NEAP program in the Austin Creek State Recreation Area only.

The State accepted the project for funding, and PWA received a signed contract with the CDFG to commence the project on August 18, 2000. During the winter and spring 2000/2001, CEQA and the 1603 permit were completed while State Park resource, ranger and maintenance personnel from the Russian River/Mendocino Districts and PWA finalized details of the project.

Location

Austin Creek State Recreation Area (ACSRA) and Armstrong Redwoods State Reserve (ARSR) are located in Sonoma County, 10 miles west of Santa Rosa. The entrance to the ARSR is

2.5 miles north of Guerneville, off of State Highway 116. Access to the ACSRA is by paved road through the ARSR. East Austin Creek is found on the Guerneville and Cazadero USGS 7.5 minute topographic map. (see location map).

The 5,683 acre Austin Creek State Recreation Area (ACSRA) comprises approximately 25% of the East Austin Creek watershed. Within the State Recreation Area boundary there are five miles of East Austin Creek, and the fish bearing reaches of Thompson Creek (1.5 miles), as well as the entire 3 mile length of Gilliam Creek, all anadromous fish habitat.

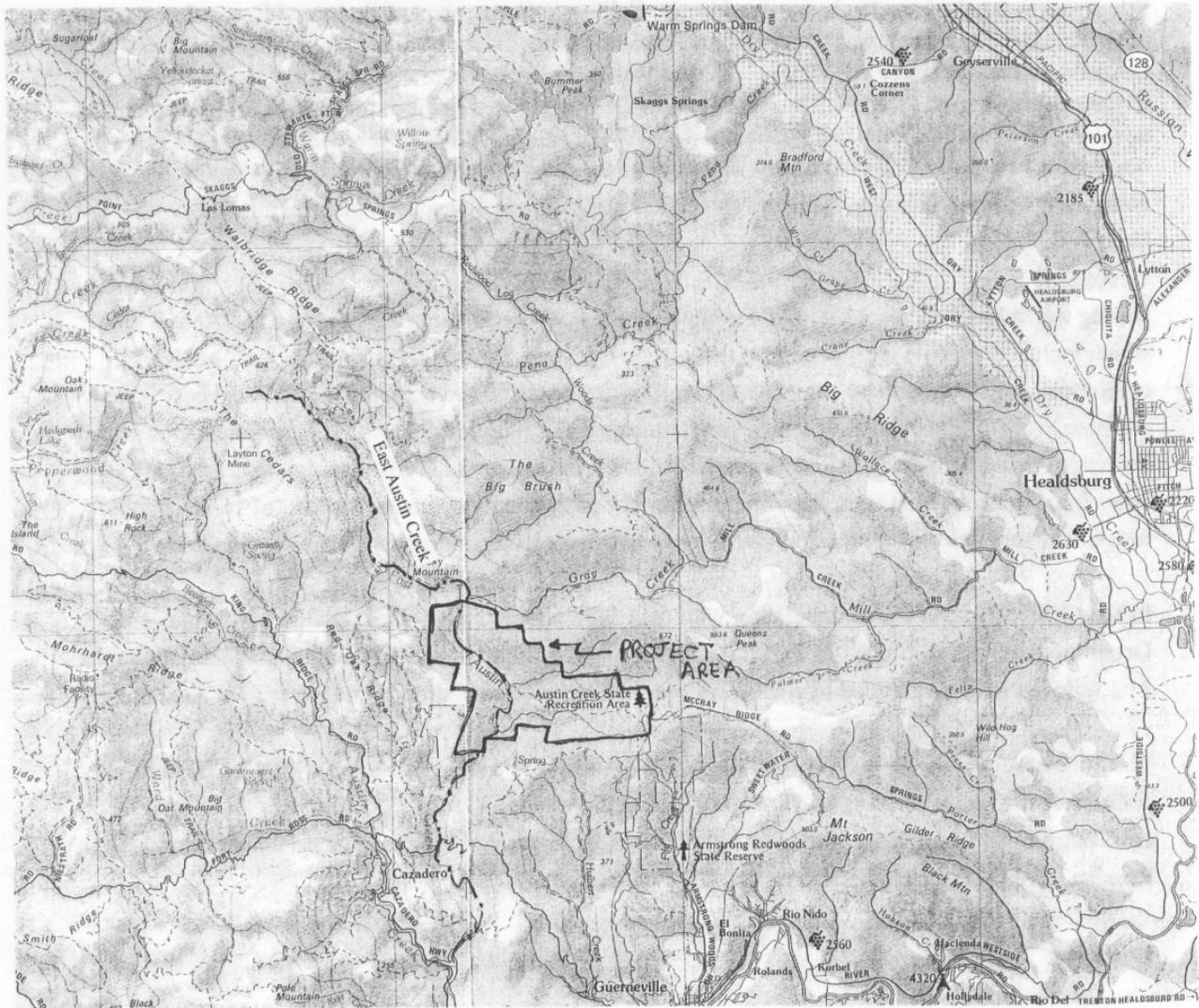


Figure 1: Location Map

Project Objectives

The project was designed to address and implement upslope restoration prescriptions recommended by PWA. 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 East Austin Creek, as well as to lower, long term, road maintenance costs for the State Park. 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 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 East Austin Creek watershed). 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 East Austin Creek watershed.

Project Description

The project, as funded by CDF&G, was initially designed to 1) lower the risk of culvert failure/fill erosion and subsequent sediment delivery at 81 stream crossings, 2) prevent fill failure landsliding at 7 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, out-sloping the road, etc. along over 34,000 feet of road, and treating 5 separate "other site" locations, mostly gullies, along the roads (**Table 1, and Attachment #1: East Austin Creek site map**).

During the winter and spring 2001, numerous meetings were held with State Park personnel and PWA 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 2: 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 in-sloped 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 (see Attachment)

Table 1. Site classification and sediment delivery from inventoried sites with future sediment delivery on East Austin Creek State Recreation Area watershed assessment area.						
Site Type	Number of sites or road miles	Number of sites or road miles to treat	Future yield (yds ³)	Stream crossings w/ a diversion potential (#)	Streams currently diverted (#)	Stream culverts likely to plug (plug potential rating = high or moderate)
Landslides	7	7	2,261	NA	NA	NA
Stream crossings	86	81	5,704	53	20	39
Ditch relief culverts	20	20	2,208	NA	NA	NA
Other	5	5	334	NA	NA	NA
Total (all sites)	118	113	10,507	53	20	39
Persistent road surface erosion ¹	6.5	6.5	6,355	NA	NA	NA
Total future delivery (yds³)			16,862			
Road bed, ditch and cutbank sediment yield calculated over a 10 year period where the road is lowered an average of 0.25 feet.						

#2: 10 page sample of 31 page Road Log). At the same time, specific Technical Specifications were developed, along with typical construction drawing for each major category of work items (see **Attachment #3: Conceptual Diagrams**).

Once Pacific Watershed Associates produced the Road Log, pre-work field trips were scheduled in early August 2001 for State Park Maintenance and Ranger personnel who were involved in the project, as well as three general engineering contracting firms: 1) Adobe Construction Inc, Petaluma, CA.; 2) Campbell Grading, Healdsburg, CA; and 3) McCanless Earth Care, Rio Dell, CA. The required culverts arrived on early August, 2001 and work commenced by first distributing the culverts to each designated work site. All heavy equipment work and associated grass seeding, and straw mulching occurred over one work season during the months of August through October, 2001.

In early May, 2002, after a very wet fall and early winter, 2000, a grader, backhoe and dump truck distributed road rock, performed grading along several reaches of road which experienced minor rilling, re-constructed 5 rolling dips which failed due to poor construction, and performed maintenance on 3 of the armored fill stream crossings.

At least 6 different field trips for public and agency personnel were conducted in the ACSRA during the contracting period. These included 3 separate field reviews of completed work with either Bob Coey or Derek Akume, our CDF&G contract managers. There was also a one day workshop for 35 equipment operators and large property managers sponsored by the Salmonid Restoration Federation, and 2 different, much smaller field trips for State Water Quality personnel.

The final invoice and a final report was prepared and sent to CDFG in May 2002.

Project Implementation

The contractors used an excavator, 2 dozer tractors, a backhoe, 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 backhoe 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" portions of 3 roads (the Bull Frog Lake Road between sites #88 and #95, the Gilliam Camp Trail Road between sites #76 to #78, and the abandoned fire/mining road on the north side of Gilliam Creek with site #88 to #95) which totaled 1.1 miles in length, while the remaining roads which totaled 10 miles were to be upgraded or "storm-proofed" (see **Attachment #1 and #2**). 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 1998, and associated with long term transportation planning by State Park personnel. **Table 2: Proposed versus Installed Treatments for the East Austin Creek Project** itemizes the number of proposed treatment types versus the actual "as built" numbers. With the exception of the sites on the abandoned fire/mining road on the north side of Gilliam Creek, all sites were treated, but some erosion control measures changed.

Sixty five (65) stream crossings were re-constructed or decommissioned to accommodate the 100 year flood flow along the 11 miles of treated road. This included installing or replacing culverts at 31 stream crossings, removing failing culverts and installing armored fill crossings at 23 stream crossings, and completely excavating or decommissioning 11 stream crossing, mostly on abandoned roads.

Table 2: Proposed verses Installed Treatments for East Austin Creek Project.		
Treatment Type	Proposed No.	Installed No.
Install or Replace Stream Culvert	32	31
Install Flared Inlet	5	6
Install Armor Crossing	22	23
Decommission Crossing	16	11
Install Critical Dip	30	31
Excavate and Dispose of Fill/Soil	55	55
Install Rolling Dips/Cross Road Drains	199	136
Install/De-water Ditch Relief Culverts	4	13
Outslope road	23,085 LF	20,700 LF
Remove berm	300 LF	7,800 LF
Rock (Rip-Rap & Road Bed)	368 YDS ³	280 YDS ³
Re-Route Road	0 LF	400 LF
Other (mainly gully treatments)	5	4

Thirty one (31) of the newly culverted stream crossings had critical dips installed on the down road hinge line to prevent stream diversions in the event a culvert does plug with sediment and debris. A total of 55 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 out slope the road bed. Eleven (11) of the sites are properly closed stream crossings, 23 are stream crossing fills which were excavated to accommodate the armored crossings, 14 are at newly installed stream crossings where channel stored sediment about the former culvert inlet had to be excavated, and 7 sites are potential fill or landing failure which were excavated.

