

Summary Report
WATERSHED RESTORATION UNIT 98-1
C-LINE SOUTH

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Redwood National Park
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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

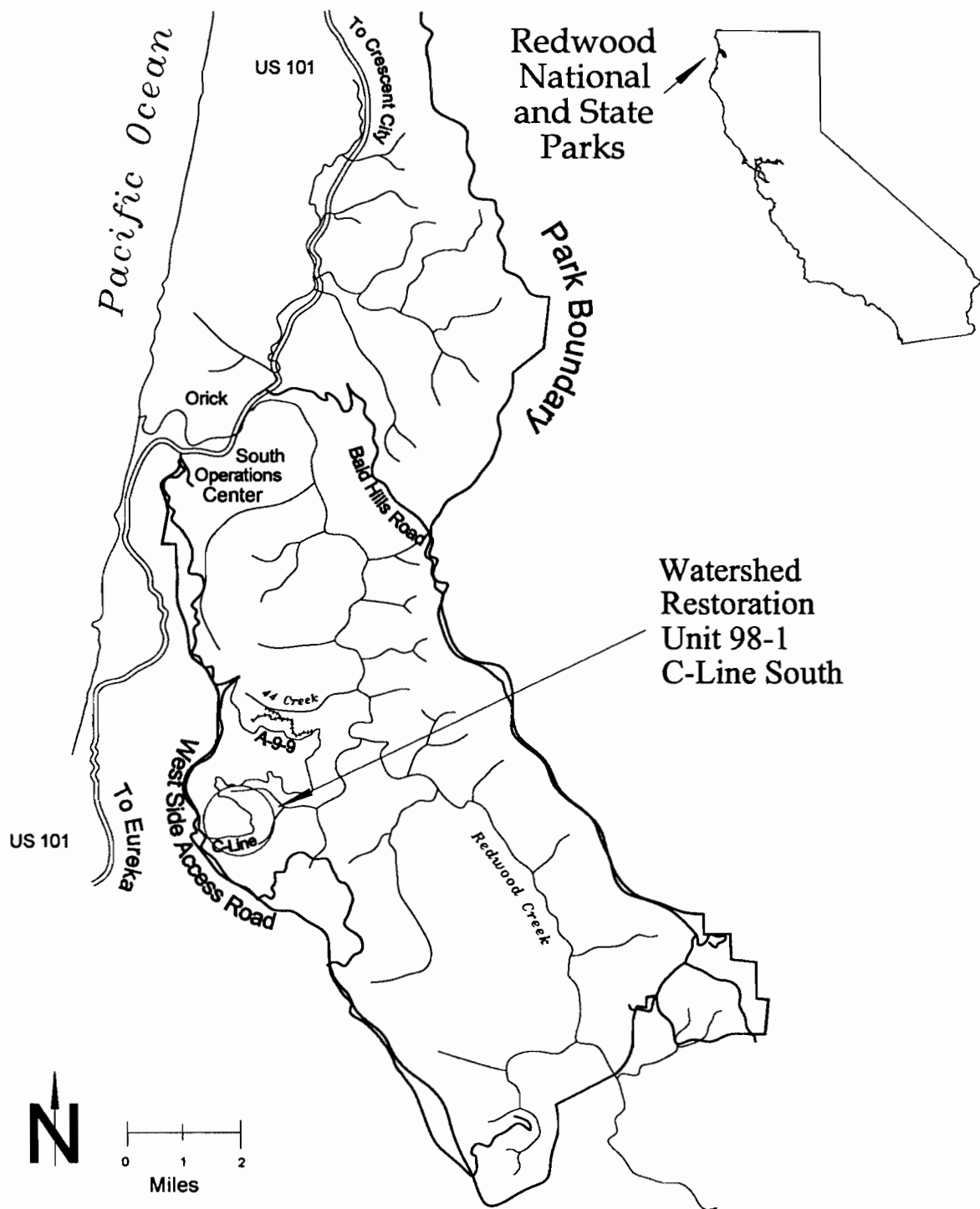


Figure 1. Location of Project Area

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.

