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INTRODUCTION

Background

Redwood Creek drains a 280-square-mile watershed in the mountainous, coastal region of northwestern California. The watershed is characterized by high relief, steep unstable slopes, and narrow valley bottoms. Redwood Creek and its tributary streams are subject to frequent flooding from winter storms, and basin soils are naturally unstable and highly erodible. Landslides and earthflows are widespread, and even under natural conditions streams swelled by winter rains transport large volumes of sediment. With over 90% of the forests in the basin harvested, and 2/3 of the basin in active timber management, sediment levels in Redwood Creek are twice the mean annual erosion rates for the north coast (U.S. Congress, House, Committee on Government Operations 1976). Redwood National Park (RNP) is located in the lower 1/3 of the Redwood Creek watershed.

Public Law 95-250 (March 27, 1978) directed that a watershed restoration program be developed for lands that had been timber harvested prior to becoming part of Redwood National Park. Timber harvesting and road construction that occurred on these lands before they were added to the park had adversely influenced erosion rates, sediment deposition, and water quality within the entire basin. These problems are being addressed in the restoration program. The purpose of the restoration program is to minimize human-induced erosion within Redwood National and State Parks, encourage the return of a natural pattern of vegetation, and protect redwood groves and aquatic communities. Ultimately, these efforts should result in the restoration of natural ecosystems to conditions similar to what would have existed without disturbance by humans. (Redwood National Park, Watershed Rehabilitation Plan, 1981)

It is National Park Service policy to "actively seek to understand and preserve the soil resources of parks and to prevent, to the extent possible, the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resources..." It is also Park Service policy that "Terrain and plants may be manipulated where necessary to restore natural conditions on lands altered by human activity. Management activities may include, but will not be restricted to, removing constructed features, restoring natural gradients, and revegetating with native park species..." (National Park Service Management Policies, 1988). Management objectives of Redwood National Park are "to restore and/or maintain the natural ecosystems of the park" and "to continue with biological and physical restoration of park lands severely impacted by past land-use practices" (Redwood National Park, Statement for Management, 1992). These policies and objectives provided the guidance and direction for the removal of this portion of the C-Line South Road.

Site Description

The project area is located approximately sixteen miles south of Orick at an elevation of approximately 1500 feet above sea level (Figure 1). The C-Line was a major haul road