Road bed drainage improvements consisted of constructing 176 rolling dips or cross road drains along the road at 100 to 350 foot spacings. The excavated material was used to eliminate or fill nearly 8,800 linear feet of inboard ditch to further improve the road out slope. Approximately 280 yds³ of road and rip-rap sized rock was used in completing the project. This was less than what we budgeted for, but increases in rock

purchase and trucking costs precluding purchasing the planned for amounts. It should be noted that State Park personnel are aware additional road rock will be needed in a few locations in the future, but all the armored crossings have been well rocked and maintenance needs should be low in the future. The other sites listed in Table 2 are mostly locations where hill slope gullies were de-watered.

The principal changes in the plan were related to re-constructing the abandoned fire/mining road located north of Gilliam Creek (see **Attachment #1, Map 1 of 3**), and how to treat site #73 located on the Gilliam Creek Trail Road. At the pre-project review of the abandoned fire/mining road, all parties agreed that approximately 80% of the predicted erosion and sediment delivery had already occurred. The road crosses rocky and sensitive ultramafic soils and bedrock, natural re-vegetation was quite good in several road reaches, and several now stable cutbank slides and completely failed stream crossings would have had to be re-constructed in order to treat the road. All parties supported not using heavy equipment to treat the road, but instead use hand crews to improve road drainage at selected locations.

At site #73, the existing culvert was undersized, had a high plug potential, was a fish barrier with a 15 foot vertical culvert outfall to the perennial stream below, and had stored approximately 1500 yds³ of channel stored sediment above the culvert inlet. The assessment had called for excavating the crossing and installing a bridge. However, as the excavation proceeded, it was clear that installing a stable bridge crossing was going to be difficult. Several meetings were held with park personnel to explore options for pedestrian and equestrian access through or around the large excavation. It was agreed that the best option was to construct 500 feet of new trail around the site. The new trail has not yet been built, but we encourage it be constructed this year.

Budget (See next page)

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 East Austin Creek project area (see **Attachment #4: Selected before and after photographs**). The photo points will provide long-term effectiveness monitoring in the future.

Significant and high intensity rainfall occurred in the project area during the fall and early winter 2001 and 2002. Minor down-cutting and channel widening occurred at 25% of the excavated stream crossings, but each are developing a well armored stream bed and we do not expect major adjustments in the future. All sites where potential road fill or landing fill was excavated to prevent landslides are functioning well with no observable slope adjustments.

All recently installed stream crossing functioned well through the winter, as did all but one of the new armored crossing. Probably the most common post construction erosional problems throughout the project area were associated with small cutbank slope failures blocking the road at several locations and disrupting road drainage patterns, and excessive rilling of the road bed at several locations. The rilling of the road bed was commonly associated with poorly constructed rolling dips, failure to retain isolated segments of inboard ditches within the higher elevation grassland areas along the first mile of the upper Fire Road, constructing outsloped roads that were not really outsloped, and failure to pay close attention to the final road bed drainage pattern at newly constructed stream crossings. Many of the problems, albeit minor, were associated with the rapid onset of heavy fall rains and our inability to perform final grading of the road bed.

Fortunately, sediment delivery associated with the erosion was minor, compared to the sediment delivery which would have occurred had the work not been performed. With the exception of the State Park needing additional road rock at a few segments of road, the post winter heavy equipment grading and fine tuning completed last week should significantly reduce similar problems next winter.

Conclusions

The expected benefit of completing erosion control and prevention work lies in the reduction of long term sediment delivery to East Austin Creek, an important Steelhead stream. The purpose of this project was to permanently reduce the amount of sediment that could erode and be delivered to East Austin Creek and its tributaries. By storm-proofing or decommissioning 11 miles of former logging/ranch roads in East Austin Creek, an estimated 16,860 yds³ of sediment was prevented from being delivered to streams within the watershed over the next decade or so. The total costs for the project was 205,880. for a cost effectiveness value of \$12.21/yds³ saved from entering stream channels.

Pacific Watershed Associates wishes to thank all of the project partners, past and present, for their generosity, their cooperation, their expertise, their professionalism, and for the tremendous effort put forth in order to see this project through to completion.

AUSTIN CREEK STATE RECREATION AREA WATERSHED IMPROVEMENT PROJECT					
(Contract #P9985131)					
BUDGET RECONCILIATION					
Personnel Costs:					
Personnel	# OF HOURS	HOURLY RATE	ORIGINAL BUDGET	MATCH FUNDS	TOTAL EXPENDED
Lead Professional (PWA)	330	\$50.	\$16,500.	0	\$16,500.
Laborers (PWA)	422	\$25.	\$10,550.	0	\$10,550.
Sonoma County Probation Camp	51	\$40.	0.	\$2,040.	\$2,040.
Ranger/Professional Staff (ACSRA) for CEQA, coordination, access, etc.	94	\$25.	0.	\$2,350.	\$2,350.
Equipment Operator (ACSRA)	1140	\$25.	0.	\$28,500.	\$28,500.
PWA Staff Benefits included in hourly rate			\$0.	0.	\$0.
Sub-Total Personnel Costs			\$27,050.	\$32,890.	\$59,940.
Materials and Supplies:					
Culverts: Includes bands, flaired inlets (see Table 3)			0	\$22,811.	\$22,811.
Rip Rap Rock: avg. 0.5 to 1.25' dia. (See Table 5)			0	\$15,069.	\$15,069.
Straw Mulch:			0	\$900.	\$900.
Seed and Plants:			0	\$500.	\$500.
Sub-Total Materials and Supplies:			0	\$39,280.	\$39,280.
Operating Expenses:					
Equipment Rental: (see Table 5 for cost breakdown)			\$75,150.	\$21,277.	\$96,427.
Rent Misc. Tools: (compactor, tamper, etc.)			0	\$1,600.	\$1,600.
Transportation Costs (4,167 miles @ .24/mi.)			\$1,000.	0.	\$1,000.
Lodging and Per Diem (est. 30 days x \$40/day)			\$1,200.	0.	\$1,200.
Misc. Field Supplies			\$400.	0.	\$400.
Printing, Duplication, Photographic Supplies for monitoring			\$800.	0.	\$800.
PWA Project Administrative Expenses (5%): includes permit costs, insurance, phone, office rent, etc.)			\$5,280.	0.	\$5,280.
Sub-Total Operating Expenses:			\$83,830.	\$22,877.	\$106,707.
Total Estimated Budget			\$110,880.	\$95,047.	\$205,927.
Percent Cost Share: 46%					
Sediment Savings: 16,860 yds³					
Cost-effectiveness for project: \$12.21 per yds³ saved from entering streams					

The State Park match provided for the purchase of culverts, road and rip-rap sized rock, seed, straw, filter fabric, etc., as well as leasing, fueling and operating the excavator, backhoe, dump truck and flatbed truck. DPR staff assisted with logistics, planning, CEQA and hiring Sonoma County Probation Camp crews who seeded and mulched many of the sites following construction.

Attachment #1.