In 1996, a small portion of the C-Line South was prioritized for removal because of the large volume of fill material in the stream crossings, the high quality of Tom McDonald Creek for aquatic life, and the availability of funding from the National Park Service Dam Safety Program.

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.

Due to this increase of funding to remove 1997 storm damaged roads, a longer portion of the C-Line could be removed. The total cost for this project was \$128,554 (see Table 1 for cost summary). The heavy equipment cost of \$110,630 was funded as follows: \$21,500 from the Dam Safety Program, \$44,586 from the Emergency Supplemental Appropriations Act; and \$44,544 from ERFO. The salary cost of \$17,924 for implementation was funded by RNP's base operating funds and the Emergency Supplemental Appropriations Act.

Watershed Restoration Unit 98-1 constitutes the second phase of a three-year strategy to remove the C-Line South. This project removed 0.5 mile of the C-Line that included one stream crossing and one skid-road stream crossing. Stream crossing RX-5 had water impounded on the upstream side of the road fill to a depth of 3 feet. This project involved the excavation of a total of 37,300 yds³ of fill material, including 22,900 yds³ associated with one stream crossing and a skid-road 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.

TABLE 1							
RESTORATION WORK COST SUMMARY FOR UNIT 98-1, 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 Crossings	22,900 yds ³	2	\$57,250	\$63,760	45	\$2.50	\$2.78
Export Outslope	9,600 yds ³	2	\$28,280	\$16,231	22	\$2.95	\$1.69
Outslope	4,800 yds ³	5	\$9,600	\$7,412	7	\$2.00	\$2.65
Misc. Bid Items		3	\$15,500	\$14,592	12		
Misc. Non-Bid Items			\$0	\$4,942	0		
Subtotal	37,300 yd ³		\$110,630	\$106,936	86		
Project Implementation ^b							
Planning	2	NA	\$56		0		
Mapping	17	NA	\$477		0		
Prescriptions and Layout	176	NA	\$4,301		3		
Surveying	156.5	NA	\$3,887		3		
Environmental Compliance	2	NA	\$48		0		
Contract Preparation	69.75	NA	\$1,925		1		
Heavy Equipment Supervision	240.5	NA	\$6,590		5		
Photo Documentation	13.5	NA	\$360		0		
Report Writing	10	NA	\$280		0		
Subtotal	687.25	NA	\$17,924		14		
Grand Total			\$128,554	\$124,860	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 monthly rental rate of each machine (or a comparable machine) divided by 180 hours to derive the hourly rental rate, 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. 345 excavator @ \$168/hr; Cat. 245 excavator @ \$190/hr; Cat. D6D dozer @ \$103/hr; Cat. D6H dozer @ \$110/hr; Cat. D9H dozer @ \$200/hr; and Cat. 631 scraper @ \$230/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.

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 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