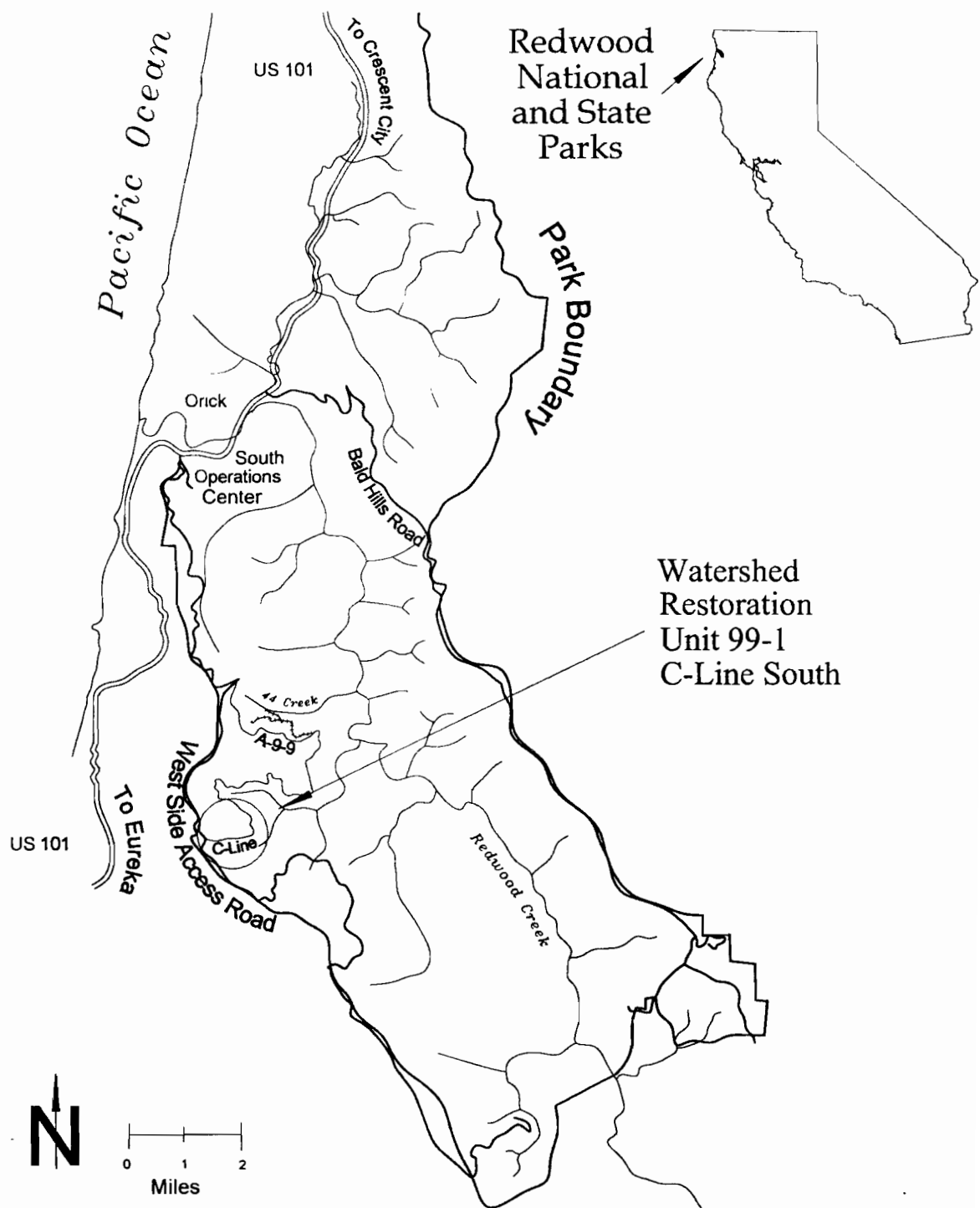


Figure 1. Project Location

constructed in approximately 1950. It is located on the west side of the Redwood Creek basin and ran, within the park boundaries, from the West Side Access Road near MP 9 to the A-9-9. A large stream crossing (C-Line Pond) was excavated in 1993, severing the C-Line into two sections - the C-Line North and the C-Line South.

On January 1, 1997, an eleven-year storm hit northern California, including the Redwood Creek basin, after three months of above average precipitation. This storm caused numerous failures, predominately mass movements along the roads in Redwood National Park. A portion of the road fill and hillslope on the C-Line South slumped, causing the road bench to drop approximately five feet. Redwood National Park received \$7.5 million from the Emergency Supplemental Appropriations Act for Recovery from Natural Disasters (PL 105-18) and \$0.5 million from the Federal Highway Administration's Emergency Relief for Federally Owned Roads (ERFO) to remove roads that had been damaged during the storm. Other roads that were public access or long term administrative access roads also received funds for repair. The C-Line South was one of the roads to be removed.

The total cost for this project was \$194,656 (see Table 1 for cost summary). The heavy equipment cost of \$177,540 was funded from the Emergency Supplemental Appropriations Act. The salary cost of \$17,116 for implementation was funded by RNP's base operating funds and the Emergency Supplemental Appropriations Act.

Watershed Restoration Unit 99-1 constitutes the third phase of a three-year strategy to remove the C-Line South. This project removed 0.5 mile of the C-Line South that included one stream crossing. This project involved the excavation of a total of 44,000 yds³ of fill material, including 17,000 yds³ associated with one stream crossing.

Restoration focused on the removal of the stream crossing fill and unstable side cast fill, and placement of this fill against the cutbanks on stable road reaches in order to restore more natural hillslope topography and drainage patterns interrupted by the C-Line South. The excavation of the stream-crossing fill uncovered the natural channel bed and banks, and excavated fill was used to re-create the natural topography. Buried organic and nutrient rich material was returned to the surface in order to help speed recovery of native vegetation. Trees removed during excavation were dispersed along the finished surface in order to provide habitat and simulate natural forest litter.

Geology

The Redwood Creek basin is almost entirely underlain by the Jurassic-Cretaceous Franciscan formation. Exposures of these rocks typically show closely spaced fractures and/or pervasive shearing. Fractures seem to have resulted from deformation from tectonic emplacement, likely by subduction, and from brecciation along high angle faults. The intensity and style of this disruption seems to be the rock characteristic that most influences differences in the erosion rates and landforms (Janda, unknown). The Grogan fault, which has a surface trace roughly coincident with the valley of Redwood Creek, separates two major lithologies of the Franciscan formation. In general, rocks on the west side of the basin consist of quartz-mica schist, whereas

TABLE 1							
RESTORATION WORK COST SUMMARY FOR UNIT 99-1, C-LINE SOUTH ROAD							
Treatment	Quantity	# of Jobs	Total Costs		% of Grand Total using Actual	Average Unit Costs	
			Actual	H.E.R.E. ^a		Actual	H.E.R.E. ^a
Heavy Equipment							
Stream Crossing	17,000 yds ³	1	\$66,200	\$53,255	34	\$3.89	\$3.13
Export Outslope	24,900 yds ³	5	\$95,260	\$102,078	49	\$3.83	\$4.10
Outslope	2,100 yds ³	3	\$4,815	\$9,695	2	\$2.29	\$4.62
Misc. Bid Items		4	\$11,266	\$7,380	6		
Misc. Non-Bid Items			\$0	\$6,308	0		
Subtotal	44,000 yd ³		\$177,540	\$178,716	91		
Project Implementation ^b							
Planning	10	NA	\$209		0		
Mapping	31	NA	\$726		0		
Prescriptions and Layout	50	NA	\$1,151		1		
Surveying	158	NA	\$3,314		2		
Environmental Compliance	1.5	NA	\$35		0		
Contract Preparation	50.25	NA	\$1,177		1		
Heavy Equipment Supervision	450	NA	\$9,545		5		
Photo Documentation	21	NA	\$424		0		
Report Writing	21.5	NA	\$534		0		
Subtotal	793.25	NA	\$17,116		9		
Grand Total			\$194,656	\$195,832	100		

^a Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Cat. D8H dozer @ \$165/hr; Cat. D8L dozer @ \$200/hr; John Deere 892D excavator @ \$160/hr; Case 220 excavator @ \$175/hr; Cat. 977K loader @ \$95/hr; and 10 yd³ dump trucks @ \$65/hr.