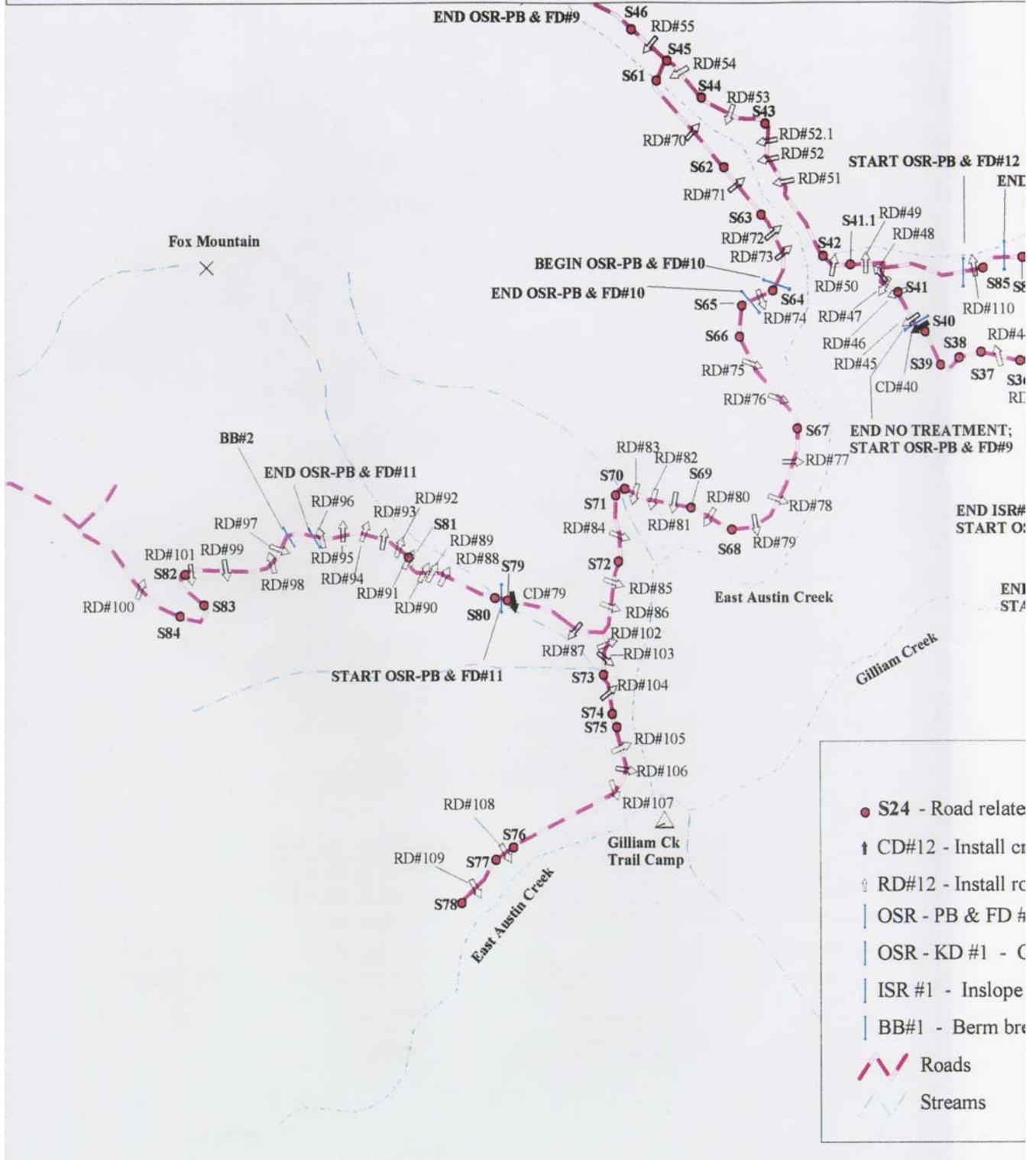
Site Map for East Austin Creek

Watershed Erosion Control and Prevention Project,

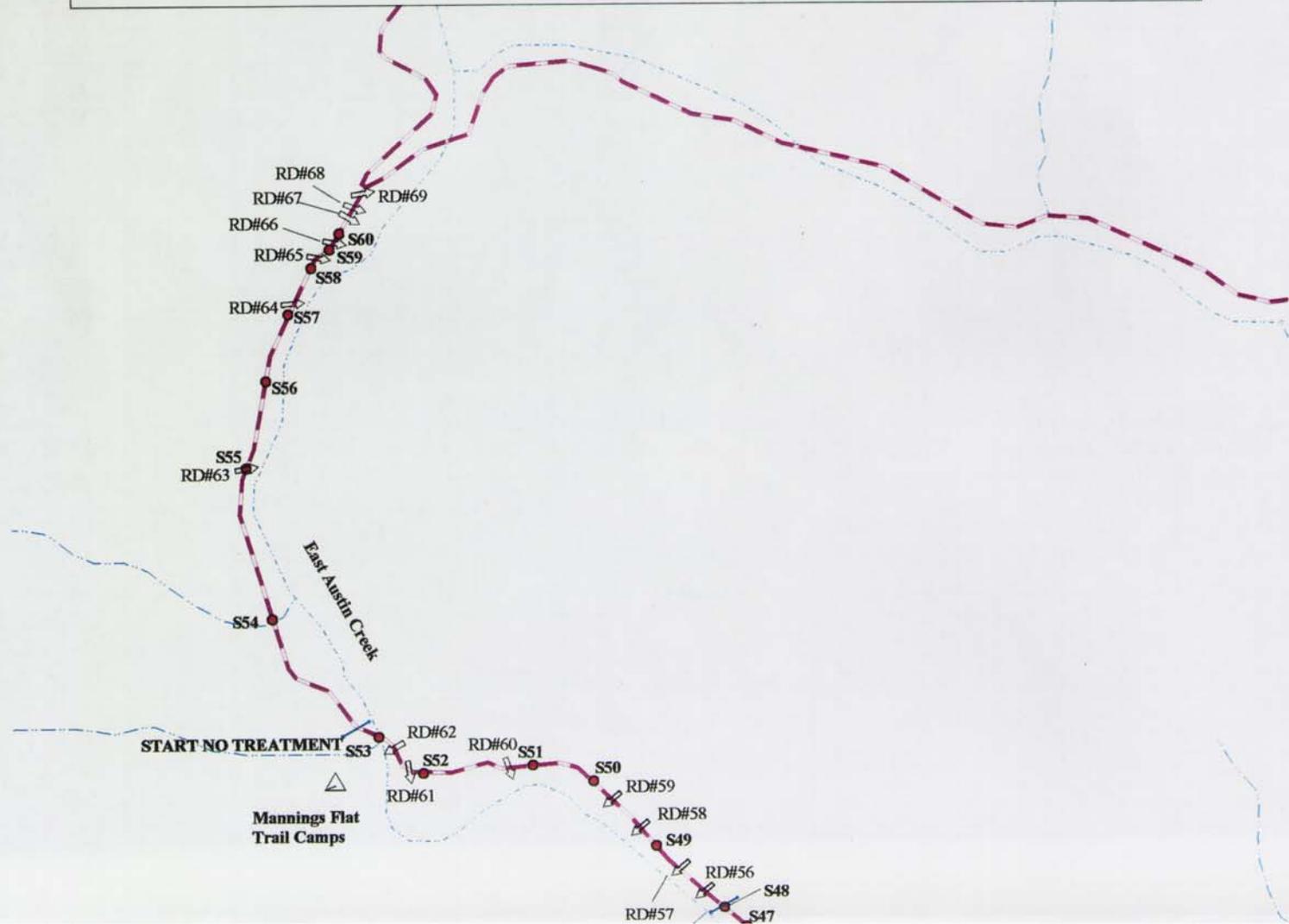
Sonoma County, California.

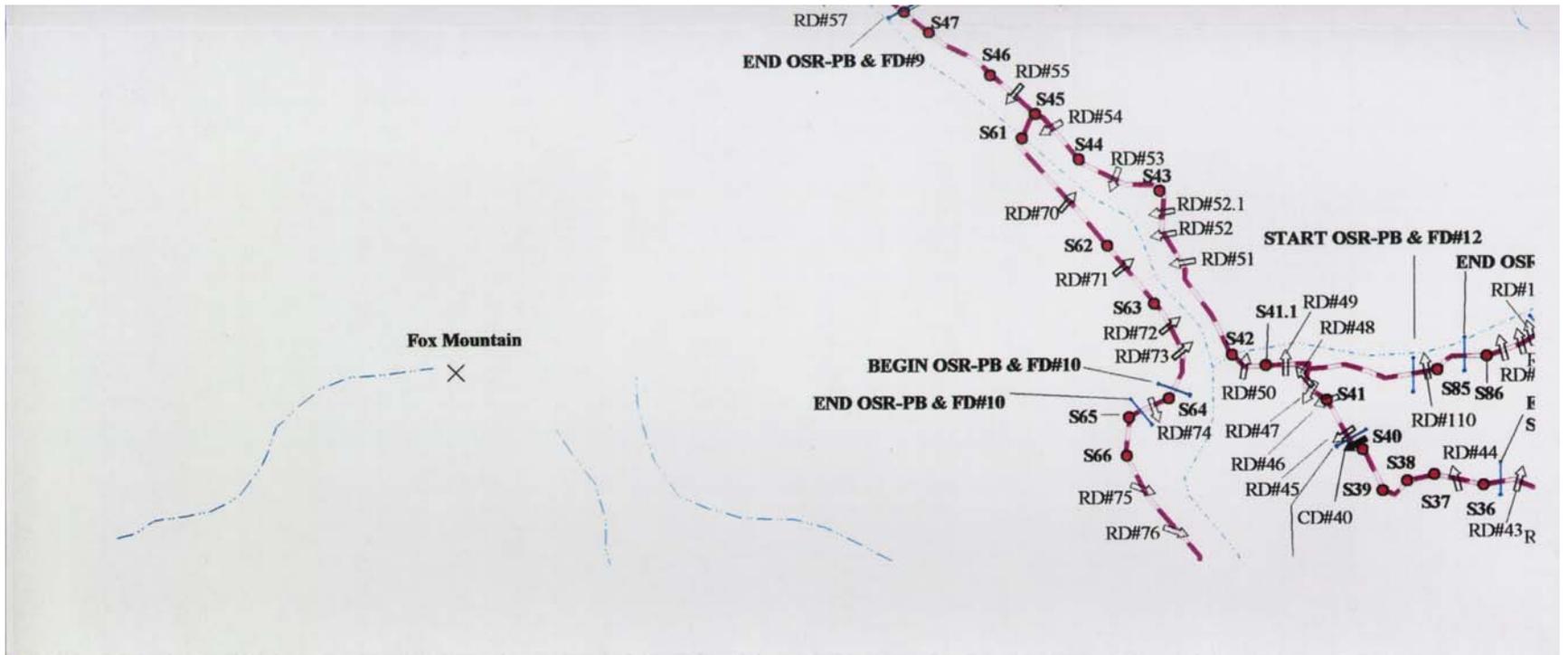
CDF&G State Contract #P9985062

Map 1 of 3. Treatments for the East Austin Creek State 1



Map 2 of 3. Treatments for the East Austin Creek State Recreation Area, Sonoma County, California.





Legend

- S24 - Road related sites with future sediment delivery
- † CD#12 - Install critical dip
- ↑ RD#12 - Install rolling dip
- | OSR - PB & FD #1 - Outslope road, pull berm and fill ditch
- | OSR - KD #1 - Outslope road and keep ditch
- | ISR #1 - Inslope road with 3% grade
- | BB#1 - Berm break
- Roads
- Streams



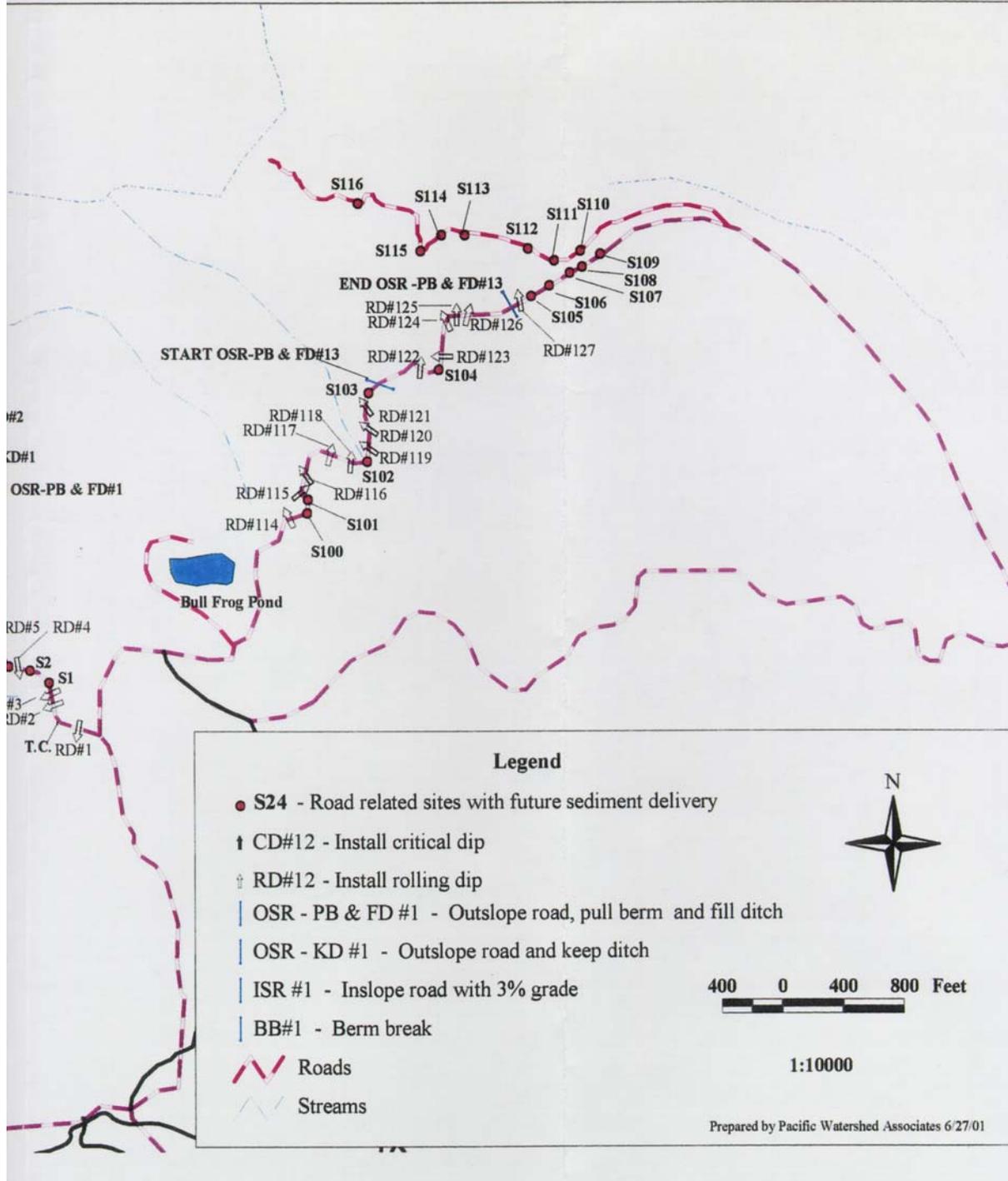
400 0 400 800 Feet



1:10000

Prepared by Pacific Watershed Associates 6/27/01

State Recreation Area, Sonoma County, California.



