

REDWOOD NATIONAL PARK

WATERSHED REHABILITATION PROJECT
UNIT 91-1

C-LINE AND C-13 ROADS IN
FORTYFOUR CREEK

SUMMARY REPORT

by
Darcia Short
May, 1992
rev. Oct, 1994

TABLE OF CONTENTS

INTRODUCTION	1
Location	1
Road and Logging History	1
Geology and Physiography	1
Soils	5
Erosion Processes / Hydrology	5
Rehabilitation Unit 84-5 (C-Line & C-13 Roads) revisited	6
REHABILITATION WORK	7
Evaluation and Prescription Phase	7
Labor Intensive Phase	8
Heavy Equipment Phase	8
Haul Road Stream Crossing Excavations	10
Rock Transport and Placement	11
Skid Trail Stream Crossing Excavation	12
Outsloping	13
Exported Outsloping	13
Horse Trail Tread	14
Haul Logs	15
DISCUSSION	16
REFERENCES CITED	16
APPENDIX	16
Table 1: Rehabilitation Work Cost Summary, Unit 91-1	17
Table 2: Stream Crossing Excavation Costs, Unit 91-1	18
Table 3: Outsloping Excavation Costs, Unit 91-1	19
Table 4: Exported Outsloping Excavation Costs, Unit 91-1	20
Table 5: Other miscellaneous costs, Unit 91-1	21

LIST OF TABLES

Table 1: Rehabilitation Work Cost Summary, Unit 91-1	Appendix
Table 2: Stream Crossing Excavation Costs, Unit 91-1	Appendix
Table 3: Outsloping Excavation Costs, Unit 91-1	Appendix
Table 4: Exported Outsloping Excavation Costs, Unit 91-1	Appendix
Table 5: Other miscellaneous costs, Unit 91-1	Appendix

LIST OF FIGURES

Figure 1: Map A, Location Map of Watershed Rehabilitation Unit 91-1; C-Line in Fortyfour Creek	2
Figure 2: Map B, Topographic Map of Fortyfour Creek Watershed with Watershed Rehabilitation Unit 91-1	3
Figure 3: Map C, Logging History	4
Figure 4: Map D, Erosion Control prescription map for Watershed Rehabilitation Unit 91-1	9

INTRODUCTION

Watershed rehabilitation project Unit 91-1 encompassed 135 acres in the Fortyfour Creek watershed which included the remaining 1.1 miles of the C-Line and 0.3 miles of the C-13 Road and hillslopes above up to the A-9-9 road. Ten acres of the unit had been previously treated in 1984 (84-5) and was re-evaluated and treated as part of this project. The purpose of the project was to address erosion problems, enhance ecosystem restoration on areas which were impacted by previous timber harvesting activities, and improve the section of the Redwood National Park Horse trail which is on the C-Line road.

Project work consisted of removing road fill from stream channels, moving unstable road fill to more stable areas, and developing a 4 foot wide horse trail tread through the rehabilitated road reach. Rip rap rock was placed within unstable wet excavations to provide slope buttress and channel armor. Horse trail rock was stock-piled for trail improvements to be completed by the park trail crew in the late spring of 1992.

Heavy equipment work was done under IFB contract awarded to Hayes and Sons Construction of Yreka, CA for \$84,788.50. The contractor used a KATO 1250 hydraulic excavator, a Cat 225 hydraulic excavator and a Cat D7H dozer in September and October, 1991 to accomplish the work.

LOCATION

The rehabilitation unit, 91-1 is located in Redwood National Park approximately 6 miles SSE of Orick, California (Figure 1). It is within T10N, R1E, Sections 34 and 35 and T9N, R1E, Section 2. The rehabilitation unit is located on the lower mid slope, below the A-9-9 Road, within the Fortyfour Creek watershed (Figure 2). The northwest portion of the rehabilitation unit comprised 10 acres which had been previously treated as part of rehabilitation unit 84-5.

ROAD AND LOGGING HISTORY

The reach of the C-Line Road which was treated in Unit 91-1 was constructed in 1962 by Georgia Pacific Corporation to provide access to harvest units within the Fortyfour Creek basin (Figure 3). Nearly all of the area within the rehabilitation unit was seed tree leave harvested between 1962 and 1965 by tractor yarding methods. The upper slope of the unit was reentered in 1974 and the remaining trees were removed by tractor yarding. A ridge area near the center of the unit, immediately below the C-Line, was uncut until 1977, at which time it was clearcut by cable yarding. A very small area of old growth remains within the rehabilitation unit which was left uncut, although a tractor skid trail passes through the small old growth grove.

GEOLOGY AND PHYSIOGRAPHY

The area is underlain by Redwood Creek schist unit of Franciscan assemblage (Harden, et al, 1982.) The schist in much of the Fortyfour Creek basin is highly sheared and prone to mass wasting and fluvial erosion. In local areas, more competent schist forms resistant ridges between sub-basins and maintains steeper, more stable slopes.