^b Project implementation costs are the total number of hours that Redwood National Park employees worked on the project multiplied by their hourly rates. Several employees making different hourly rates worked on this project, so the total hourly rate is not consistent.

unmetamorphosed sedimentary rocks are found on the east side. The Grogan fault is more linear than other major NNW trending faults in the region which suggests a near vertical dip (Hardin et al., 1982).

The north-northwest trend of these units and the younger faults that cut them is a signature of the overall tectonic structure of the northwest. This structure is dominated by north-north west trending, imbricated thrust faults that dip to the east and accounts for the prominent north-northwest trend of many of the ridges and rivers in the northern Coast Ranges as well as the obvious shearing. The overall amount of shearing in the major units can usually be predicted by the topography because the amount of shearing strongly influences both type and abundance of landslides.

The project area is situated on the west side of the Redwood Creek basin, and is underlain by the schist of Redwood Creek. The most common rock type within this unit is metamorphosed mudstone. Metamorphosed sandstones, which locally display graded bedding, are also present. Another major lithologic component is metamorphosed basalt and tuff. Large metabasalt outcrops form prominent knobs on the landscape. Considerable variations in mineralogy, texture, lithology, and structure are evident but intense shearing and complex folding and faulting preclude mapping subunits.

Timber Harvest History

The 1948 air photos covering Tom McDonald Creek show that no road construction or timber harvest had begun in the area. By 1954, the C-Line had been constructed and limited timber harvesting had begun. All the areas that were cut in the project area prior to 1954 were harvested using cable-yarding techniques. By 1962, most of the project area had been cut except for three parcels that were cut in the 1970s. (Figure 2) Before the 1970s, areas below the C-Line were harvested by cable yarding and areas above the C-Line were harvested by tractor yarding. The harvesting done in the 1970s was by tractor yarding. Clearcutting and seed-tree leave were the silvicultural practices used in the 1950s. Between 1962 and 1968, no large-scale harvesting was done in the project area, but some of the seed trees left during earlier logging were harvested. Between 1973 and 1976 three old-growth patches were clearcut. No additional timber harvesting was performed after 1976 and Redwood National Park acquired the land in 1978.

Erosional Features

The most dominant erosional features are landslides and debris flows (Figure 2). The 1954 air photos show one recent slide originating above the C-Line in a cable yarded unit just east of the intersection of the G-Line. The 1972 photos show four recent land slides/debris flows that originated on the outboard edge of the C-Line and terminated at the creek, east of the intersection with the G-Line. Between 1972 and 1973, immediately following clearcutting of an old-growth patch and construction of very large skid roads above the C-Line, a debris flow occurred originating on the outboard edge of the C-Line and terminated in the creek below RX-1 and RX-2. Between December 5 and 9, 1996, the outboard edge of the road at RX-2 failed and debris flowed