Attachment #2.

Ten Page Sample of Road Log,

East Austin Creek State Recreation Area,

Sonoma County, California.

CDF&G State Contract #P9985131

Final Road Log of Treatments for East Austin Creek Recreation Area, Sonoma County, 8/1/01

Notes: 1) All live streams will be de-watered prior to implementing erosion control measures outlined in this application. 2) All fish bearing reaches of stream will have the resident fish captured and moved just prior to conducting the proposed work, 3) All areas of disturbed ground and bare soil will be seeded with grass at 25 pounds/acre and straw mulched at 6000 pounds/acre. Most areas will be planted with conifers, alder and maples in order to re-establish a functional riparian zone, 4) At all existing temporary erosion control straw bale dams, the stored sediments and the dams will be removed unless they are deemed necessary to prevent future sedimentation. Dams which remain through the next winter season will be discussed with CDF&G staff, 5) New gullies which formed below the roads associated with waterbars will be evaluated as to the need for silt fences, straw bale dams or seeding and mulching.

Road: Fire Road

Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
0.00			Start log at gate		
0.035		RD#1	7% grade, 24' wide road		3 yds ³ - 2" minus road rock
0.080		RD#2	9% grade, 22' wide road. Make sure dip captures spring flow.		3 yds ³ -2" minus road rock
0.100		RD#3	11% grade, 13' wide road.		
0.120	1		Undersized concrete culvert installed at shallow gradient. Treatment: Install 24"x30' plastic pipe in axis of stream channel.	24"x30' plastic pipe, 1 band	
0.130	2		Short ditch relief culvert damaged at inlet with gully down fillslope. Treatment: Install 24"x40' pipe at base of fill.	24"x40' plastic pipe, 1 band	

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
0.155		RD#4	10% grade, 21' wide road. Make sure dip captures ditch flow.		4 yds ³ -2" minus road rock
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip; BB# = Breach berm.					
0.180	2.1		Ditch relief culvert at broad ridge with 300' gully to stream. Treatment: see road treatments.		
0.210		RD#5	11% grade, 20' wide road.		
0.235	3		Undersized culvert that has plugged and diverted in past. Treatment: Install 24"x40' plastic pipe in axis of stream. Install single post trash rack above culvert inlet.	24"x40' plastic pipe, 1 band, single post trash rack	
0.243		CD#3	Install at released Doug fir		
0.263		RD#6	10% grade, 16' wide road. Dip should drain to gully.		2 yds ³ -2" minus road rock
0.287	4		Undersized culvert drains small stream and good sized spring has diverted in past creating gully on fillslope. Treatment: Install 24"x30' plastic pipe in axis of stream.	24"x30' plastic pipe, 1 band	

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
0.294		CD#4			
0.325		RD#7	9% grade, 12' wide road.		
0.345	5		50% plugged, shotgun culvert draining meadow at headwall swale. Treatment: Clean culvert inlet.		
0.349		CD#5			
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip.					
0.370	6		Diverted small stream. Treatment: Install 24"x 80' plastic pipe at 10% grade, 5' down road from axis of channel to lessen plug potential from erosion off cutbank. Place culvert outlet at BOT flag Build up road immediately down road from new culvert to function as critical dip. Install 20' full road downspout on culvert	24"x80' plastic pipe, 3 bands	
0.374		CD#6			
0.374		Start OSR- PB & FD #1			
0.400	7		Separated ditch relief culvert with gully at outlet. Treatment: see road treatments		
0.404		RD#8	11% grade, 23' wide road. Dip drains to poison oak and gully.		

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
0.440		RD#9	14% grade, 20' wide road. Dip drains to small gully.		
0.472	8		Ditch relief culvert with gully at outlet. Treatment: see OSR#1 and RD#8 and RD#9		
0.475		RD#10	7% grade, 18' wide road. Dip drains to gully.		
0.500		RD#11	17% grade, 18' wide road. Dip drains to gully.		
0.530		RD#12	10% grade, 20' wide road.		
0.535	9		Ditch relief culvert with gully at outlet. Treatment: see road treatments		
0.567	10		Ditch relief culvert with gully at outlet. Treatment: see road treatments		
0.582		RD#13	15% grade, 29' wide road.		
0.582		End OSR - PB & FD #1			
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip.					
0.582		Start OSR- KD#1			
0.630		End OSR - KD#1			
0.630		Start OSR - PB & FD #2			

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
0.630	11		Undersized shotgun culvert with gully at outlet. Treatment: see road treatments		
0.635		CD#11			
0.680		RD#14	15% grade, 33' wide road.		
0.680		End OSR - PB & FD #2			
0.680		Start OSR - KD#2			
0.725	12		Ditch relief culvert with gully at outlet. Treatment: see road treatments		
0.725		End OSR - KD#2	OSR -KD #2		
0.725		Start OSR - PB & FD #3	OSR -PB & FD #3.		
0.765		RD#15	2% grade, 15' wide road.		
0.765		End OSR - KD#2	OSR -KD #2		
0.765		Start ISR#1	ISR#1.		
0.803		BB#1	Open 30' of berm via sidecasting to drain through cut at steeper angle than road.		
0.803		End ISR#1	ISR#1		

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
0.803		Start OSR - PB & FD #4	OSR -PB & FD #4.		
0.845		RD#16	6% grade, 20' wide road.		
0.845		End OSR - PB & FD #4	OSR -PB & FD #4.		
0.870	13		Road and ditch runoff create gully through steep meadow area. Treatment: see road treatments		
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip.					
0.875		RD#17	0% grade, 20' wide road.		
0.900		Start re-route			
0.985	14		Ditch relief culvert with high plug potential placed at low gradient. Site drains abundant flow from road surface and actively eroding ditch. Treatment: To be discussed in field. Either re-route road and fill in through-cut or armor road and ditch.		
1.000		RD#18	13% grade, 22' wide road.		
1.010		End re-route			
1.037	15		Two diversion gullies formed by excessive road drainage. Treatment: see road treatments		
1.080		RD#19	15% grade, 16' wide road. Really just improve outslope to 6% to shed all water from up road through-cut.		

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
1.107		RD#19.1	Top of skid trail.		
1.178	16		Bottom of skid trail. Undersized culvert that drains 3 small streams and long, steep section of road. Treatment: 1) Install 36"x 40' CMP in axis of stream channel. 2) Strongly recommend opening skid road between stations 1.107 and 1.178. Good road prism with lower road gradient and good drainage except for 1 spring area. Decommission 375' steep section of current road adjacent to stream. Outslope new road and install 4 rolling dips and rock road for 150'x20' where spring occurs with 3" minus road rock.	36"x40' CMP, 1 band	25 yds ³ - 3" minus road rock
1.190	17		Undersized culvert at low gradient with 50% plugged outlet. Treatment: Remove CMP and install armored ford crossing by lowering road 3 feet through crossing creating broad rolling dip. Dig key way below OBR in channel and armor outside edge of road with 3 yds ³ of 0.5-1' diameter rip rap.		3 yds ³ - 0.5 to 1' mix rip rap
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip.					
1.226	18		Undersized concrete culvert with active head cut through stored sediments above inlet. Treatment: Excavate 20 yds ³ above inlet. Lay back slopes to 2:1. Seed and mulch excavation. Install armored fill by lowering road 2' in axis of stream creating broad rolling dip. Excavate key-way in to channel below road and place 0.3-1' rip rap from key way and halfway through road bed (12' wide x 5' high with 2' key-way) . Use spoils to assist in outsloping road above site #16.		5 yds ³ of 0.3 to 1' mix rip rap

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
1.252	19		Large deep-seated landslide with toe in creek. Treatment: no treatment. If slide fails further in future, continue to ramp down onto slide. Do not build up slide with fill or will increase driving forces.		
1.290			At concrete spring box.		
1.306		RD#20	0% grade, 18' wide road. Just improve outslope to 6%.		
1.339		RD#21	5% grade, 20' wide road.		
1.360	20		Undersized concrete culvert draining steep stream that has overtopped in past. Treatment: Replace current pipe with 30"x40' placed in axis of stream channel. Clear stilling basin above inlet. Make sure there is no diversion potential after installation.	30"x40' CMP, 1 band	
1.373	20.1		Diverted small stream. Treatment: Not a good place for a culvert. Install armored fill crossing by excavating broad 3' rolling dip with low point in axis of channel. Excavate key-way and armor outboard fill from BOT to center of road with 0.3-1' diam. rip rap (18' long x 12' wide x 0.75 deep).		5 yds ³ of 0.3 to 1' mix rip rap
1.392		RD#22	8% grade, 18' wide road.		
1.410	21		Diverted small stream. Treatment: Install armored fill by lowering road 3' in axis of steam creating broad rolling dip. Excavate key-way and rock armor from BOT to center of road (15' long x 10' wide x 0.5' deep = 3 yds ³).		3 yds ³ of 0.2 to 0.5' mix rip rap
1.434		RD#23	1% grade, 18' wide road.		
1.451	22		Bridge over Gilliam Creek. Treatment: no treatment.		
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip.					