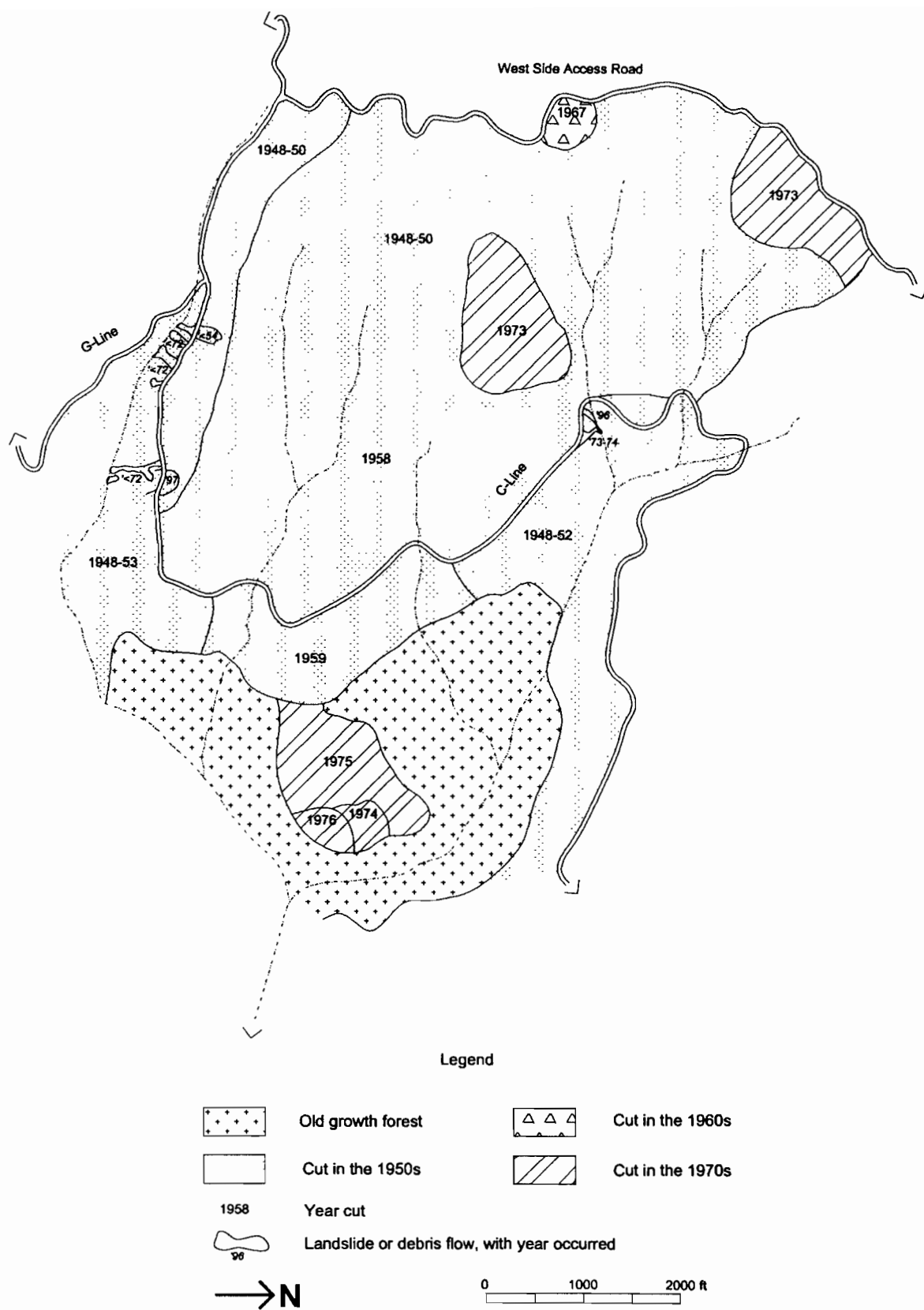


Figure 2. Timber Harvest History and Recent Mass Movement Features

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 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.

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 outsloping 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 the contract, oversaw heavy equipment operations as the contracting officer's technical representative (COTR), photo documented the work, and wrote the final report.