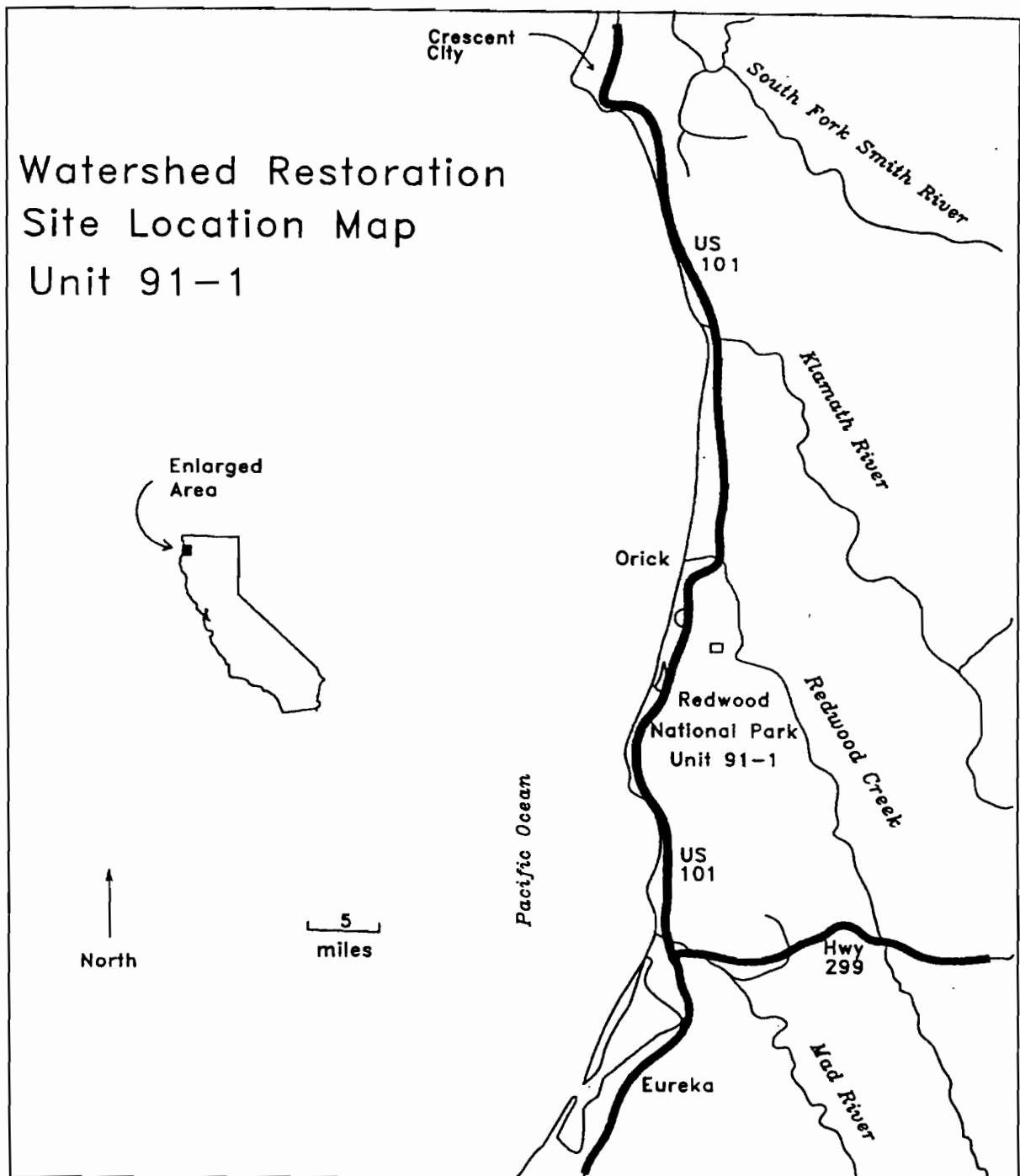


Figure 1. Map A. Location map of watershed rehabilitation Unit 91-1; C-Line in Fortyfour Creek.

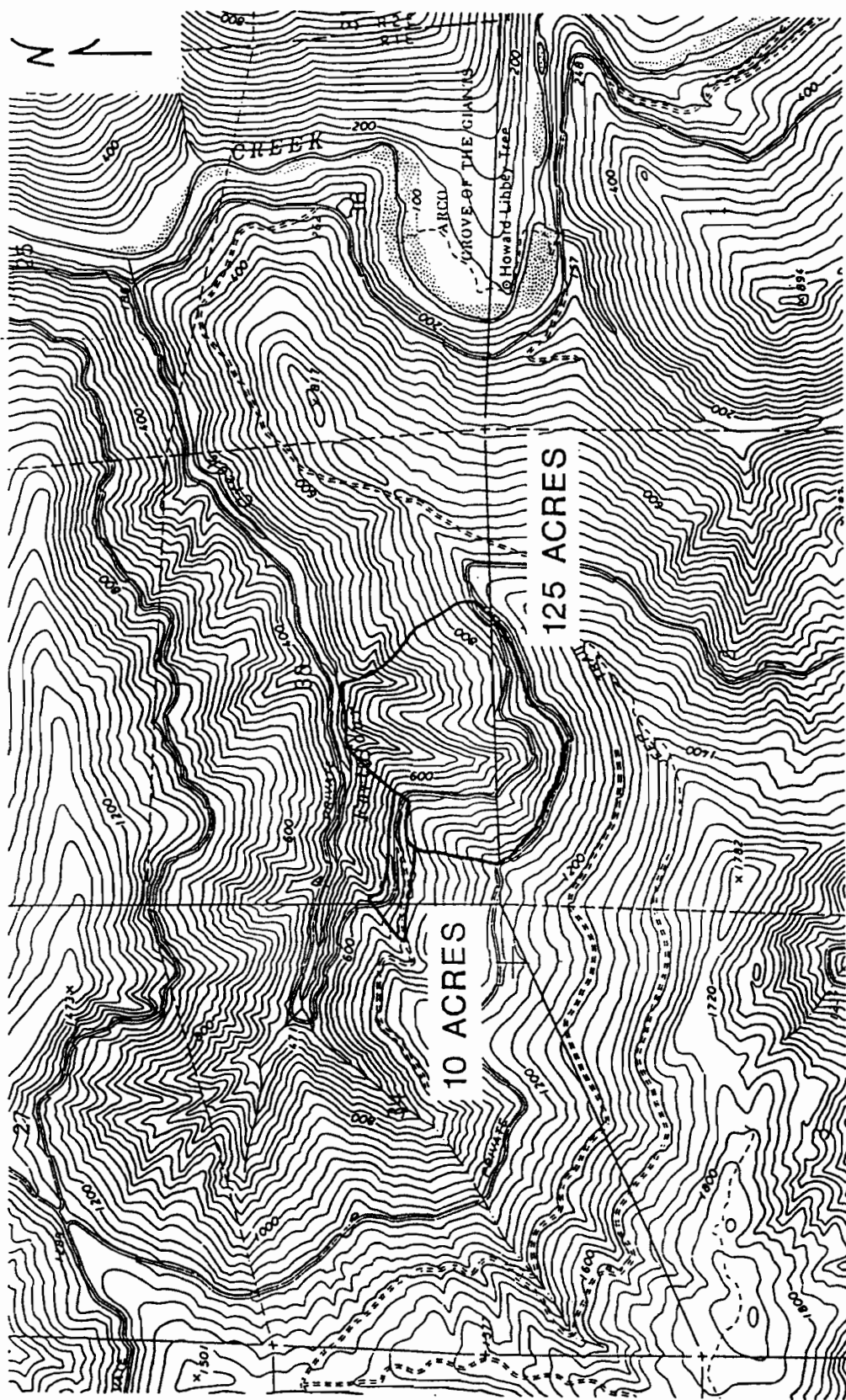


FIGURE 2; MAP B

Topographic map of Fourtyfour Creek Watershed Rehabilitation Unit 91-1. From U.S. Geological Survey Topographic Series

Map: Rodgers Peak 7.5 Minute Quadrangle. Scale 1:24000

The 10 acre unit was mapped and treated as part of Watershed Rehabilitation Unit 84-5. This area was re-evaluated and treated as part of Watershed Rehabilitation Unit 91-1. The 125 acre area was treated entirely as part of this rehabilitation project.

[illegible]

Rehab Unit 41-1

The rehabilitation unit is predominantly located on or immediately above concave upward hillslope facing from north to east. Average hillslope gradient is 40% ranging from 10% to 110%.