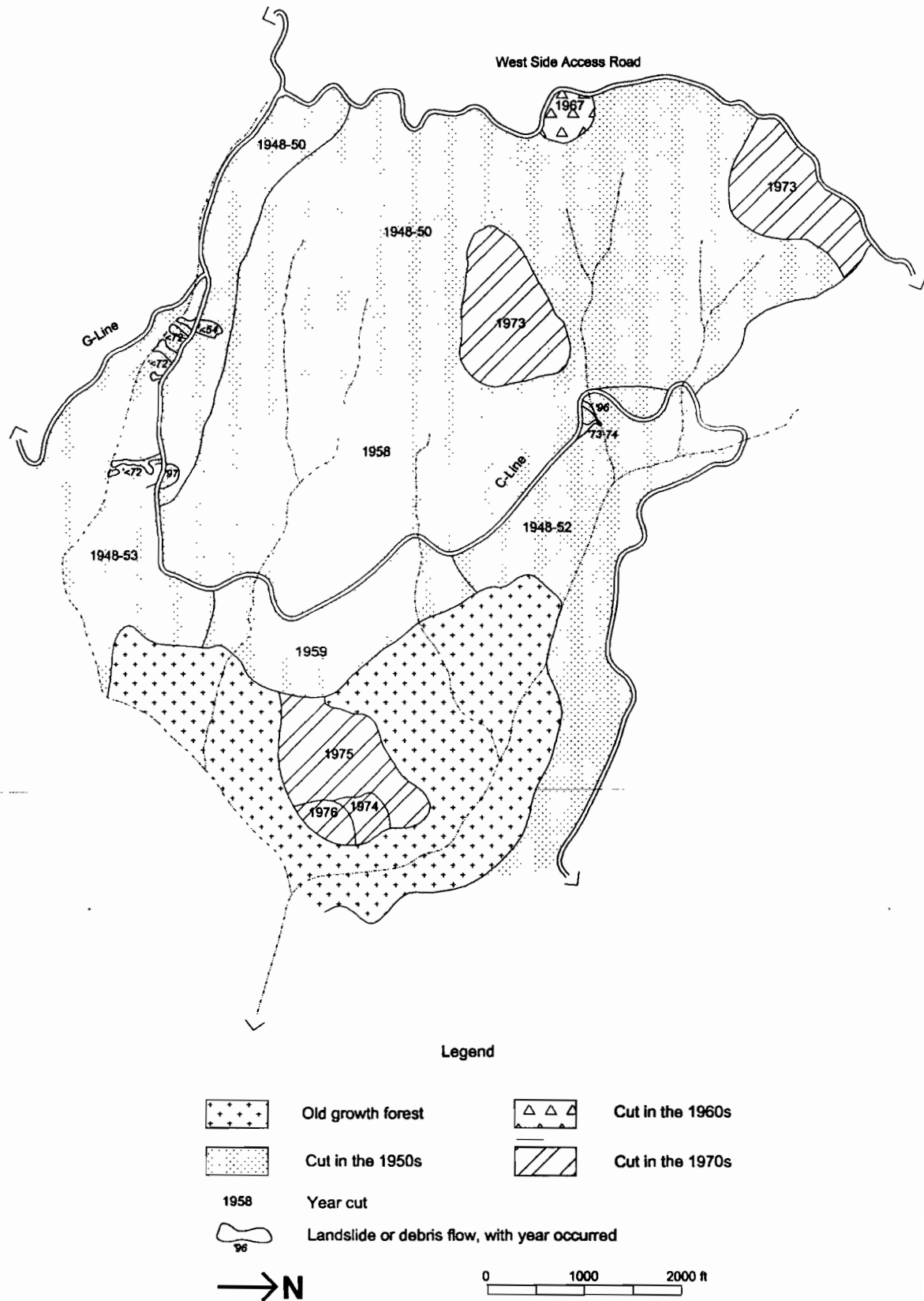


Figure 2. Timber Harvest History and Recent Mass Movement Features

into the creek. During the New Year's storm on January 1, 1997, a section of the C-Line east of the G-Line intersection slumped, dropping the roadbed approximately five feet. In addition, the soils below the C-Line are very prone to gullyng. A ditch relief pipe at station 73+80 discharged water onto the hillslope at a ridge. This water created a gully with dimensions up to 5' wide by 3' deep running all the way down to the creek.

Threatened and Endangered Species Concerns and Work Schedule

Two bird species that are listed as threatened under the Endangered Species Act occupy areas in or near the project area: the northern spotted owl and the marbled murrelet. On May 6, 1997, coho salmon were also listed as a threatened species. Because old-growth forests serve as critical habitat for these species, Redwood National and State Parks is considered a critical conservation area for their survival.

The U.S. Fish & Wildlife Service (USFWS), as administrator of the Endangered Species Act for northern spotted owl and marbled murrelet, has set noise and habitat modification restriction guidelines designed to reduce human impact, especially to nesting sites during the breeding season.

The National Marine Fisheries Service (NMFS) is responsible for administering the Endangered Species Act for protection of the coho salmon.

In July, 1998, Biological Assessments (BA) and Biological Opinions (BO) to determine the effects 1997 Storm restoration projects on threatened and endangered species and their critical habitat were completed by RNP, USFWS, and NMFS. The purpose of the BA/BOs was to meet the criteria for formal consultation with the USFWS and NMFS as required under Section 7 of the Endangered Species Act of 1973, as amended. The BA/BOs determined that restoration work on the C-Line South could begin on July 10 and continue until November 1. Work could continue beyond Nov. 1 if weather and soil conditions were dry so that the work would not introduce sediment to watercourses.

RESTORATION WORK

Project Implementation

Restoration work focused on restoring the land to a condition similar to what would have existed without disturbance by humans. This included complete excavation of road fill out of stream crossings and swales, complete outslping of the road, and rebuilding of ridges resulting in the road fill being shaped to mimic the natural hillslope topography above and below the road (Figure 3). Recontouring provides a solid, beneficial foundation morphologically, hydrologically, and aesthetically for landscape evolution.