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
1.472		RD#24	3% grade, 15' wide road.		
1.500		RD#25	3% grade, 15' wide road.		
1.537		RD#26	3% grade, 19' wide road.		
1.553	23		Undersized shotgun culvert. Treatment: Replace culvert with 24"x30' plastic pipe in axis of stream channel. Add single post trash rack above inlet.	24"x30' plastic pipe, 1 band, single post trash rack	
1.611		Start OSR - PB & FD #5	OSR -PB & FD #5 with 5 % outslope.		
1.658	24		Undersized concrete culvert with evidence of past plugging and overtopping. Treatment: Install armored fill by ramping down 4' in axis of thalweg creating a broad rolling dip. Excavate key way and armor outboard fill from BOT to center of road using 10 yds ³ of 0.75 to 1.5' mix rip rap. (20x15x1) Use existing armor at site. Use spoils to improve road outslopes to either side of the crossing.		10 yds ³ of 0.75 to 1.5' mix rip rap
1.691		RD#27	4% grade, 20' wide road.		
1.725		RD#28	9% grade, 15' wide road.		
1.753	25		Past fillslope failures along inner gorge. Treatment: see road treatments		
1.813			At big cutbank slide		
1.848	26		Steep, diverted tiny stream at headwall swale. Treatment: Excavate 10x10' spillway on fillslope, line with fabric and backfill with 0.3 to 0.75' rip rap.		3 yds ³ of 0.3 to 0.75' mix rip rap

Road: Fire Road					
Miles	Site #	Road Tmt ¹	Comments/Treatment	CMP Needs	Rock Needs
1.859	27		Small stream diverts to site #26. Treatment: Excavate 10x6' spillway on fillslope, line with fabric and backfill with 0.3 to 0.75' rip rap.		3 yds ³ of 0.3 to 0.75' mix rip rap
1.877	28		Undersized, shotgun and rusted culvert with gully at outlet. Treatment: Install 48"x50' culvert in axis of stream between TOP and BOT flags, 5' to left of present installation. Install new inlet 5 feet upstream from current inlet. Remove dead tree and fill at downstream bend above culvert inlet. Install single post trash rack.	48"x50' CMP, 2 bands, single post trash rack	
1) DRC = Install ditch relief culvert; ISR# = Inslope road with 3% grade; OSR# = Outslope road with 3% grade; OSR-KD# = Outslope road and keep ditch; OSR- PB and FD = Outslope road by pulling berm and filling ditch; RB-Side# = Remove berm and sidecast; RB-Pull = Remove berm by pulling fill onto the road and outsloping the road or hauling to a stable spoil location; RD# = Install rolling dip; CD# = Install critical dip.					
1.877		End OSR - PB & FD #5	Outslope road through thru-cut between sites #28 and #29.		
1.908		CD#29			
1.914	29		Undersized, shotgun culvert at steep stream with gully at outlet. Treatment: Install 30"x40' culvert in axis of stream. Install single post trash rack above inlet.	30"x40' CMP, 1 band, single post trash rack	
1.930		RD#29	4% grade, 20' wide road.		
1.955		RD#30	9% grade, 18' wide road.		
1.970		CD#30	Drain at existing inactive gully.		
1.978	30		Undersized, shotgun culvert at small, steep stream with gully at outlet. Treatment: Install 30"x40' culvert in axis of stream between TOP and BOT flags. Install single post trash rack above inlet.	30"x40' CMP, 1 band, single post trash rack	

Attachment #3.

Conceptual Drawing of Typical Road

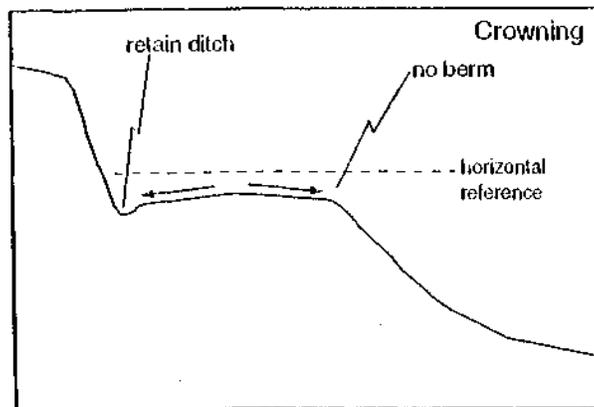
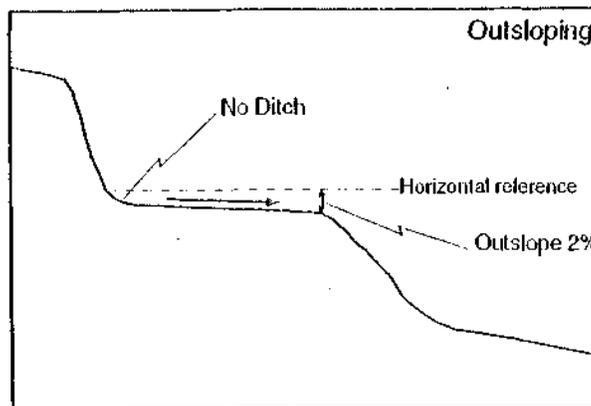
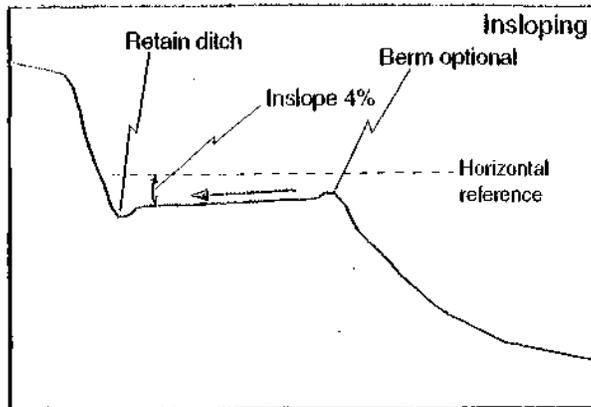
Upgrading and Decommissioning Treatments,

East Austin Creek State Recreation Area,

Sonoma County, California.

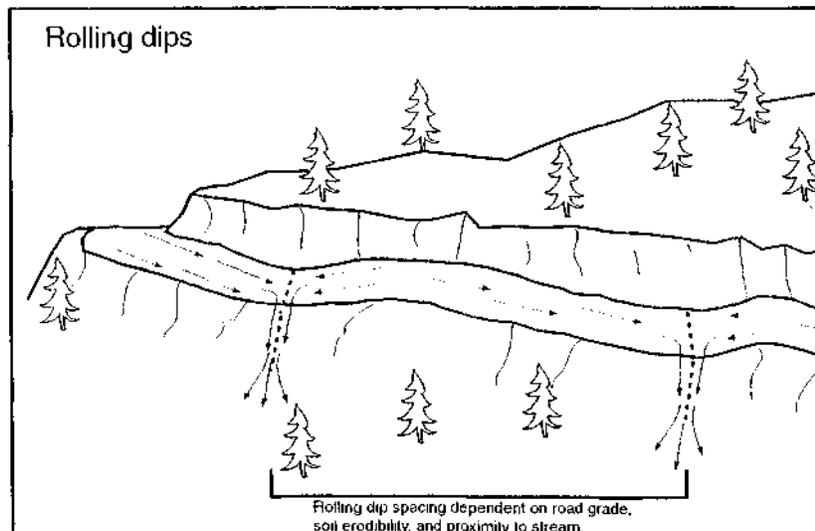
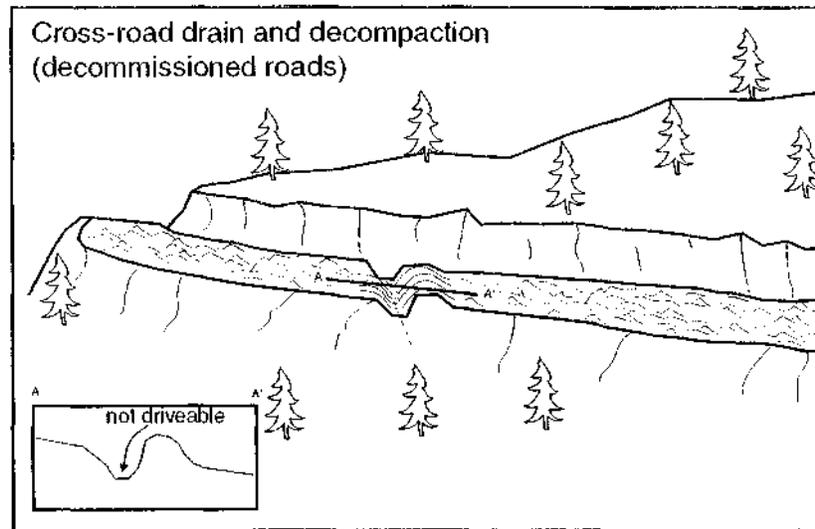
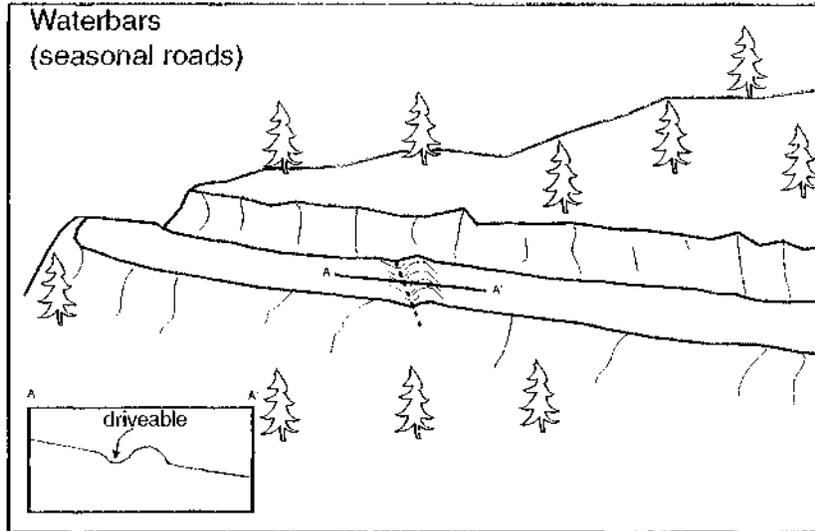
CDF&G State Contract #P9985131