SOILS

The soils along the portion of the C-Line treated within this rehabilitation Unit are mostly of the Copper Creek, Ahpah and trailhead series with minor presence of DevilsCreek and Lacks Creek series. The interested reader is directed to maps and discussion of the soils in Popenoe and Martin, 1984.

EROSION PROCESSES / HYDROLOGY

This portion of the Fortyfour Creek basin is characterized by a large concave upward bowl shaped hillslope suggesting that it may have been sculpted by large landsliding. Emergent ground water in the form of springs is common on the slope within a zone located roughly 50-300 feet upslope of the C-line between stations 24+00 and 38+00. Valley incision develops immediately downslope of the springs, and there is no valley form above the springs.

The C-Line road prism, through this rehabilitation reach, was mostly intact at the time of mapping and evaluation (1991). Previous partial fill failures were evident at many locations, particularly within the bowl feature between stations 30+00 and 38+00. Fill failures consumed the outer one quarter to one half of the road prism, and generally had scarps ranging in height from 2 inches to three feet. Most fill failures were associated with persistently wet seeps and springs along the inboard ditch which contributed to saturated fill conditions. The fill at the landing between stations 18+00 and 20+00 was characterized by 1 - 3 foot high scarps and a high amount of woody debris. This landing was on the side slope of a dry ridge composed of relatively more competent Redwood Creek Schist. All stream channels and swales were undercut by construction along this section of the C-Line. Channel instability migrated a few 10's of feet upstream and were generally checked by large woody debris and boulders.

Large gully features are present at two culvert outlets as a result of diverted and concentrated flow from two or more stream channels directed into one flow course at the road. The gully from the discharge of the culvert that was at station 31+20 averages 30 feet wide, 10 feet deep, and approximately 200 feet long (2200 yd³). Flow to this culvert had been diverted along the IBD for 368 feet from RX7 at 34+88, RX6 (sta 32+72), and RX5 (sta 31+62). A reach of emergent ground water along a 50 foot reach of hillslope near sta 34+00 (between RX6 and RX7) had also been diverted along the IBD to the culvert at station 31+72. The total hillslope area contributing runoff that was captured by the IBD and diverted to the culvert was 100 acres. The culvert flow was discharged onto a dry hillslope which gullied probably in the first winter following road construction in 1962. It is likely the flows of the 1964 storm had significant impact in forming the gully, although airphoto interpretation is inconclusive. The side slopes of the gully were raw and actively eroding during the winter of 1991. Old growth stumps and second growth trees along the margins of

the gully were actively being undermined and slumping into the feature. Standing conifers along the margins were significantly contorted in response to the unstable hillslope.

Another large gully, located downslope of station 34+00 formed as a result of 18 acres of hillslope directed into a swale that, prior to road construction, drained approximately 2 acres. The resultant gully is approximately 40 feet wide, 10 feet deep, and 100 feet long (1500 yd³), and was actively eroding during the winter of 1991.

A significant road failure is evident at station 21+00 in the 1968 airphoto. The failure occurred as a debris torrent causing loss of the entire road prism and some of the upslope original ground within the swale. The road reach is located in a swale with persistent emergent ground water and DevilsCreek soils at the inboard edge of the road and immediately upslope. Water is diverted from hillslope runoff and cut bank springs from 500 linear feet of adjacent road past this site. All flow from the inboard ditch and the spring was directed further down the inboard ditch beyond the swale an additional 1000 feet to a ditch relief culvert. After failure of the road in 1968, the section was rebuilt and a 24 inch culvert was installed at the site.

Rehabilitation Unit 84-5 (C-Line and C-13 Roads) revisited

During mapping and evaluation of the area in 1991, active erosion was evident along the C-Line and C-13 Roads within the adjacent rehabilitation site 84-5. Stream crossings and deep drains on the 1984 rehabilitation site had been under-excavated and subsequently the fill remaining in the crossings was being further eroded. Gullies were present in some of the crossings ranging from minimal size in RX at 3+42 (91-1 number) to 8 ft X 5 ft in the drain at 1+75 (91-1 number). A debris torrent occurred in 1986 between two underexcavated drains at stations 5+80 and 6+90 (91-1 numbers). The torrent crown scarp was at the inboard edge of the C-Line road and was about 12 feet high. The under-excavation of these crossings was the result of hasty decisions made at the end of the fiscal year 1984, to quickly spend "surplus" money from any and all park divisions to provide a zero balance at year end. Rehabilitation on the C-Line and C-13 was in progress in 1984 as an equipment rental site which allowed for the extension of use of the equipment until all money was spent. This pushed the rehabilitation of the road beyond the area of that which the geologists had thoroughly evaluated for erosion potential prior to treatment (G. Bundros, 1987 and personal communication).

Only one significant winter storm had occurred in northcoastal California during the period of time between rehabilitation in 1984 and re-evaluation in 1991. In 1986 a less than 5 yr recurrence interval storm occurred in the lower Redwood Creek basin (M. Madej, personal comm.). The erosion that had occurred on the 1984 rehabilitation site was the result of minimal winter flows and the larger flow in 1986. Greater erosion within these excavations was possible during higher runoff events. Therefore, all flow courses within this last 1200 feet of the C-Line and the last 1000 feet of the C-13 Road within rehabilitation Unit 84-5 were re-evaluated and subsequently re-excavated as part of this project. Re-excavations were

designed to match original channel grade and the side banks were laid further back (to a lesser grade) to follow original ground.

Where two small drains had been installed in 1984, around station 0+75 through station 1+50, substantial concentrated water flow was eroding remaining road fill and destabilizing the hillslope above the old road alignment. A large crown scarp above the road alignment and significant debris within the fill material and downslope of the road prism, suggest that landsliding and road building were possibly contemporaneous. Interpretation of geomorphic processes at this site from air photo analysis is inconclusive due to oldgrowth canopy cover.

REHABILITATION WORK

EVALUATION AND PRESCRIPTION PHASE

The evaluation phase for most of Unit 91-1 was performed in the winter of 1990-91 by D. Short. The evaluation and prescription phase included: 1) mapping of geomorphic, hydrologic and land use disturbance features through air photo analysis and field mapping; 2) prescription and layout of erosion control work; surveying and calculation of volumes of prescribed treatments; and peer review of proposed prescriptions; 3) establishment of permanent photo points for documentation of erosion control work and future changes resulting from revegetation and channel adjustments; and 4) preparing specifications and plan sheets for inclusion in an Invitation for Bid (IFB) contract for heavy equipment work.

Geomorphology and hydrology of the unit was mapped at a scale of 1:1200 (1 inch = 100 feet) on mylar overlaid on black & white airphoto enlargements. Photos were from 1978 flightline, photos 6-23, 7-21 and 7-22. Additional mapping was accomplished as part of mapping for rehabilitation Unit 84-5 by G. Bundros and D. Burns in 1984. Mapping is on file at South Operations Center, Orick.