The project geologist, Becca Smith, mapped geomorphic and hydrologic features, prescribed restoration treatments, surveyed the volumes of all worksites before and after excavation, prepared

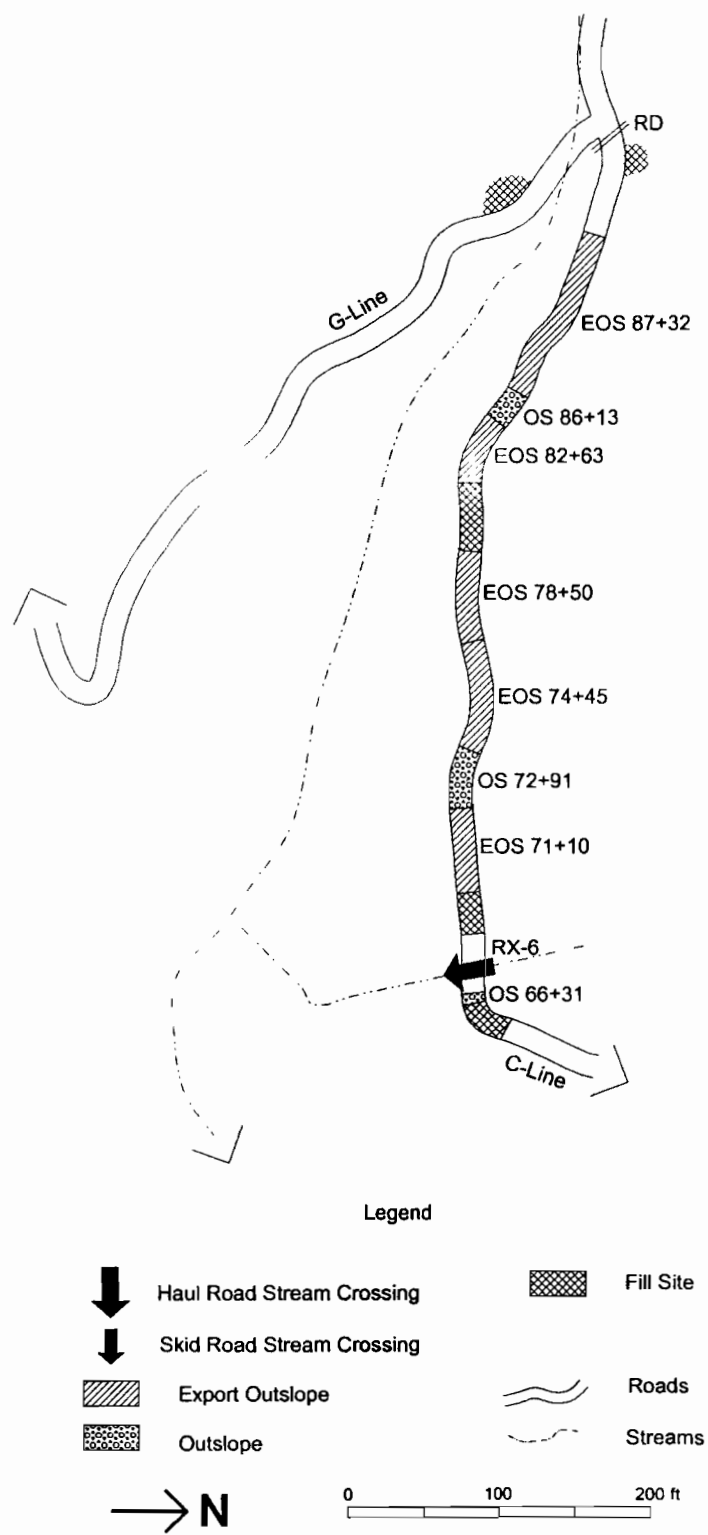


Figure 3. Location of Treatment Types in the Project Area

the contract, oversaw heavy equipment operations as the contracting officer's technical representative (COTR), photo documented the work, and wrote the final report. Phil Freiberg and Aileen Stuart assisted with surveying. Aileen Stuart served as project inspector for the last week and a half of the contract.

Heavy Equipment Phase

The heavy equipment phase included completion of all primary restoration treatments. A total of 0.5 mile of the C-Line South was removed at a total heavy equipment cost of \$177,540. A total of 44,000 yds³ of material was excavated from 1 haul road stream crossing (17,000 yds³), 1884 feet of haul road export outslope (24,900 yds³), and 353 feet of haul road outslope (2,100 yds³). The haul road surface was ripped prior to placement of fill on fillsites.

The heavy equipment phase was done by "request for proposal – indefinite quantity/indefinite delivery" contract. Proposals were due July 6, 1999 and contracts were awarded to three contractors on July 28, 1999. The amount of work remaining on the C-Line South for this year was estimated to take six to eight weeks. The delivery order for the C-Line South was issued to Z Logging L.L.C. (Larry Zuber) on August 23, 1999. This project was sub-contracted by Twin Parks (Jay Franke). The heavy equipment work on 99-1 began on September 16, 1999 and all work except for the rolling dips was completed on November 9, 1999. The rolling dips were completed by November 22, 1999. Work began so late because the amount of work on the C-Line South was not a full season (estimated to take six to eight weeks), the COTR was working on another project (99-2, A120/A100) until September 14, 1999, and the sub-contractor was finishing work on other jobs until September 16, 1999.