Heavy Equipment Phase

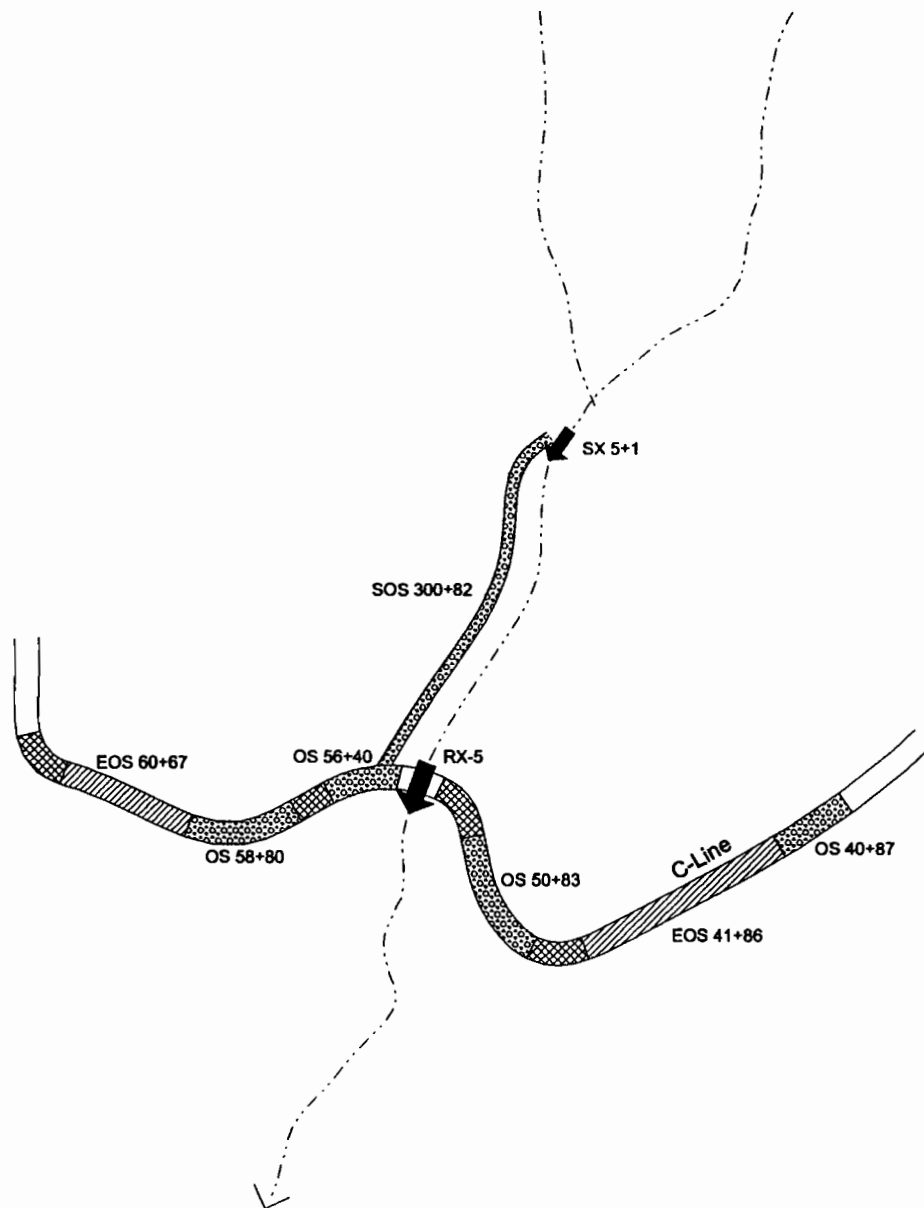
The heavy equipment phase included completion of all primary restoration treatments. A total of 0.5 mile of the C-Line South and 0.11 mile of skid road was removed at a total heavy equipment cost of \$110,630. A total of 37,300 yds³ of material was excavated from 1 haul road stream crossing (21,000 yds³), 1 skid-road crossing (1,900 yds³), 1085 feet of haul road export outslope (9,600 yds³), 720 feet of haul road outslope (2,800 yds³), and 797 feet of skid-road outslope (2,000 yds³). The haul road surface was ripped prior to placement of fill on fillsites.

The heavy equipment phase was done by "invitation for bid" contract. The bid opening was on June 9, 1998. The following is a summary of the bids received.

Barber Construction Inc.	\$142,070
Passage Excavating	\$147,402
Trinity River Construction	\$176,000
Yreka Construction	\$379,500

The contract was awarded to the lowest, responsive bidder, Barber Construction Inc. on June 23, 1998. The notice to proceed authorized work to begin on August 25, 1998. The project on the adjacent portion of the C-Line South (97-1) had to be completed with a different contractor before work could begin on the 98-1 contract. Heavy equipment work on 97-1 was completed on August 21, 1998.