Survey work and Photo documentation were performed in the spring and early summer of 1991 by Darcia Short, Jim Wood, Ted Abel, Kelly Helstrom, and Diane Pierce. Table 1 (in appendix) summarizes the cost for the rehabilitation work on Unit 91-1.

Preparation of an Invitation for Bid Contract for the heavy equipment phase of the rehabilitation work was prepared in April through June, 1991 by D. Short. The rehabilitation site had originally been scheduled to be implemented as an equipment rental project, but in late March, 1991, Tekla Vines (Contracting Officer, REDW), with confirmation from the regional office, determined that rehabilitation work should be performed under the framework of an "Invitation For Bid" contract. This decision is based on an interpretation of road rehabilitation work as being "construction", which, according to contracting requirements cannot be performed with hourly rental agreements with an equipment operator. The park or rehabilitation staff will have to show that the work is not

construction if future projects are to be performed with heavy equipment rental agreements (a more time- and cost-effective approach and preferred arrangement of rehabilitation staff).

LABOR INTENSIVE PHASE

The labor intensive phase of the work included site brushing for survey work, removal of large standing trees growing on the fill slopes of the C-Line road and the distribution and spreading of straw mulch on the finished slopes. The costs for this phase of the project are shown in Table 1 (in appendix).

HEAVY EQUIPMENT PHASE

The heavy equipment phase of Unit 91-1 began September 7, 1991 and was completed October 9, 1991. The work consisted of rehabilitating 1.4 miles of logging haul road and 120 feet of skid trail accounting for 135 acres of watershed area treated (Figure 4). Total heavy equipment costs for the site were \$84,784.50 (Table 1; in appendix). Eight stream crossings and one skid trail stream crossing were excavated. Export outsliping (EOS) was prescribed for 1,548 linear feet of road and 3,638 linear feet of road was outslipped (OS).

Heavy equipment work was done under IFB contract awarded to Hays and Sons Construction of Yreka, CA. The contractor's bid for the contract, as issued, was \$74,108. Modifications to the contract regarding transport and placement of additional rock armor and excavation of additional fill from stream crossings and export outslope reaches added \$10,676.50 to the contract cost for a final cost of \$84,784.50. Other bids received were from Twin Parks Lumber Company of Arcata, \$78,945; Pumnea Construction, Inc. of Redding, \$112,058; J. W. Brashear Construction, Inc. of Redding, \$137,838.40; and Carl M. Kjer and Sons of Arcata, \$162,752.75.

The contractor used three pieces of heavy equipment on the site; a KATO 1250 hydraulic excavator, a Cat 225 hydraulic excavator and a Cat D7H Crawler Tractor with rippers and straight blade. The Kato 1250 had a reach of about 30 feet (horiz) and a 2 yd³ bucket when struck. The Cat 225 also had a 30 foot reach and had a 1 yd³ rock bucket. Two to four 10 cubic yard dump trucks were on site at various times and in various numbers to haul excavated fill material to disposal sites, rip rap rock for use in stream channel excavations, to haul horse trail gravel and to haul the stock piles of felled trees, which had been cleared from the fillslope by Redwood National Park Labor Crew. The contractor had a John Deer 544 loader with a 2 yd³ at the M-Line Deck for loading rock. The dump truck drivers loaded their own trucks with the loader.

Equipment was operated by Jerry Hayes, Owner and Jim Hayes, Owner (Jerry's son) and Herman Lorenzini life long friend of the Hayes family. Two of the dump trucks were owned by Hayes & Sons and were operated by company employees, Richard Lighthill and Greg Hayes (Jerry Hayes' nephew.) Two additional dump trucks were subcontracted on a daily basis as needed to Steve Martin of Orleans and Joe Hufford of Orick.

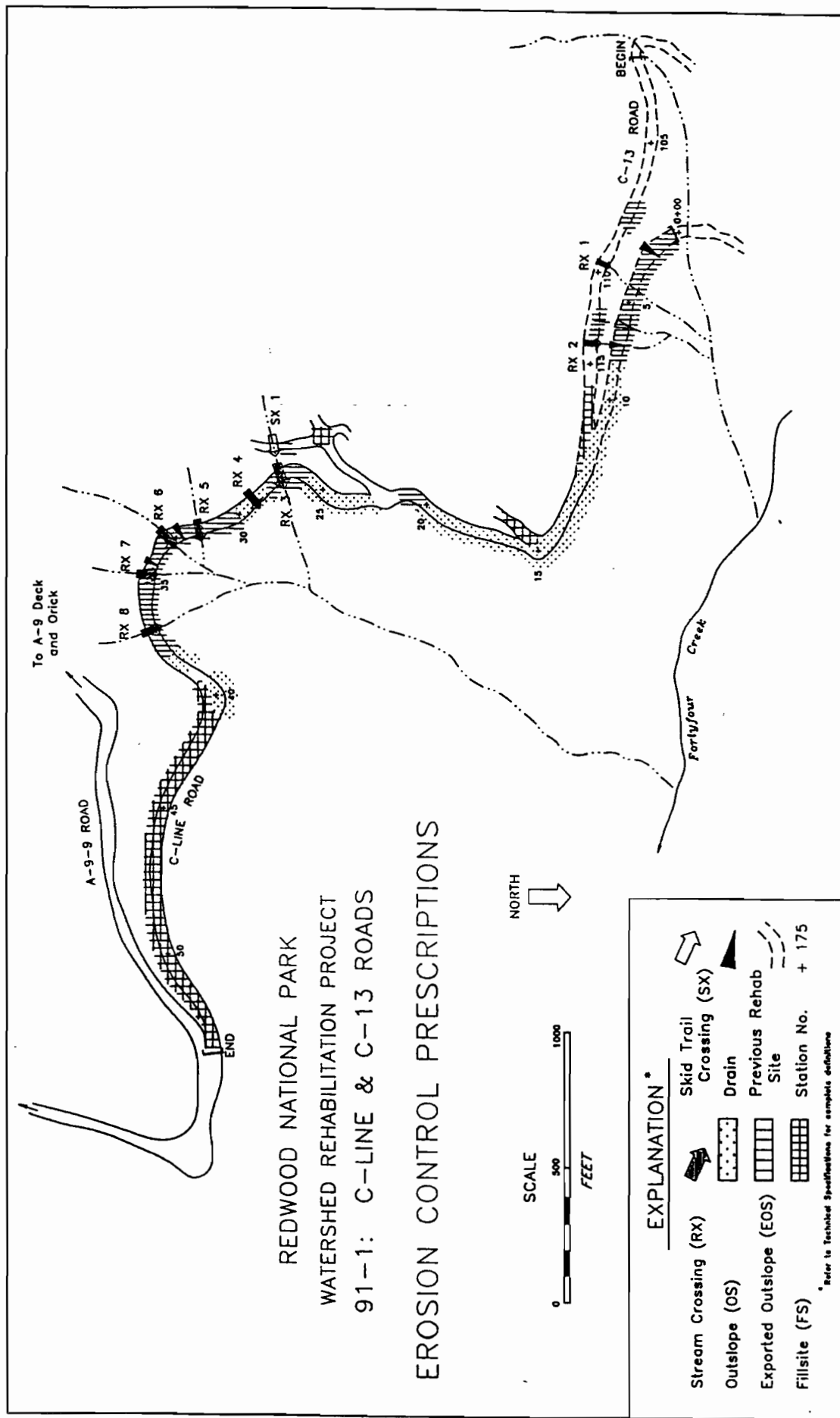


Figure 4. Map D. Erosion control prescription map for watershed rehabilitation Unit 91-1.