The following equipment was used: a John Deere 892D-LC excavator with thumb; a Case 220 excavator; a Caterpillar D8H dozer with winch; a Caterpillar D8L dozer with winch; a Caterpillar 977K loader; and four 10 yds³ dump trucks when needed. The equipment operators were Jay Franke sub-contractor, 220, D8L, D8H, and 977; Jay Chamberlain 892 and 220; and Del McLaughlin D8H and D8L.

Stream Crossing

A summary of stream crossing excavation costs and production rates is shown in Table 2. A narrative of the excavation of the crossing follows.

RX-6

A little over a third of the volume of material on this project was contained in this item. The crossing was designed to be 15,000 yds³. Excavation of this crossing began by the two D8s dishing down this crossing as much as they could. The 892 bushed out the crossing and fillsites and then started working in the bottom of the crossing once the dozers had it dished down far enough. A small amount of water was flowing into the top of the crossing and through the culvert on the left side during excavation. The excavator operator accidentally dug up the outlet end of the

culvert prematurely. A trench was dug from the exposed culvert outlet to the edge of the fill along the former culvert alignment so that the water stayed away from the work area as much as possible. The majority of the fill was dry with just small amounts of wet material at the top and bottom of the crossing. Topsoil was found in most of the crossing and numerous stumps were uncovered. Fill was pushed to fillsites on both sides of the crossing. The excavation was designed to have 3,300 yd³ endhauled to the G-Line Rock Pit. However, the downroad fillsite was able to accommodate more fill than designed so endhauling was not necessary. The bottom portion of the channel was very flat and deeper than designed. The final excavation was very wide and slightly larger than designed with a volume of 17,000 yd³.

Export Outsloping

A summary of export outslope excavation costs and production rates is shown in Table 3. Export outslope treatments were done in five road reaches where there was not sufficient space against the cutbank within the item to store all the material. The fill was pushed to other fill sites with the dozers and occasionally endhauled with the dump trucks. As with the previous portions of the C-Line South removed (97-1 and 98-1), very little black topsoil was uncovered in EOS and OS reaches. Red dirt with small roots in it was the primary indicator marking original ground.

EOS 71+10 was very steep and narrow making excavation difficult. A bench at the lower portion of the excavation is the result of blending the excavated portion into the remaining fill slope downslope of the excavation. EOS 74+45 contained the slump that had occurred during the 1/1/97 storm. Original ground was encountered well above the CTH stakes, so the volume was less than designed. The production rate for EOS 78+50 was much lower than the other EOSs. Dump trucks were not available while EOS 78+50 was being excavated so the fill material was pushed into a pile in fillsite 81+00. When the trucks arrived, this pile was loaded into the trucks and transported to the G-Line Rock Pit. The distance the fill was moved and the fact that it had to be moved three times may account for the low production rate. EOS 82+63 was composed of two subtle swales with a small ridge in between. A bedrock knob was uncovered approximately in the middle of this item. A bench at the lower, uproad portion of the excavation is the result of blending the excavated portion into the remaining fill slope downslope of the excavation. EOS 87+32 was composed of two pronounced swales with a ridge in the middle. Each of the swales had experienced debris flows in the past. The downroad swale had experienced a large debris flow that had deposited some of the material in a bench below the CTH flags. The contractor and the site inspector agreed to retrieve some of this material. This material was a small amount of the total item, but it was very wet and had to be moved three or four times. A feature that appeared to be an old scarp was uncovered in this swale. This caused the fillsite to be steeper than designed and unable to hold as much fill as designed. The small rock pit at 97+00 as well as the G-Line rock pit were used as additional fillsites.

Outsloping

A summary of outslope excavation costs and production rates is shown in Table 4. As with the EOS items, topsoil was not easy to locate. Clues indicating original ground included some soil

color change to dark red or brown soil, schist bedrock, and stumps. Excavation rates were fairly consistent for the different outcrops.

Miscellaneous Bid Items

A summary of miscellaneous bid item costs is shown in Table 5. All miscellaneous bid items were lump sum items. Ripping was done to decompact the remaining road bench and inboard ditch underneath fillsites. Since neither of the dozers had rippers, decompaction was done by digging up the road bed with the excavator buckets. This was effective in terms of decompacting the road, but was much slower than a dozer with ripper teeth. Five rolling dips were constructed on the G-Line and one on the C-Line to prevent diversions of stream flow in the event that the old, rotten, undersized culverts plug and to drain water off the road below the G-Line rock pit fillsite. Equipment times were not recorded for rolling dip construction.

Non-Bid Items

Non-bid items are categorized as jobs that result in non-recoverable costs on the part of the contractor. These items are distinguished by requiring time that is generally not directly attributable to any specific bid item. Non-bid item times were recorded to compare the costs of the contract with that of an hourly rental. Table 6 provides a cost breakdown for non-bid items.