The heavy equipment work on 98-1 began on August 31, 1998 and was completed on October 1, 1998. The following equipment (all Caterpillar) was used: a 245 excavator with thumb, a 345 B excavator with thumb, a 631 C scraper, a D9H dozer with ripper, two wide-track D6H dozers, and a D6D dozer with winch. The equipment operators were Rich Barber foreman,



Legend

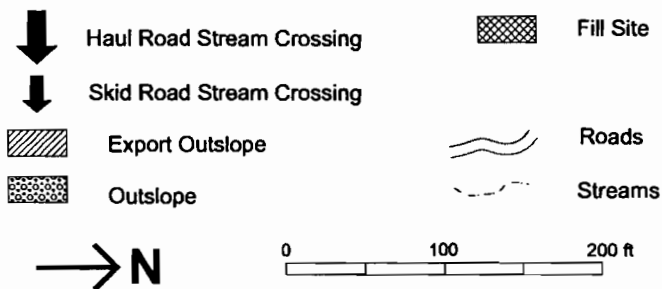


Figure 3. Location of Treatment Types in the Project Area

245 and 345; Randy Moore 245 and 345; Frank McAllister 631, D6H and D6D; Butch Brundin D9H; Dan Reynolds D6H; Paul Johnson D6D; and Reno Pifferini laborer.

Stream Crossings

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

RX-5

The bulk of the volume of material on this project was contained in this bid item. The crossing was designed to be 33,000 yd³. Rich began dishing down this crossing from the first day, using the D9H and the 631 scraper. The scraper was very efficient in moving the material from the crossing to the fill site, more so than endhauling with dump trucks would have been. The D9 and the scraper were able to work on the crossing while the excavator and D6 worked on outslopes and export outslopes, instead of tying the excavator up loading dump trucks. The excavators excavated the fill closer to the channel once the dozer and scraper got the bulk of the drier material out. As the excavation got close to the existing flow course and culvert, the water flowing into the top of the crossing was pumped and diverted around the work area. Several old growth redwoods had to be worked around on the outboard edge of the road.

As the excavation progressed, a bedrock knob was uncovered on the middle right side. The middle and lower parts of the left side was a steep bedrock slope. Very little topsoil was encountered in this crossing. Bedrock and stumps primarily defined the boundaries. Perhaps the topsoil was very thin on top of the bedrock. The fill was relatively dry even though water was ponded in the upper end. The two large excavators were able to walk out onto alder logs laid across the mud in the upper part of the crossing and work without sinking. The two wide track D6s were very effective in pushing the wet material to the fill site. The final excavation was significantly narrower and shallower than designed, causing the actual excavation volume to be 21,000 yd³.

SX-5+1

This skid-road crossing was located upstream of RX-5. There was a bedrock knob on the middle left side which caused a bend in the channel. A lot of logs were in the bottom of the channel.

Export Outsloping

A summary of export outslope excavation costs and production rates is shown in Table 3. Export outslope treatments were done in two road reaches where there was not sufficient space against the cutbank within the bid item to store all the material. The fill was pushed to other fill sites with the dozers and occasionally with the scraper.

Typically, export outslope treatments are used to treat headwater swales. However, geomorphically EOS 41+86 was a planer hillslope. It was designated as an export outslope because there was not enough room for the fill to be stored against the cutbank within the bid item and so the fill had to be shifted down the road to the nose of ridge between this bid item and OS 50+83. Topsoil was extremely difficult to find so the excavation was simply sloped in a relatively straight line from the CTH to FTH.

EOS 60+67 was a large, bowl shaped excavation. The hillslope above the road sloped gently while the hillslope below the road was a relatively flat bench. The final excavation ended up being a wide bowl with a well-defined swale in the center.

Outsloping

A summary of outslope excavation costs and production rates is shown in Table 4. In many areas, 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.

C-Line

Excavation rates varied considerably for the different outslopes. OS 50+83 was slower than the others. This may be due to the narrow fill prism and steep and long fill slopes from the TOC and CTH.

Skid Roads

A skid road that was perched above the creek between RX-5 and SX 5+1 was outsloped. Most of SOS 300+31 simply involved reaching down to the bottom of the fillslope with the excavator and placing the material against the cutbank. This caused the excavation rate to be very high despite the high ratio of trees growing on the fill slope to volume of dirt moved.