Haul Road Stream Crossing Excavations

Haul-road stream crossing excavations are prescribed where logging haul roads cross stream channels. The excavation entails the removal of road fill from the buried stream valley and channel. This work eliminated the potential for future diversion of stream flow out of the stream valley and directly removes sediment sources from entering flow courses.

Eight haul road stream crossings were excavated on this rehabilitation unit. Six were located along the C-Line and two on the C-13 Roads. A total of 6,165 yd³ of fill was removed from stream channels and endhailed to stable locations. All stream crossing excavation were designed to be excavated to original (pre-road) configuration. Design specifications were established based on sufficient field evidence indicating valley side-slopes and channel grade and width

Table 2 (in appendix) summarizes the costs and equipment hours for the stream crossings excavations and the skid trail excavation. The total amount of time that the Cat 225 spent in RX3 through RX8 has a great amount of uncertainty. While I was monitoring the work within EOS 0+06, the Cat 225 was sent to pull the outboard edge of the C-Line for the full length. The Cat 225 loaded this material into the dump trucks without regard to what the prescription was. I impressed upon the operator the importance of noting which worksite he was working in for proper documentation and for the most part he was responsible to this. However, the large variation in production rates between the different worksites leads me to believe that there probably are errors in the operators time keeping, as I don't feel that their production really varied as much as is indicated in the table.

The two crossings on the C-13 Road had been previously partially excavated by heavy equipment as part of the rehabilitation work on the C-13 Road in 1984 (Unit 84-5). RX-1 had an additional 1130 cubic yards excavated as part of this project to remove remaining fill which underwent gully erosion after the first storms following the first excavations in 1984. The remaining fill was perched within the steep stream channel with most of the flow subsurface, flowing along buried logs. RX-2 was similarly under-excavated in 1984 and an additional 445 cubic yards was removed as part of this project.

RX-3 was located on the C-Line downstream of the Skid Trail crossing. The crossing was on a perennial stream which flowed through a 24 inch culvert. The stream discharged runoff from a 17 acre watershed and had a discharge of about 0.1 cfs at the time of excavation.

Channel flow in RX3 at the time of excavation was sufficient enough to warrant diverting out of the worksite during the excavation to allow for a dry clean job, however, the contractor was unable to get a trash pump working, and opted to excavate the fill with the flow in the channel. The channel was filled with a moderate amount of organic debris of moderate size, with the exception of a 6 foot diameter, 35 foot long redwood log which was stuffed into the bottom of the crossing in a near vertical position. This log, if left in the channel, would have diverted flow into the steep side banks ultimately destabilizing the excavation. The log was removed by the excavator (KATO). In similar stream crossings on past rehabilitation

sites, D8 size dozers equipped with a winch have been used to remove comparable sized logs in a matter of a few minutes. The contractor did not have a dozer with winch on site and chose to remove the log with the excavator. To remove the log, the excavator had to shred it, continually tearing off slab after slab of beautiful straight grain, clear heart, old growth redwood. The log was buried in fully saturated mud in the center of the bottom of the excavation, making for very difficult conditions for the machine. The contractor did not attempt to pull the log with any other equipment and could only remove it with the KATO by tearing it into pieces. Removal of the log took nearly 2 hours of the 13.75 hours of excavator time at RX-3.

The excavation of RX3 was extended downstream beyond original design to remove logs which were sitting in unstable positions in the channel bottom. Logs were removed and relocated on the side banks of the excavation to prevent diversion of stream flow into the steep side banks. Natural channel armor was not located within the excavation, but solid side banks with in-place stumps indicating original grounds surface were exhumed. As a result of excavating large logs and debris well below design grade, it became apparent about midway through the excavation that the upper portion of the excavation was going to have to be quite steep in order to meet the grade with the designed top of the excavation. The alternative to meeting the TOP stake was to continue excavating below the design grade up to and beyond the TOP stake, which would have led into the log debris jam above that separated the Skid Trail crossing from RX-3. This would have opened up the entire hillslope area to excavation, and incredible cost. It was felt that the organic debris jam was holding the bottom of the skid trail crossing and if RX-3 could be kept from headcutting up into the organic debris, then all may remain stable for a fairly long time. Thus, the excavation was tied in to daylight at the TOP stake. This left the upper portion very steep and required armoring with large rock. A modification was agreed upon with the contractor to bring in 100 cubic yards of large size rock from the Park's stock pile at the M-Line Deck.

RX-5 was a very long (87 feet), steep (48%) crossing which required the excavators to bench down and double bail much of the fill. The fill was clean, compared to the other crossings on this site.

RX-6 was well stuffed with medium sized logs and a lot of subsurface water dammed up behind the logs, saturating the fill. A bedrock ledge revealed itself about two thirds of the way up from the bottom. This ledge was composed of highly sheared but somewhat competent bedrock. We chose to not excavate through the bedrock, but to just remove the loose fill and organic debris. This made for a stream crossing excavation with some fairly well undulating side banks.

Rock Transport and Placement

All streams along the C-Line in this rehabilitation site were undercut during road construction. Headcuts had migrated up channel a few 10's of feet to a point of semi-stability. Excavating the buried channels provides a new local base level which can rejuvenate new head cutting. Rock armor was prescribed for channel excavation (both RXs

and drains) where site condition suggested headcutting processes would occur. Vulnerable site conditions included upslope channels lacking good armor structure of boulders and large solid woody debris and evidence of unstable side slopes.

Rock armor used on this site was acquired from stock piles on the M-Line Deck. The rock was originally generated during closure and rehabilitation of the Y-Line Rock Pit in 1988 and stored at the M-Line deck for future park use (particularly rehabilitation work). Rock was transported from the M-Line deck to the C-Line in dump trucks. The contractor had a John Deer 544 loader with a 2 yd³ bucket obligated to the M-Line deck for loading rock into the dump trucks. The drivers loaded their own trucks and did not keep a record of loading time.