"Discussion time" is defined as periods of time where equipment operations were interrupted by discussions lasting 15 minutes or more. Several shorter discussion periods were sometimes combined into one when they added up to approximately 15 minutes (time was recorded in 15 minute intervals). Most of the discussion time recorded was when the operators and COTR would stop to discuss the progress of a particular phase of a bid item or develop a strategy for the work. On occasion, the COTR or site inspector would interrupt the operators to make sure that the specifications of the contract were understood and would be met.

"Stuck" refers to a piece of equipment getting stuck in the mud and needing to be pulled out with another piece of equipment. This includes both the time one piece was stuck and the time another piece spent assisting in rescuing the stuck equipment.

"Down time" occurred when equipment was unable to perform at its expected capacity. Down time was most often the result of mechanical failure.

"Idle time" represents the time a piece of equipment was inactive while work proceeded. Idle time differs from down time in that the equipment could be used but the contractor or operator chose not to use it. For this contract, there were times when the contractor had multiple pieces of equipment on site, but was not using all of them. The extra equipment allowed the contractor greater flexibility in day to day planning, and in approaching specific worksites. Not all times when equipment was on site, but was not being used were recorded. In a rental situation, such flexibility would likely be prohibitively expensive.

Labor Intensive Phase

Labor intensive restoration and erosion control work usually includes all secondary treatments for surface erosion which, in the past, have typically involved the application of straw mulch to critical areas on finished rehabilitation worksites. Straw mulch was not applied on unit 99-1 for several reasons. Logs and brush were placed on the surface, which helped protect it from surface erosion. After restoration work was completed, redwood fronds and alder leaves naturally dropped from the surrounding second-growth forest onto the finished surface. Natural revegetation, especially initial alder growth, is expected to be excellent. Previous studies indicate that straw may not be good in forest settings since it alters the soil to be more like that of a grassland and it may also introduce exotic species.

No labor-intensive work was done on this project.

Documentation Phase

The final restoration phase is the documentation process. This includes post-heavy equipment volumetric surveys, photo point documentation, cost data compilation, and writing the restoration project report. This work was done by Becca Smith with essential help by numerous assistants, and was completed in February 2000.

DISCUSSION

Project 99-1 met the goals of the watershed restoration program by minimizing human-caused potential erosion and sedimentation from roads into creeks and onto hillslopes. Road fill was removed from stream crossings, swales, and road benches and natural topography and hydrology were restored. Topsoil was uncovered where possible. Woody debris was spread on the finished slopes. A total of 44,000 surveyed yds³ were excavated from potentially unstable areas and moved to stable fillsites at a total heavy equipment cost of \$177,540 which equates to an overall average of \$4.04/yds³.

This was the first year that request-for-proposal / indefinite quantity type contracts were used for road removal work. These contracts allowed the park to select contractors based on their past experience and past performance as well as price. The contracts were not automatically awarded to the lowest bidder. In addition, the contracts can be renewed for two additional years, eliminating the need to put contracts out to bid each year. The subcontractor on this job, Twin Parks, has extensive experience doing road removal projects. The two operators hired by Twin Parks (Del McLaughlin and Jay Chamberlain) were also very good operators. The finished product was very good. All the operators, the sub-contractor, and the prime contractor were very easy to work with.

TABLE 2 STREAM CROSSING EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 99-1, C-LINE SOUTH ROAD													
Worksite	Volume (yds ³)	Heavy Equipment Hours					Total Costs		Unit Costs		Original Bid (\$/yd ³)	Average Fillsite Dist. (ft)	Excav. Rate (yds ³ /hr)
		Cat. D8H	Cat. D8L	Case 220	John Deere 892D	10 yd ³ Dump Trucks	Actual	H.E.R.E.* (\$/yd ³)	Actual (\$/yd ³)	H.E.R.E.* (\$/yd ³)			
RX-6	17,000	90.00	77.00	27.00	114.25	0.00	\$66,200	\$53,255	\$3.89	\$3.13	\$4.24	300	55

TABLE 3 EXPORT OUTSLOPE EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 99-1, C-LINE SOUTH ROAD														
Worksite	Volume (yds ³)	Heavy Equipment Hours				10 yd ³ Dump Trucks		Total Costs		Unit Costs		Average Fillsite Dist. (ft)	Excav. Rate (yds ³ /hr)	
		Cat. D8H	Cat. D8L	Case 220	John Deere 892D	Cat. 977K	Actual	H.E.R.E.* (\$/yd ³)	Actual (\$/yd ³)	H.E.R.E.* (\$/yd ³)	Original Bid (\$/yd ³)			
EOS 71+10	2,700	29.25	4.00	4.25	34.75	0.00	0.00	\$9,720	\$11,930	\$3.60	\$4.42	\$3.40	170	37
EOS 74+45	3,500	20.00	3.75	17.00	18.75	0.00	0.00	\$12,950	\$10,025	\$3.70	\$2.86	\$3.69	250	59
EOS 78+50	2,900	28.00	12.50	26.75	24.00	1.50	44.75	\$13,460	\$18,693	\$4.64	\$6.45	\$4.40	2000	21
EOS 82+63	4,900	33.00	10.50	2.50	49.50	0.00	17.25	\$16,660	\$17,024	\$3.40	\$3.47	\$3.30	200	43
EOS 87+32	10,900	62.25	63.25	18.25	100.00	0.00	35.25	\$42,470	\$44,406	\$3.90	\$4.07	\$3.56	600	39
Total/Ave.	24,900	172.50	94.00	68.75	227.00	1.50	97.25	\$95,260	\$102,078	\$3.83	\$4.10			44