Using road shape to control road runoff

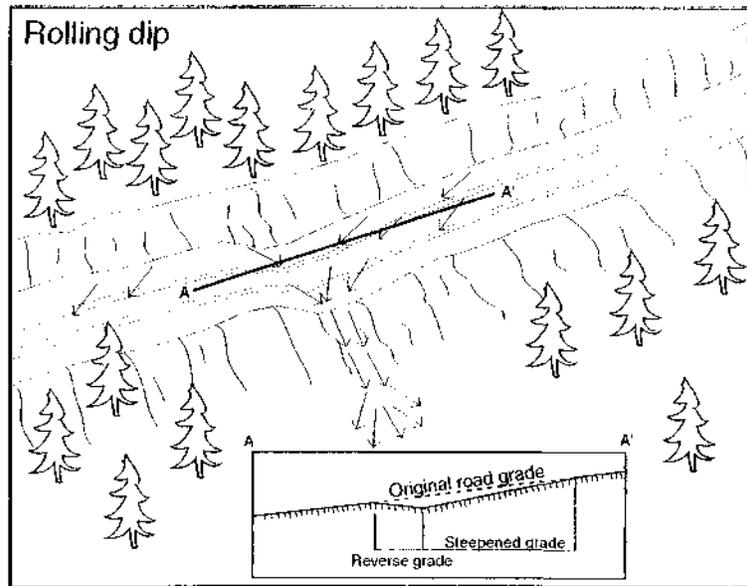


Outsloping pitch for roads up to 8% grade		
Road grade	Outslope pitch for unsurfaced roads	Outslope pitch for surfaced roads
4%, or less	3/8" per foot	1/2" per foot
5%	1/2" per foot	5/0" per loot
6%	5/8" per foot	3/4" per loot
7%	3/4" per loot	7/8" per fool
8%, or more	1" per foot	1 1/4 per foot

Dispersing road surface runoff



Road surface drainage by rolling dips

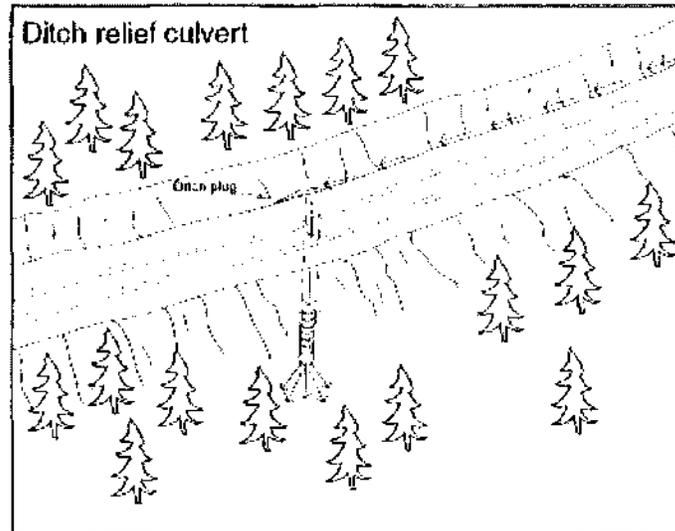


Rolling dip installation:

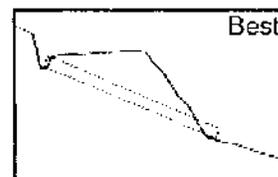
- 1) Rolling dips are installed in the road bed as needed to drain the road surface.
- 2) Rolling dips can be sloped either into the ditch or to the outside of the road edge as required to properly drain the road and disperse surface runoff.
- 3) Rolling dips are usually built directly across the road 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 trough) (ft)	Reverse grade (Distance from trough to crest)	Depth below average road grade at discharge end of trough. (ft)	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 ditch relief culvert installation



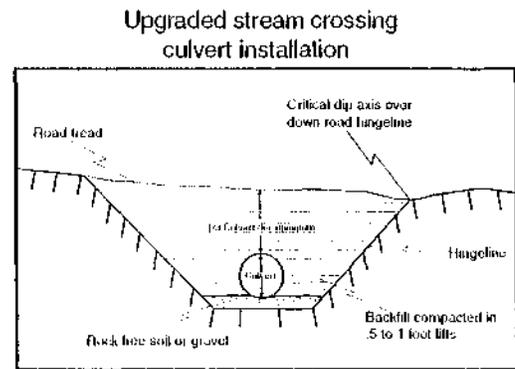
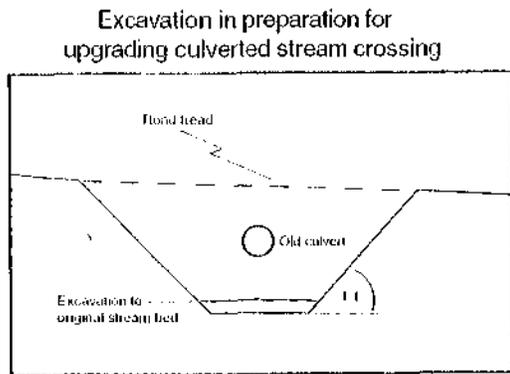
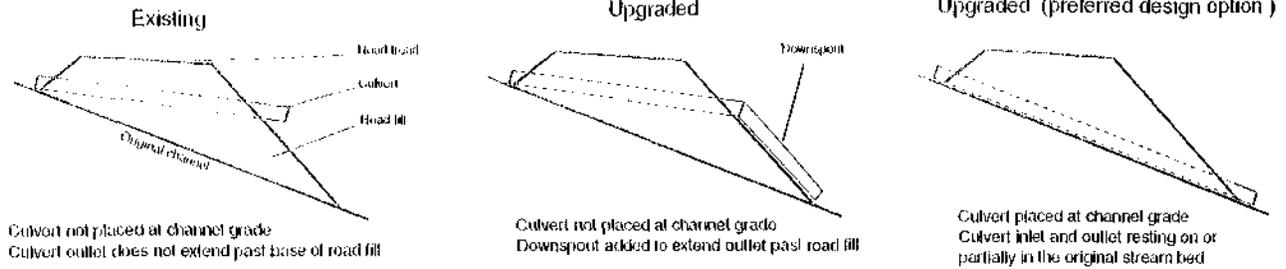
Cross sections of typical installations



Ditch relief culvert installation

- 1) The same basic steps followed for stream crossing installation should be employed.
- 2) Culverts should be installed at a 30 degree angle to the ditch to lessen the chance of inlet erosion and plugging.
- 3) Culverts should 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 should be installed at a slope of 2 to 4 percent steeper than the approaching ditch grade, or at least 5 inches for every 10 feet of length.
- 5) Backfill should be compacted alongside and over the top of the culvert.
- 6) Culvert outlets should extend beyond the base of the road fill (or a flume downspout should be used to carry flow beyond the fill).

Typical design of non-fish bearing culverted stream crossings



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.

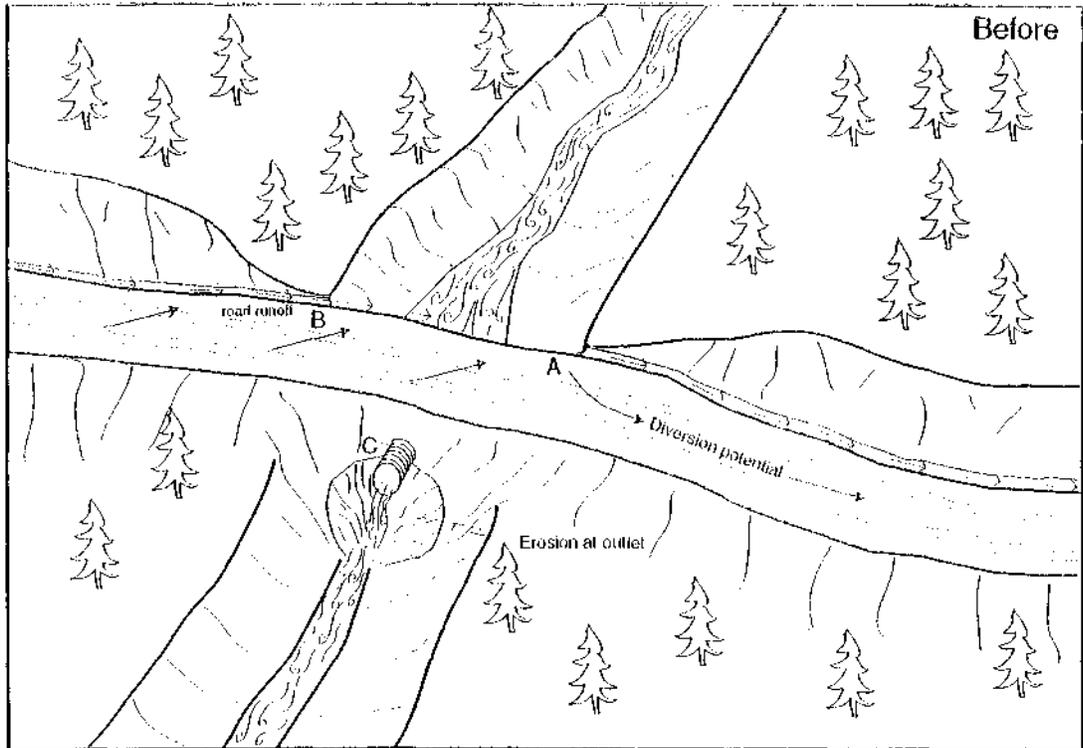
Erosion control measures for culvert replacement:

- 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) Dune 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 watercourse.
 - 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.

Typical Schematic Components of an upgraded stream crossing

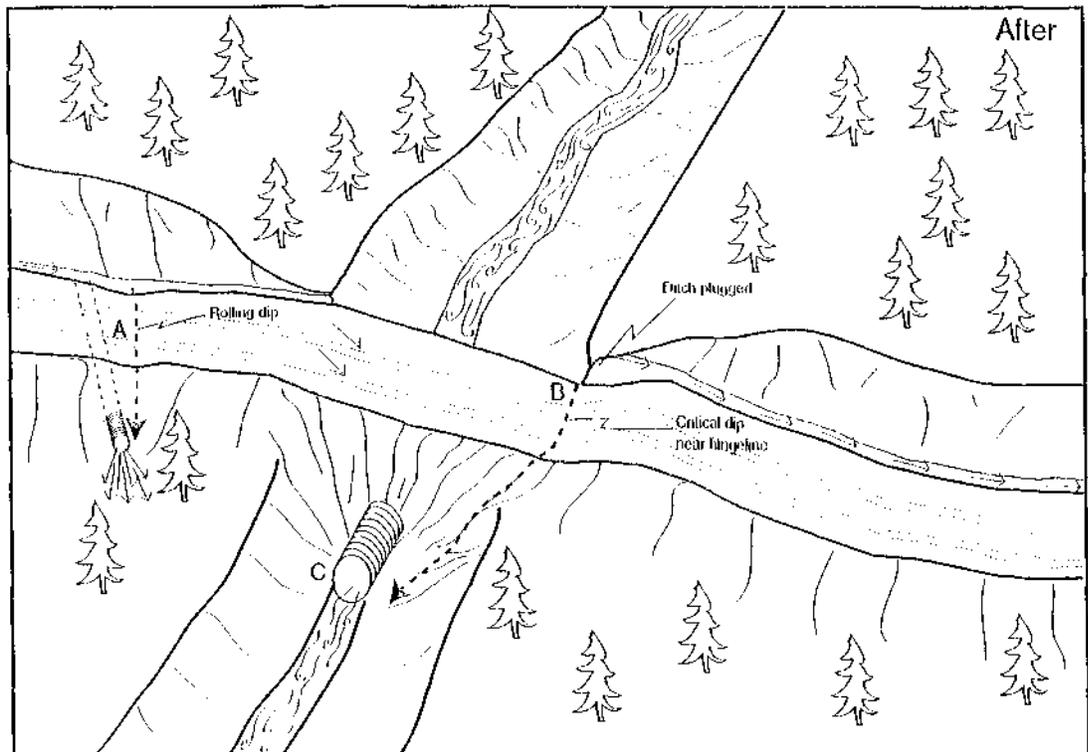
Common problems

- A - Diversion potential
- B - Road surface and ditch flows drain to stream
- C - Undersized culvert high in fill with outlet erosion