Rock was placed on the site as follows:

<u>STATION</u>	<u>ROCK VOLUME</u>	<u>ADDITIONAL</u>	<u>SITE DESCRIPTION</u>
1+35	12 yd ³	150 yd ³	Drain
1+75	13		Drain
3+42	65		Previously excavated RX
5+80	15		Drain
26+80		100	RX3
34+88	50		RX7

Additional rock was that which was prescribed during heavy equipment work as excavation revealed unstable slope areas.

Skid Trail Stream Crossing Excavation

Skid trail stream crossing excavations are prescribed where a skid trail crosses a stream channel. They are treated the same as haul road stream crossings with the removal of fill from the buried stream valley and channel. As with haul road crossing excavations, skid trail crossing excavations eliminate the potential for future diversion of stream flow out of the stream valley and directly removes sediment sources from entering flow courses.

The skid trail stream crossing on this rehabilitation site is located upslope of RX-3. The two excavations are separated by approximately 80 to 100 feet of channel which was thoroughly stuffed with large organic debris supporting a large slump feature on the left bank. This Skid trail crossing was a partially eroded humboldt crossing on a perennial stream with an adjacent perennial spring crossing from the upper right hillslope, and a perennial spring diverted along the skid trail from about 60 feet to the north. The crossing had steep side banks (up to 81%) and moderately steep (41%), narrow channel bottom (6 feet.) Thus, it was paid as a unit price bid item, and was well monumented, expecting that the large organic debris could lead to an excavation well beyond that which was prescribed.

The excavation of the crossing proved to be somewhat of a challenge due to the size of the logs within the channel and the presence of water flowing along the buried logs which had fully saturated all the fill in the bottom of the crossing. The KATO excavator performed all

of the excavating while the dozer pushed the fill to the fillsite. The level push was along the 12 - 14 foot wide skid trail which was cut into the hillslope that has an average grade of about 60%. Many very large logs were excavated from the crossing. The largest and most challenging was 6 feet in diameter and 25 feet long, laying in the center of the channel bottom parallel with the flow. The excavator was able to lift the log out of the channel while sitting on the skid trail, but the excavator could not turn with the log due to lack of room. The excavator backed up while continually rolling the log towards himself until he got to the fillsite and could maneuver the log around the back side of himself and into a stable place. A similar sized log was found partially buried in the lower right bank of the crossing and was left to help provide bank stability and to prevent chasing a full blown excavation looking for original, hopefully stable ground.

The excavation was to original ground in the upper part along the side banks. I don't feel that the channel bottom or the lower portion of the crossing was excavated to original ground or channel elements. The large log jam at the bottom of the crossing will provide base level control and possible buttress to the side banks until regrowth vegetation matures and provides further protection from erosion.

Outsloping

Outsloping was prescribed for 3,638 feet of road, accounting for 10,910 yd³ of material moved (Table 3; in appendix). Outsloping was done to remove fill from the outboard edge of the road prism in areas where the dry cutbank allowed for placement of the fill on the inboard edge of the road. Most reaches were outsloped to provide for a free draining finished surface and to recontour the corridor of the horse trail to match the surrounding natural topography. About one sixth of the outslope length incorporated areas where the outboard portion of the road was failing.

Exported Outsloping

Exported outsloping was prescribed for 1,548 feet of road, accounting for 11,730 cubic yards of material relocated to stable fillsites (Table 4; in appendix). Exported outsloping was prescribed in reaches where the inboard edge of the road was persistently wet from seeps and springs in the cut bank and/or adjacent upslope area and the fill at the outboard edge of the road had failure potential. Fill removed from the outboard edge of the road was "exported" to stable fillsites at landings and on stable road reaches. Excavation were designed to remove the entire road fill prism. Where the road had been built on a cut bench, the bench was left, although shaped to provide outward sloping surface of 5- 10% to allow for free surface drainage.

The EOS reach from 0+06 to 7+08 included an area from about 1+00 to 1+40 which appeared to be an old landslide. This was suspected during evaluation and prescription phase, but the severity of it was not appreciated until excavation of highly sheared, wet, saturated material rich with logs and debris. At the time of excavation, we added an additional 150 yd³ of rip-rap rock to the worksite to buttress the remaining material and provide a base for the horse trail. Excavation of the landslide material was not a

consideration as the volume of the excavation would have been excessive and would have very likely further destabilized the steep fillslope above.

Horse Trail Tread

The Redwood National Park horse trail follows the C-Line through most of the fortyfour Creek watershed. In planning for the rehabilitation of section of the C-Line, the presence of the horse trail was given great consideration. Previous rehabilitation work in the Little Bald Hills (87-?) incorporated trail work within the heavy equipment work and demonstrated that, with proper planning, it is more economical to perform some of the trail work with the on-site heavy equipment rather than wait until the road is gone and enter with hand labor. For this project, the trail foreman and rehabilitation geologist worked together in designing components of the project that could benefit the horse trail. Horse trail surfacing rock (gravel) was procured and stockpiled at three locations on the finished worksites as part of the rehabilitation contract. This allowed dump trucks to bring in the gravel to the stock pile sites on the finished rehabilitation work while a drivable road was still present. This is far less expensive than using a trail tractor to haul the gravel over the entire length of the completed project.

In addition to stock piling gravel, the rehabilitation project developed a rough trail tread through most of the length of the rehabilitation site. This was experimented with on the Little Bald Hills site in 1987 and was found to take little extra time to notch a trail in the finished worksites with an excavator. The following specifications were prepared for the C-Line:

The Redwood National Park Horse Trail follows the C-Line through this Rehabilitation Unit. The intent of this job is to construct a stable horse trail that is sufficiently well defined for a park crew to fine tune the tread and spread gravel with minimal cost. This work is not a separate bid item but is included as part of the finish work where indicated in the plan sheets, along the C-Line Road. A horse trail tread shall be constructed through each job site where indicated in the plan sheets before that particular bid item is approved for payment purposes. The horse trail tread shall meet the following specifications:

The trail tread shall be a minimum of 4 feet wide and a maximum of 5 feet wide. It shall have an outslope of between 2 and 5 percent and shall be a free draining surface. the slope above and adjacent to the inboard side of the trail tread shall not exceed 100% (1:1). The slope below the outboard edge of the trail shall conform to and blend with contract specifications for that CP. The trail shall be located on or near the TOC. Any adjustments in trail location away from the TOC shall be first approved by the COR. In EOS reaches where the prescribed cut provides a bench, it may not be necessary to do further work to provide a trail.

The tread was developed by the KATO excavator for most of the length of the trail. After a worksite was completed, the KATO excavator would return and finish up any necessary smoothing or disperse downed vegetation and prepare the tread as it backed out of the site. This work required little time of the heavy equipment, and therefore was not broken out for time requirements.