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. The D9H dozer did the ripping.

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). Discussion time was less than on most other contracts because the equipment operators wore radios so they could communicate with each other without having to stop and get off the equipment. This enhanced communication between the operators, but left the COTR (who didn't have a radio) out of many of the discussions. Most of the discussion time recorded is 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 98-1 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. The winter of 1998-1999 was moderately wet and erosion over the project area was minimal.

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 May 1999.

DISCUSSION

Project 98-1 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 37,300 surveyed yds³ were excavated from potentially unstable areas and moved to stable fillsites at a total heavy equipment cost of \$110,630 which equates to an overall average of \$2.97/yds³.

The contractor on this project, Rich Barber, is very fast at completing this type of work. He owns a large variety and number of pieces of equipment that gives him the flexibility to choose which piece to use at any given time. The D6s with wide tracks were very effective at pushing mud. The D9, scraper, and large excavators were able to move large quantities of material at one time.

TABLE 2																
STREAM CROSSING EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 98-1, C-LINE SOUTH ROAD																
Worksite	Volume (yds ³)	Heavy Equipment Hours						Total Costs			Unit Costs		Original Fillsite Dist. (ft)	Excav. Rate (yds ³ /hr)		
		Cat.	245	Cat.	345	Cat.	D9H	Cat.	D6H	Cat.	D6D	Actual			H.E.R.E. ^a (\$/yd ³)	Actual
C-LINE																
RX-5	21,000	62.25	47.25	51.25	79.25	61.50	43.50	9.75	\$52,500	\$59,957	\$2.50	\$2.86	\$2.50	900	59	
SKID ROAD																
SX 5+1	1,900	0.00	17.00	0.00	0.00	6.50	0.00	2.25	\$4,750	\$3,803	\$2.50	\$2.00	\$2.50	100	74	
Total/Ave.	22,900	62.25	64.25	51.25	79.25	68.00	43.50	12.00	\$7,250	\$63,760	\$2.50	\$2.78	\$2.50		60	

* 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 monthly rental rate of each machine (or a comparable machine) divided by 180 hours to derive the hourly rental rate, 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. 345 excavator @ \$168/hr, Cat. 245 excavator @ \$190/hr, Cat. D6D dozer @ \$103/hr, Cat. D6H dozer @ \$110/hr, Cat. D9H dozer @ \$200/hr, and Cat. 631 scraper @ \$230/hr.

TABLE 3 EXPORT OUTSLOPE EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 98-1, C-LINE SOUTH ROAD													
Worksite	Volume (yds ³)	Heavy Equipment Hours						Total Costs			Unit Costs		Excav. Rate (yds ³ /hr)
		Cat.	Cat.	Cat.	Cat.	Cat.	Cat.	Actual	H.E.R.E.* (\$/yd ³)	Actual	H.E.R.E.* (\$/yd ³)	Original Bid (\$/yd ³)	
EOS 41+86	4,400	245	345	631	D9H	D6H	D6D	14.25	\$7,687	\$3.00	\$1.75	\$3.00	400
EOS 60+67	5,200	13.50	0.00	0.00	21.75	1.00	0.00	14.75	\$8,544	\$2.90	\$1.64	\$2.90	300
Total/Ave.	9,600	14.25	14.25	2.75	37.00	1.00	0.00	29.00	\$16,231	\$2.95	\$1.69		98

TABLE 4															
OUTSLOPE EXCAVATION COSTS AND PRODUCTION RATES FOR UNIT 98-1, 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.	245	Cat.	345	Cat.	D6H	Cat.	D6H	Cat.	D6D				Actual (\$/yd ³)
C-LINE															
OS 40+87	500	0.00	4.25	0.00	0.00	0.00	0.00	3.00	\$1,000	\$1,023	\$2.00	\$2.05	\$2.00	50	69
OS 50+83	900	1.25	12.00	0.00	0.00	2.00	10.00	0.00	\$1,800	\$3,574	\$2.00	\$3.97	\$2.00	100	36
OS 56+40	500	1.50	2.75	0.00	0.00	0.75	0.50	0.00	\$1,000	\$885	\$2.00	\$1.77	\$2.00	75	91
OS 58+80	900	6.25	1.00	0.00	1.50	2.50	0.00	0.00	\$1,800	\$1,931	\$2.00	\$2.15	\$2.00	100	80
Total/Ave.	2,800	9.00	20.00	0.00	1.50	5.25	10.50	3.00	\$5,600	\$7,412	\$2.00	\$2.65			57
SKID ROAD															
SOS 300+31	2,000	0.00	9.00	0.00	0.00	0.00	0.00	0.00	\$4,000	\$1,512	\$2.00	\$0.76	\$2.00	50	222