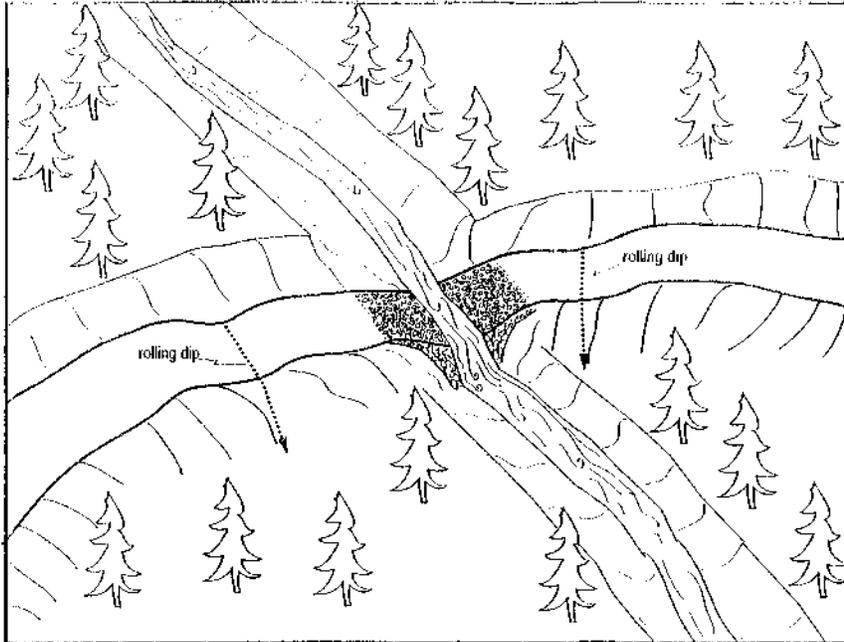


General Standards

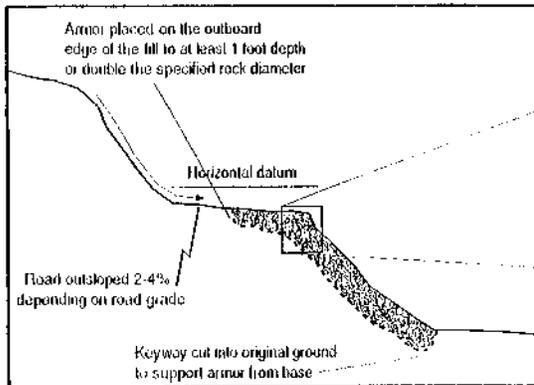
- A - Road surface and ditch "disconnected" from stream
- B - No diversion potential
- C - 100 year culvert set at base of fill



Typical armored fill crossing installation



Cross section parallel to watercourse



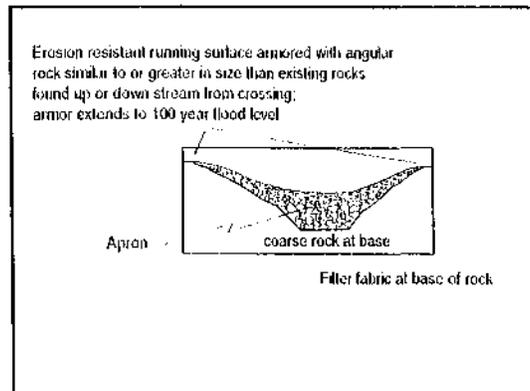
Fine grained surface coarse on running surface

Woven geotextile

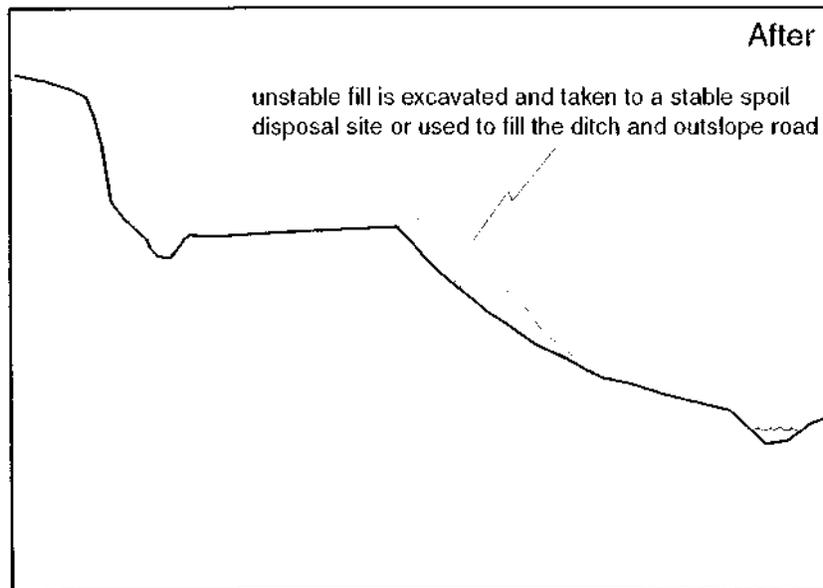
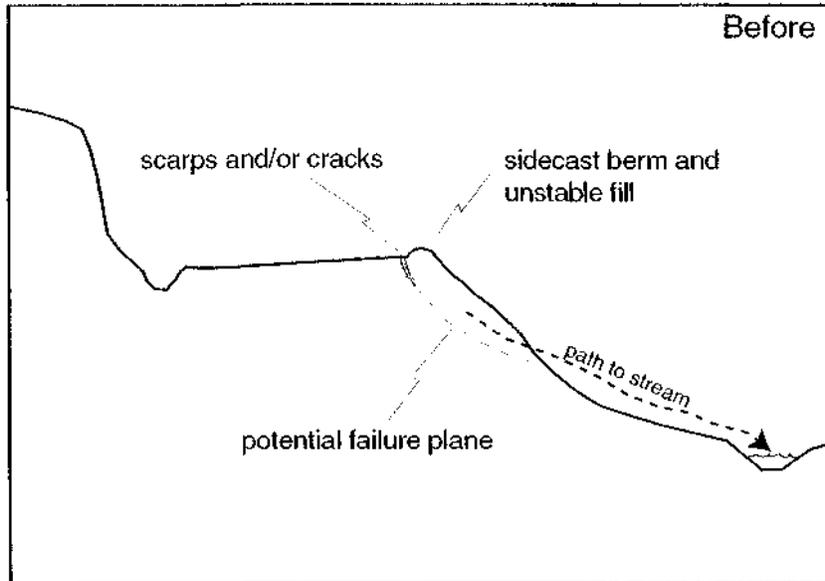


Base coarse rock protects fill

Cross section perpendicular to watercourse



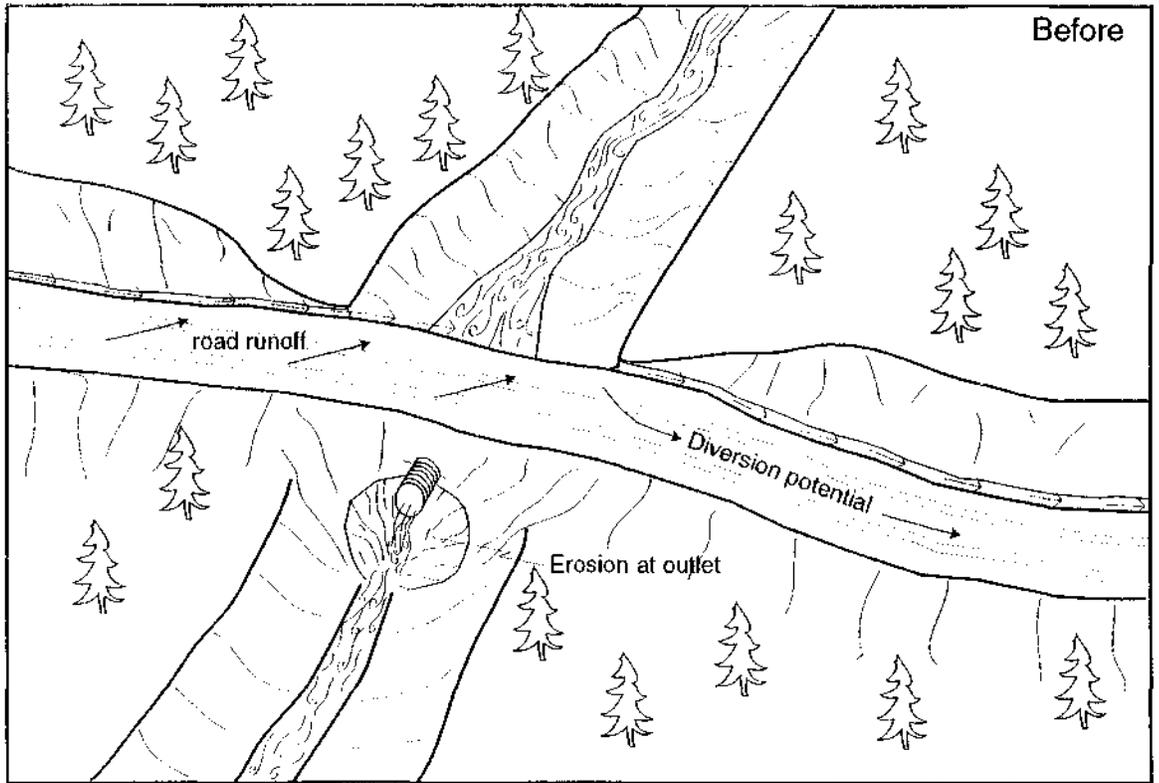
Excavating unstable fill slope on maintained road