In areas where the fill was rocky from turning over the road surface rock, the remaining tread was very rough. The C-Line was surfaced with up to 2 feet thickness of river run gravel. Much of the gravel was coarse, ranging in size up to 12 inches diameter. In these areas, the trail foreman and the COR felt it was in the best interest of the trail to bring in a hand labor crew to rake out the rocks and shape up the trail before the trail settled.

The excavator worked well to define the initial railway and to shape the side banks and develop the gross outslope. In reaches with tremendous amounts of large surface rocks, however, it is best to have hand crews on site removing the rocks from the railway and tossing them offsite. The site was allowed to settle over the winter and spring and then the trail crew returned to spread filter cloth and trail rock within the wet reaches and upgraded and defined surface drains the following summer.

Haul Logs

The outboard edge of the C-Line was occupied by a dense regrowth of 15 to 30 year old alder and conifers. Past rehabilitation projects have dealt with the outboard edge vegetation in various ways and with various degrees of success and frustration. Because of the presence of the National Park Horse Trail through this rehabilitation site, it was felt that on site disposal of the large trees during heavy equipment phase of rehabilitation would leave an unsightly mess, therefore, an alternative approach was tried. All of the trees on the outboard edge of the road down to the CTH (cut to here) line were felled and yarded to landings by the Park labor crew. The contract required the subsequent removal of the logs from the landing sites to the A-9 Deck.

The contractor held off on hauling the logs to the A-9 deck until the equipment had worked its way to each stock pile of logs. The logs were cut to 12 to 15 foot lengths with a chain saw, then loaded by the excavator onto the dump trucks. The contractor's son operated the saw thereby not requiring the need to hire a laborer for the task. This approach saves money compared to a contractor that would have to hire a laborer under Davis Bacon wage rates and which often include Union employees limited to performing specific job duties. Owners of contracting companies and family member employees are exempt from Davis-Bacon wage rates.

DISCUSSION

It was enjoyable to prescribe rehabilitation in a site which has very high erosion potential combined with a need for visitor use. The development of the contract included some interesting, new challenges which I feel were successful and could have application in other park projects. It was great to work with the trail foreman, Dick Mayle, in integrating horse trail development with road obliteration. The benefits of the cooperative work to the park resources and visitors is evident.

This contract was awarded to a contractor who had never worked in Redwood National Park before. I was concerned when the bid came in so much lower than the government estimate, and significantly lower than most of the other experienced bidders. This was discussed with Jerry Hayes in the pre-work meeting and he assured us that his bid was valid. During the course of the project, Mr. Hayes shared with me that the work was different than what he had expected and that he would have bid differently if he had known that the stream crossings were so full of very large logs and wet unstable fill. I can only speculate, but I presume that the contractor did not lose money on this project, even though their bid was tremendously low. Variations in bids represent the variations in overhead and profit margins of the bidders. Hays and Sons Construction owned their own dump trucks, dozer and the Cat excavator, and employed family members which allowed them from having to pay Davis/Bacon prevailing wages to those employees and therefore kept their overhead low.

The contractor worked very long hours, often more than 5 days per week which caused a great deal of fatigue and ultimate burnout for both the contractor's crew and the COR (D. Short). In reviewing the final finished product, I recognize areas, that had we approached the project with the heavy equipment in a more tempered pace, I would have made different decisions at a couple of the stream crossing excavations to better secure side banks and channel profile.

REFERENCES CITED

- Bundros, G. J. 1989. Erosion control work performed on the C-Line, Fortyfour Creek. Unit 87-9. Redwood National Park unpublished report. On file at Redwood National Park, South Operations Center, Orick, California.
- Harden, D. R., Kelsey, H. M., Morrison, S. D. and Stephens, T. A., 1982, Geologic map of the Redwood Creek drainage basin, Humboldt County, California. U. S. Geological Survey Water Resources Investigation Open File Report 81-496.
- Popenoe, J. and Martin, R., 1984, Soils of the Fortyfour Creek tributary watershed rehabilitation unit. Redwood National Park unpublished report. On file at Redwood National Park, South Operations Center, Orick, California.

APPENDIX

Table 1. Rehabilitation Work Cost Summary, Unit 91-1

TREATMENT	WORKSITE QUANTITY	ACTUAL TOTAL QUANTITY	ACTUAL TOTAL COST	AVERAGE UNIT COST \$/YD ³
HEAVY EQUIPMENT				
<u>Primary Treatments</u>				
Stream Crossing Excavations	8	6,165 yd ³	\$ 15,341	\$ 2.43/yd ³
Skid Trail Crossing Excavation	1	390 yd ³	819	2.10/yd ³
Outsloping	7	3,638 LF	18,711	1.72/yd ³
Exported Outsloping	12	1,548 LF	31,162	2.63/yd ³
Cross-road Drain	1		130	
Other (see table 5)			6,950	
<u>Secondary Treatments</u>				
Rock Transport and Placement (table 5)		405 yd ³	11,675	28.83/yd ³
TOTAL HEAVY EQUIPMENT COSTS			\$ 84,789	
LABOR INTENSIVE				
Straw Materials		60 bales	231	3.85/bale
Straw Delivery and Spreading		60 bales	1,666	27.78/bale
TOTAL LABOR INTENSIVE			\$ 1,897	31.63/bale
PROJECT IMPLEMENTATION				
<u>Evaluation</u>				
Mapping		68 ph	1,267	
Prescription/survey		286 ph	4,679	
Contract Preparation		168 ph	3,161	
<u>Supervision</u>				
Contract Administration		257 ph	4,744	
COR Training		62 ph	669	
<u>Documentation</u>				
Photo-documentation		30 ph	409	
Cost Analysis and Report		176 ph	2,600	
TOTAL PROJECT IMPLEMENTATION			\$ 17,529	
TOTAL REHABILITATION PROJECT			\$104,215	

Table 3. Outslowing Excavation Time, Rates and Costs, Unit 91-1.