* 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 monthly rental rate of each machine (or a comparable machine) divided by 180 hours to derive the hourly rental rate, 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. 345 excavator @ \$168/hr, Cat. 245 excavator @ \$190/hr, Cat. D6D dozer @ \$103/hr, Cat. D6H dozer @ \$110/hr, Cat. D9H dozer @ \$200/hr, and Cat. 631 scraper @ \$230/hr.

TABLE 5 MISCELLANEOUS BID ITEM COSTS FOR UNIT 98-1, C-LINE SOUTH ROAD									
Job	Quantity	Heavy Equipment Hours		Total Costs		Unit Costs		Original	
		Cat.	345 D9H	Actual	H.E.R.E. ^a	Actual (\$/unit)	H.E.R.E. ^a (\$/unit)	Bid (\$/unit)	
Move In	1			\$5,000	\$7,000	NA	NA	\$5,000	
Move Out	1			\$5,000	\$7,000	NA	NA	\$5,000	
Ripping	2,636	0.25	2.75	\$5,500	\$592	\$2.09	\$0.22	\$5,500	
Total				\$15,500	\$14,592			\$15,500	

^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 monthly rental rate of each machine (or a comparable machine) divided by 180 hours to derive the hourly rental rate, 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. 345 excavator @ \$168/hr; Cat. 245 excavator @ \$190/hr; Cat. D6D dozer @ \$103/hr; Cat. D6H dozer @ \$110/hr; Cat. D9H dozer @ \$200/hr; and Cat. 631 scraper @ \$230/hr.

TABLE 6 NON-BID ITEM COSTS FOR UNIT 98-1, C-LINE SOUTH ROAD													
Job	Heavy Equipment Hours								Total				
	Cat.	245	Cat.	345	Cat.	631	Cat.	D9H	Cat.	D6H	Cat.	D6D	H.E.R.E. Costs
Discussions		1.50		2.50		0.25		1.75		0.00		0.50	\$1,219
Set Up Pump and Pipe in RX-5		0.00		2.75		0.00		0.00		0.25		0.25	\$517
Stuck in RX-5		0.50		0.75		0.25		0.25		0.25		0.75	\$464
Move Down D9H off EOS 60+67		0.75		0.00		0.00		0.00		0.00		0.50	\$194
Walking Equipment		0.00		0.50		0.00		0.00		0.00		0.00	\$84
Move Fuel Trailer		0.00		0.00		0.00		0.75		0.00		0.00	\$150
Idle - Labor on Pump & Pipe RX-5		3.75		2.00		0.00		0.00		6.50		5.00	\$2,314
Subtotal		6.50		8.50		0.50		2.75		7.00		6.50	\$4,941.75
Down		1.75		0.00		3.25		9.75		1.75		1.00	NA
Idle		6.25		5.50		5.25		11.25		1.50		4.50	NA
Lunch		6.25		7.75		4.00		8.75		5.25		4.25	NA
Totals		14.25		13.25		12.50		29.75		8.50		9.75	4.25

* 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 monthly rental rate of each machine (or a comparable machine) divided by 180 hours to derive the hourly rental rate, 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. 345 excavator @ \$168/hr; Cat. 245 excavator @ \$190/hr; Cat. D6D dozer @ \$103/hr; Cat. D6H dozer @ \$110/hr; Cat. D9H dozer @ \$200/hr; and Cat. 631 scraper @ \$230/hr.

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