Typical stream crossing decommissioning

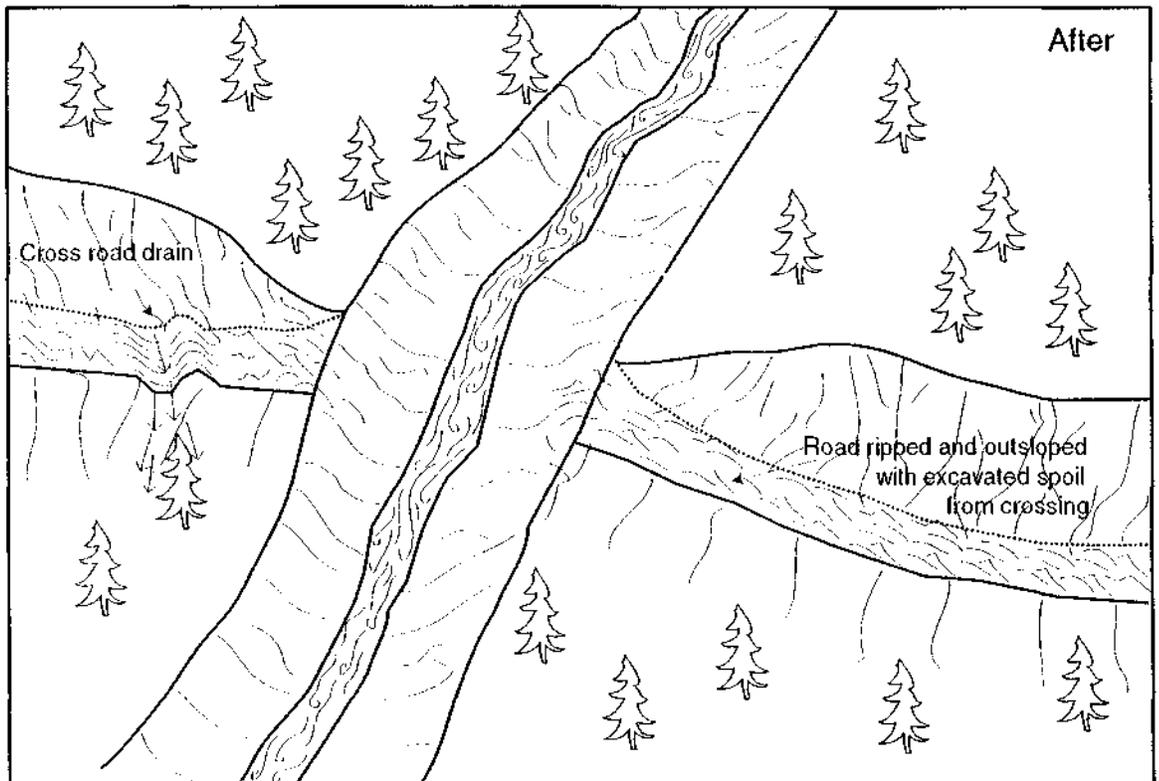
Condition

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

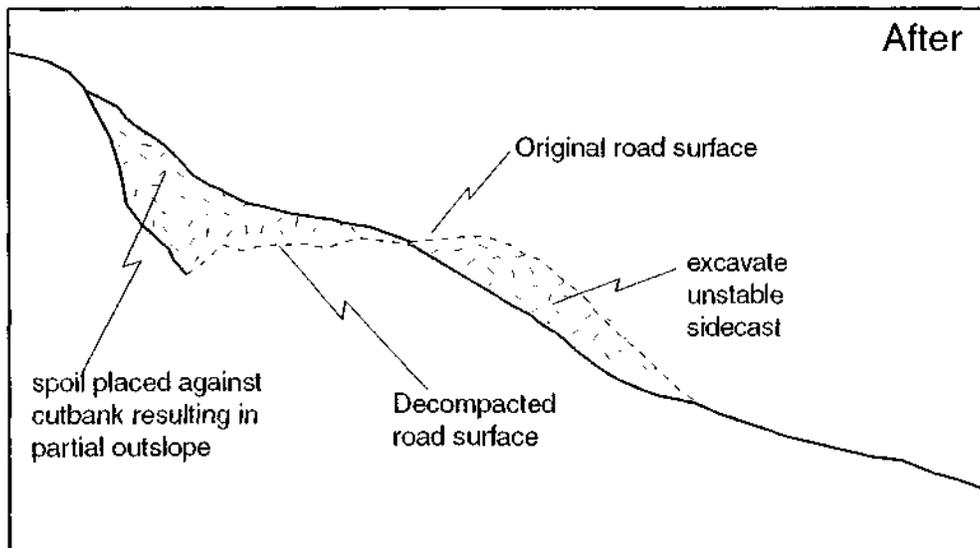
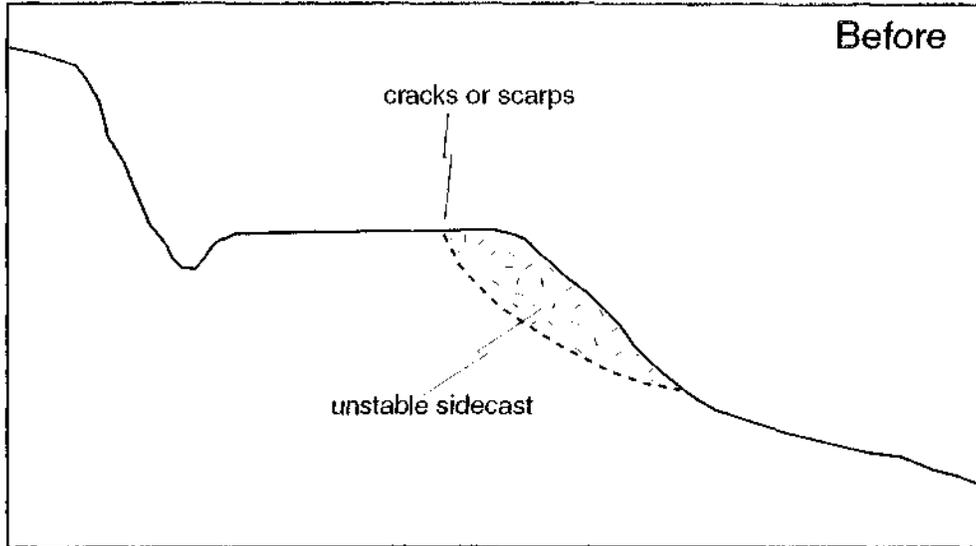


Treatment

- 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 #4.

Selected Before, During and After

Photo Point Photographs of

Completed Work in the East Austin Creek Watershed,

Sonoma County, California.



Figure 1A and 1B. Examples of typical erosional problems in Austin Creek State Recreation Area which lead the State Parks and PWA to seek CDF&G funding to protect important aquatic habitat in the East Austin Creek watershed. Failed stream crossings and direct sediment delivery (upper photo), un-culverted diverted streams resulting in hillslope gully erosion and sediment delivery (lower photo).



Figure 2A and 2B. Examples of typical erosional problems in Austin Creek State Recreation Area which lead the State Parks and PWA to seek CDF&G funding to protect important aquatic habitat in the East Austin Creek watershed. Large road bed drainage areas between ditch relief culverts resulting in the formation of large man-made channels (hillslope gullies) and direct sediment delivery (upper photo), long lengths of un-controlled or un-planned road drainage resulting in high sediment delivery rates of road bed. surface lowering erosional products (lower photo).



Figure 3A (top) and 3B (bottom). View downstream. Before and during excavation of channel stored sediment above undersized culvert stream crossing at Site #73. The culvert installation was a barrier to upstream fish migration and had also resulted in channel aggradation for 100 feet upstream of the culvert inlet. The stream crossing was properly closed by excavating all road fill and channel stored sediment upstream from the culvert.



Figure 4A (top) and 4B (bottom). Thirty-one stream crossings had culverts installed which were sized for the 100 year storm. The culverts were installed at the base of the fill in line with the natural channel, had sufficient culvert length to construct stable fill slopes and were fitted with critical dips to prevent future stream diversions.



Figure 5 A (top) and 5B (bottom). View downstream at Site #43. Before and after photographs of upgraded stream crossing. Note prior and current culvert size, use of flared inlet to lower the plug potential at the inlet, use of low berm at outside edge of road to protect newly constructed fill slope and the excavation of channel stored sediment above the prior culvert inlet.



Figure 6. View downstream at Site #43 one winter after installation. Channel is flowing on bedrock with minor channel adjustments in cross sectional area, and the site has stable sideslopes.



Figure 7. Twenty-three armored fill stream crossings were constructed in the East Austin Creek watershed during 2001. Armored fill crossings are appropriate along low use roads, and where properly sized culverts are difficult to install or where the culvert inlet would still have a high plug potential.



Figure 8A (top) and 8B (bottom). View upstream at Site #44. Before and during photographs of armored fill stream crossing installation. The shallow fill crossing limited the ability of Park Staff to install a properly sized culvert. Consequently, the culvert plugged frequently resulting in stream diversions and hillslope gullies. During installation, the road is lowered several feet vertically with a broad rolling dip, a keyway is dug from the base of the fill to the mid-point of the road bed, filter fabric is placed over the keyway, and a mix of rock armor is applied which is coarser than the stream is capable of transporting at high flows.



Figure 8C. View upstream at Site #44 one winter after installation. The stream must flow over the armored apron at all stream flows to function properly and prevent future sediment delivery to stream channels.



Figure 9. One hundred and thirty-six rolling dips were installed along roads in the Austin Creek State Recreation Area. Where appropriate, the road bed was outsloped, berms were removed and used to fill the inboard ditch, and broad, very driveable rolling dips were installed in order to disperse road runoff to the maximum degree possible.



Figure 10. Often in grassland settings, ditches must be retained to insure a stable road bed. However, the road bed should be outsloped and berms removed, where possible, to disperse fine sediment originating from the road bed off the outside edge of the road, and not be delivered to live ditch. Heavy fall rains terminated the project last year prior to final road grading and the distribution of road rock. Some rilling of the road bed occurred during the winter. This section of road was recently re-graded to improve the outslope and insure the road drains properly in future years.



Figure 11. The erodability of the soil and the spacing between rolling dips dictates the extent of erosion occurring on the road bed. This rolling dip shows rills developing on the road bed when the road grade steepens, however all the sediment is deposited on the hillslope beyond the road with no sediment delivery to nearby streams.