STA. NO.	TOTAL QUANT.		EQUIPMENT										AV. UNIT COST			
	YD ³	Linear ft.	YD ³ / H	EXCAVATORS			DOZER		TOTAL HOURS	EXC. RATE ^b YD ³ /HR	TOTAL CONTRACT COST ^c \$	TOTAL H.E.R.E. COST ^d \$	CONTRACT		H.E.R.E.	
				KATO \$130 ^a HR	225 \$120 ^a HR	D7 \$100 ^a HR	D7 \$100 ^a HR	DUMP TRUCKS \$50 ^a HR					\$/YD ³	\$/LF	\$/YD ³	\$/LF
07+08	6,935	2084	3.3	17.25	13.25	26.25	26.25	16.75	73.50	112.2	12,483	7,295	1.80	5.99	1.05	3.50
22+05	1,735	415	4.2	4.00	--	5.25	5.25	2.25	11.50	187.6	2,082	1,158	1.20	5.02	0.67	2.78
27+71	730	93	7.8	.50	--	1.75	1.75	--	2.25	324.4	1,314	240	1.80	14.13	0.33	2.58
26+91	390	109	3.6	.50	--	1.75	1.75	--	2.25	173.3	702	240	1.80	6.44	0.62	2.20
38+30	100	80	1.3	1.25	--	--	--	--	1.25	80.0	200	162	2.00	2.50	1.62	2.03
39+42	470	175	2.7	2.00	2.50	.25	.25	--	4.75	98.9	940	585	2.00	5.37	1.24	3.34
42+10	550	1390	0.4	10.25	1.50	1.50	1.50	--	13.25	41.5	990	1,663	1.80	0.71	4.20	1.66
TOTAL/ AVE.	10,910 4,346		2.5	35.75 17.25		36.75	36.75	19.00	108.75	100.3	18,711	11,343	1.72	4.31	1.04	2.75

^aValue for rental equivalent. Price determined by consensus of discussion between G. Bundros and D. Short. No bids were requested for heavy equipment rental in 1991.

^bRate does not include dump truck hours.

^cBid cost.

^dBased on cost per hour shown in note 1, above.

^eVolumes determined from pre-heavy equipment design surveys. I feel that the volume actually excavated is somewhat less, perhaps from 5% to as much as 30% less (D. Short).

Also, see note on page 8 regarding possible errors in worksite equipment hours.

Table 4. Exported Outslowing Excavation Time, Rates and Costs, Unit 91-1.

STA. NO.	TOTAL QUANT.		EQUIPMENT HOURS										AV. UNIT COST			
			EXCAVATORS			DOZER										
	YD³	Linear ft	YD³/Hr	KATO \$130¹ HR	225 \$120¹ HR	D7 \$100¹ HR	DUMP TRUCKS \$50¹ HR	TOTAL HOURS	EXC. RATE³ YD³/HR	TOTAL CONTRACT COST³ \$	TOTAL H.E.R.E. COST⁴ \$	CONTRACT \$YD³	\$/M	H.E.R.E. \$YD³	\$/M	
107+32	600	140	4.3	4.75	--	5.75	--	10.50	57.1	1,800	1,193	3.00	12.86	1.99	8.52	
111+18	1,300	182	7.1	8.25	--	8.25	8.00	24.50	78.8	2,600	2,298	2.00	14.29	1.77	12.63	
00+06	4,245⁵	702	6.1	39.25	14.75	28.00	86.25	168.25	100.5	14,857	13,984	3.50	21.16	3.29	19.92	
20+84	875	98	8.9	3.25	2.00	4.75	4.00	14.00	87.5	963	1337	1.10	9.82	1.53	4.01	
26+20	105	25	4.2	.50	--	.25	1.25	2.00	140.0	263	153	2.50	10.52	1.45	6.12	
27+03	740	68	10.9	5.00	6.75	2.50	12.50	26.75	51.9	1,850	2,335	2.50	27.20	3.16	34.34	
30+00	785	135	5.8	1.00	7.75	2.25	25.75	31.75	130.8	1,962	2,573	2.50	14.53	3.28	19.06	
31+85	820	49	16.7	7.50	3.75	3.50	19.75	32.25	65.6	2,050	2,762	2.50	41.84	3.23	54.08	
33+03	1,025	165	6.2	5.00	1.50	5.50	10.00	22.00	85.4	2,152	1,880	2.10	13.03	1.83	11.39	
35+00	385	170	2.3	6.50	3.75	6.00	21.25	37.50	23.7	770	2,958	2.00	4.53	7.68	17.40	
37+00	720	130	5.5	2.25	2.50	--	4.25	9.00	151.6	1,440	805	2.00	11.08	1.12	6.19	
SKID TRAIL	130	71	1.8	2.25	--	1.00	--	3.25	40.0	455	393	3.50	6.41	3.02	5.54	
TOTAL / AVE	11,730	1935	6.1	85.50	42.75	67.75	193.00	381.75	62.1	31,162	32,671	2.65	16.10	2.91	17.62	

¹Value for rental equivalent. Price determined by consensus of discussion between G. Bundros and D. Short. No bids were requested for heavy equipment rental in 1991.

²Rate does not include dump truck hours.

³Bid cost.

⁴Based on cost per hour shown in note 1, above.

⁵Unit priced bid item. The volume for EOS 00 + 06 was determined from a detailed post-excavation survey. All other EOS worksite volumes were determined from pre-heavy equipment design surveys. I feel that the volume actually excavated from these EOS worksites is somewhat less than shown, perhaps from 10 to 15% less (D. Short).

Also, see note on page 8 regarding possible errors in worksite equipment hours.

Table 5. Other Miscellaneous Costs, Unit 91-1.

BID ITEM	EQUIPMENT HOURS						
	EXCAVATORS			DOZER			
	TOTAL QUANT.	KATO \$130 ¹ HR	225 \$120 ¹ HR	D7 \$100 ¹ HR	DUMP TRUCKS \$50 ¹ HR	TOTAL HOURS	
Move in							Unknown
Move out							Unknown
Haul Logs		3.75	--	--	8.50	12.25	913 ²
Open roads		5.50	.50	9.50	--	15.50	1,725
Gravel Procure							Unknown
Record Keeping							Unknown
Rip roads	5,446 ft			2.75		2.75	800 see note 6
NON BID ITEMS							
Discussion		7.50	--	1.50	--	9.00	na 1,125
Brushing		1.75	--	2.25	--	4.00	na
Walk		.75	1.50	.75	--	3.00	na 453
Rock Transport and Placement	405 yd ³	6.25	3.25	1.50	85.25	96.25	28.83/yd ³ 5,615 ⁵
TOTAL							6,950

¹Value for rental equivalent. Price determined by consensus of discussion between G. Bundros and D. Short. No bids were requested for heavy equipment rental in 1991.

²A laborer was also on site to cut the logs shorter for hauling in dump trucks. The laborers time was unrecorded, as it generally was one of the equipment operators keeping busy while equipment was either down or idle, or after normal work hours.

³Bid cost.

⁴Based on cost per hour shown in note 1, above.

⁵Does not include the cost associated with the John Deer loader which was parked at the M-Line deck for the duration of the project. The loader was used as needed for loading rock into the dump trucks by the truck operators.

⁶Ripping was prescribed for all areas where fill was placed on the road. This includes the entire road bench for fill sites and the inboard section of road for outslope reaches. Stream crossings and Exported Outslope reaches are not included in total length ripped. The contractor also ripped some additional reaches to loosen the compacted surface rock for easier excavating (not included in length). Dozer operator generally worked alone, out of site of COR/inspector. His documentation of where he worked, and when, is suspect. However, with this in mind, contract ave. cost for ripping = .15/lf and H.E.R.E. ave. cost for ripping = .05/lf.