TABLE 4 OUTSLOPE EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 99-1, C-LINE SOUTH ROAD														
Worksite	Volume (yds ³)	Heavy Equipment Hours					Total Costs		Unit Costs		Original Bid (\$/yd ³)	Average Fillsite Dist. (ft)	Excav. Rate (yds ³ /hr)	
		Cat. D8H	Cat. D8L	John Deere 892D	Case 220	Cat. 977K	10 yd ³ Dump Trucks	Actual	H.E.R.E.* (\$/yd ³)	Actual (\$/yd ³)				H.E.R.E.* (\$/yd ³)
OS 66+31	200	4.50	0.00	1.00	0.00	0.00	0.00	\$450	\$903	\$2.25	\$4.51	\$2.25	50	36
OS 72+91	1,300	8.00	7.25	10.75	12.50	0.00	0.00	\$2,925	\$6,678	\$2.25	\$5.14	\$2.25	75	34
OS 86+13	600	3.25	0.00	8.50	1.25	0.00	0.00	\$1,440	\$2,115	\$2.40	\$3.53	\$2.25	75	46
Total/Ave.	2,100	15.75	7.25	20.25	13.75	0.00	0.00	\$4,815	\$9,695	\$2.29	\$4.62			37

* Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Cat. D8H dozer @ \$165/hr; Cat. D8L dozer @ \$200/hr; John Deere 892D excavator @ \$160/hr; Case 220 excavator @ \$175/hr; Cat. 977K loader @ \$95/hr; and 10 yd³ dump trucks @ \$65/hr.

TABLE 5 MISCELLANEOUS BID ITEM COSTS FOR UNIT 99-1, C-LINE SOUTH ROAD									
Job	Quantity	Heavy Equipment Hours		Total Costs		Unit Costs		Original	
		Cat.	John Deere	Case	Actual	H.E.R.E. ^a	Actual	H.E.R.E. ^a	Bid
		D8L	892D	220			(\$/unit)	(\$/unit)	(\$/unit)
Move In	1				\$2,850	\$3,000	NA	NA	\$2,850
Move Out	1				\$2,850	\$3,000	NA	NA	\$2,850
Ripping	2,163	1.75	4.25	2.00	\$4,726	\$1,380	\$2.18	\$0.64	\$4,726
Rolling Dips ^b	6				\$840	unknown	\$140	unknown	\$140
Total					\$11,266	\$7,380			\$10,566

^a Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead.

Overhead includes maintenance, fuel, profit, insurance, etc. These rates are: Cat. D8H dozer @ \$165/hr; Cat. D8L dozer @ \$200/hr; John Deere 892D excavator @ \$160/hr; Case 220 excavator @ \$175/hr; Cat. 977K loader @ \$95/hr; and 10 yd³ dump trucks @ \$65/hr.

^b Time spent constructing rolling dips was not recorded, so no H.E.R.E. rates are available.

TABLE 6 NON-BID ITEM COSTS FOR UNIT 99-1, C-LINE SOUTH ROAD							
Job	Heavy Equipment Hours					10 yd ³ Dump Trucks	Total H.E.R.E. Costs
	Cat. D8H	Cat. D8L	John Deere 892D	Case 220	Cat. 977K		
Discussions	7.00	10.25	12.25	5.25	0.00	0.00	\$6,084
Move Fuel Trailer	0.75	0.50	0.00	0.00	0.00	0.00	\$224
Subtotal	7.75	10.75	12.25	5.25	0.00	0.00	\$6,308
Down	9.25	50.75	26.00	33.50	0.00	1.25	NA
Idle	87.00	181.25	15.00	202.50	175.75	0.00	NA
Lunch	20.50	10.25	16.00	7.25	0.00	0.00	NA
Totals	116.75	242.25	57.00	243.25	175.75	1.25	

^a Heavy Equipment Rental Equivalent (H.E.R.E.) is the cost to complete each job based on the actual hours worked. These rates were calculated using the Caltrans hourly rental rate of each machine (or a comparable machine), added to Bacon-Davis operator wages for each machine, then that total multiplied by 1.4 to account for a 40% overhead. Overhead includes maintenance, fuel, profit, insurance, etc. These rates are:
Cat. D8H dozer @ \$165/hr; Cat. D8L dozer @ \$200/hr; John Deere 892D excavator @ \$160/hr; Case 220 excavator @ \$175/hr; Cat. 977K loader @ \$95/hr; and 10 yd³ dump trucks @ \$65/hr.

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