

The M-3-1-2 Road and Slope
Watershed Rehabilitation Project

Unit 86-5

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Unit 86-5

INTRODUCTION

The M-3-1-2 Rehabilitation Unit, 86-5, is located on the west side of Redwood Creek, roughly 16 miles upstream from Orick, in the Bridge Creek drainage. The unit encompasses 225 acres extending in a narrow arcuate north-south band along the headwaters of Bridge Creek (Map A). The unit consists of the M-3-1-2 road which runs roughly on contour, and the hillslope above the road to the ridge top M-2 1/2 road (eastern boundary). The rehabilitation work began at the intersection where the M-2 1/2 road intersects the M-3-1-2 road on the ridge top at the northern boundary, and extends 3.1 miles to the southern boundary which is along a major ridge dividing two main tributaries of Bridge Creek. The hillslope below (west of) the M-3-1-2 road was included in Rehabilitation Units 81-4, 83-2 and 87-5.

Total relief on the unit averages 400 feet, with elevations ranging from 2,200 feet just below the M-3-1-2 road, to 2,610 feet at the highest point along the ridge top (Map B). Hillslope gradients are consistently steep, averaging 55 to 95 percent. An area of gentle to moderate slopes, averaging 15 to 45 percent, is present along the unit's southern boundary. The M-3-1-2 unit contains zero and first order, ephemeral and intermittent streams that make up the southeastern headwaters region of the Bridge Creek drainage. These streams have steep profiles, are slightly incised, and are controlled by organic debris where actual flow channels have established.

This rehabilitation unit is underlain by the schist unit of Redwood Creek. Soils adjacent to the southern boundary of the unit are mostly deep red, clay-rich ultisols of the Trailhead series, which are quite resistant to erosion by surface runoff. Most of the rehabilitation unit is characterized by soils of the Coppercreek, Ahpah, Lacks creek and Devils creek series. All of these soils are very susceptible to erosion by surface runoff where mineral soil is exposed on steep slopes. With the exception of the Devils creek series, these soils are well drained and have a low to moderate landslide potential, depending on slope gradient and hydrologic conditions. Because they occupy wetter areas, Devils creek soils are very prone to landslides. A detailed description of these soils may be found in the 1985 inhouse report, "Soils of the M-2-1-1, M-3-1-2, M-4-1 and beginning of M-3 and M-4 roads" by J. Popenoe.

The rehabilitation cost (including the evaluation and documentation phases) for the M-3-1-2 unit was \$99,856.05 (Table 1). Of this total, contract heavy equipment and labor intensive costs accounted for 77 percent and 14 percent, respectively. Evaluation and documentation phases comprise the remaining 9 percent. These costs are discussed in detail in the Erosion Control Work section.

Over three miles of the M-3-1-2 logging haul road was rehabilitated. A total of 13,400 cubic yards of channel fill was excavated from 22 headwater haul road crossings (which were prescribed as Total Outslopes and Bench Outslopes in the contract), and 1,800 cubic yards from 2 skid trail stream crossings. Fifty-four cross road drains were installed along 1.2 mile of the M-3-1-2 haul road, and 0.8 mile of the haul road was outsloped, totalling 8,665 cubic yards.

LEGEND:

PARK BOUNDARY - - - -

DRAINAGES Bridge Creek

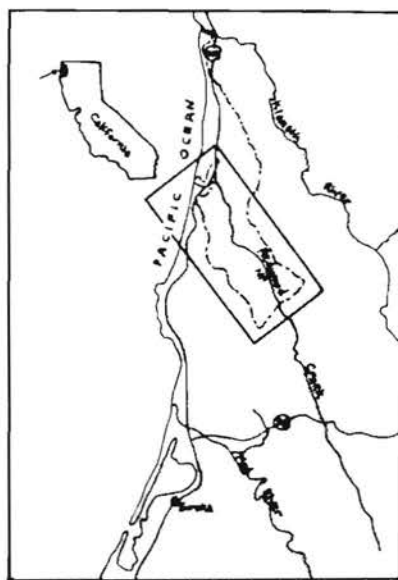
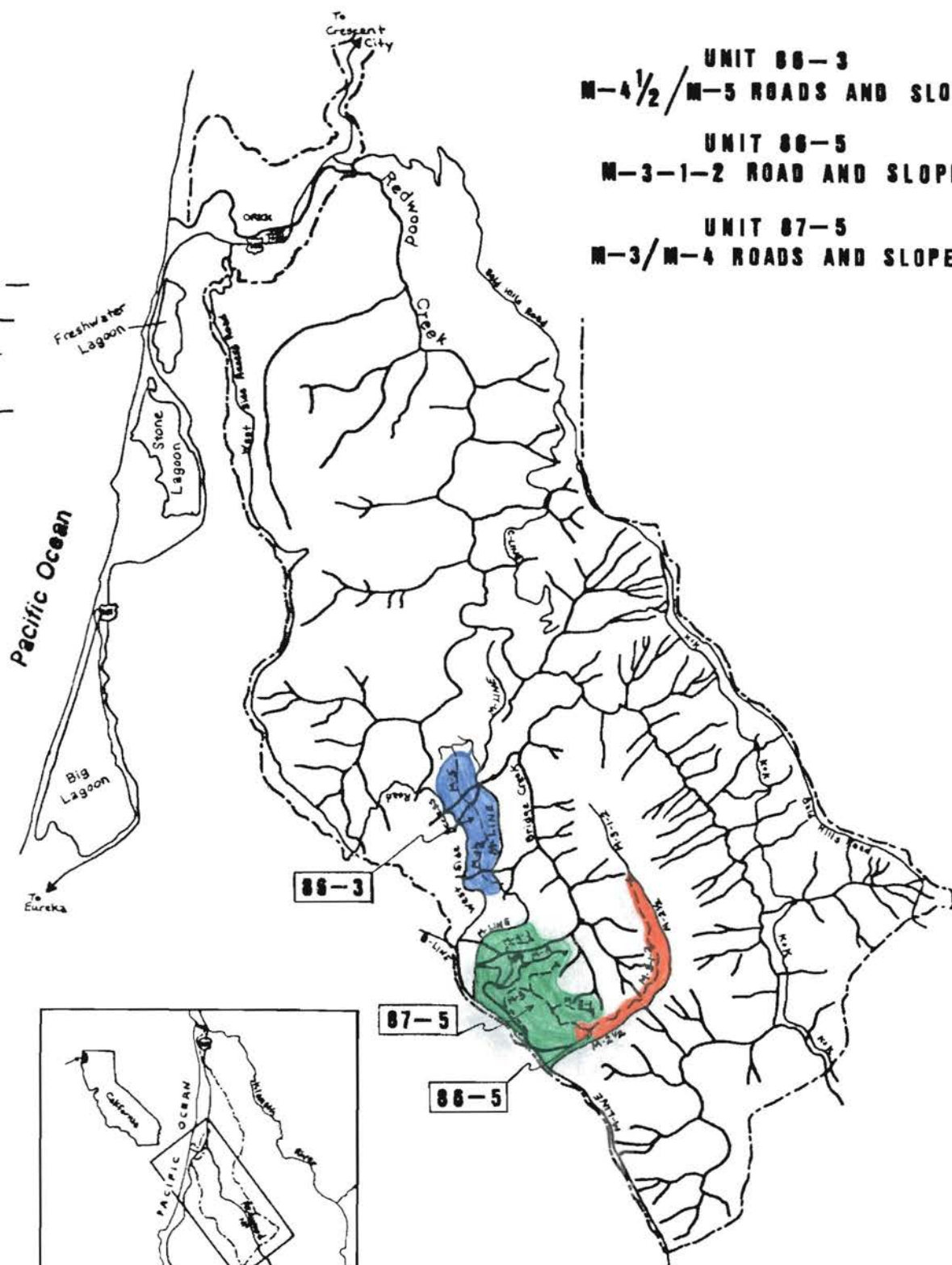
ROADS M-LINE

REHABILITATED ROADS M-3

UNIT 88-3
M-4 1/2 / M-5 ROADS AND SLOPE

UNIT 86-5
M-3-1-2 ROAD AND SLOPE

UNIT 87-5
M-3/M-4 ROADS AND SLOPE



N
↑

0 4000 8000 12000 16000 Feet

MAP A

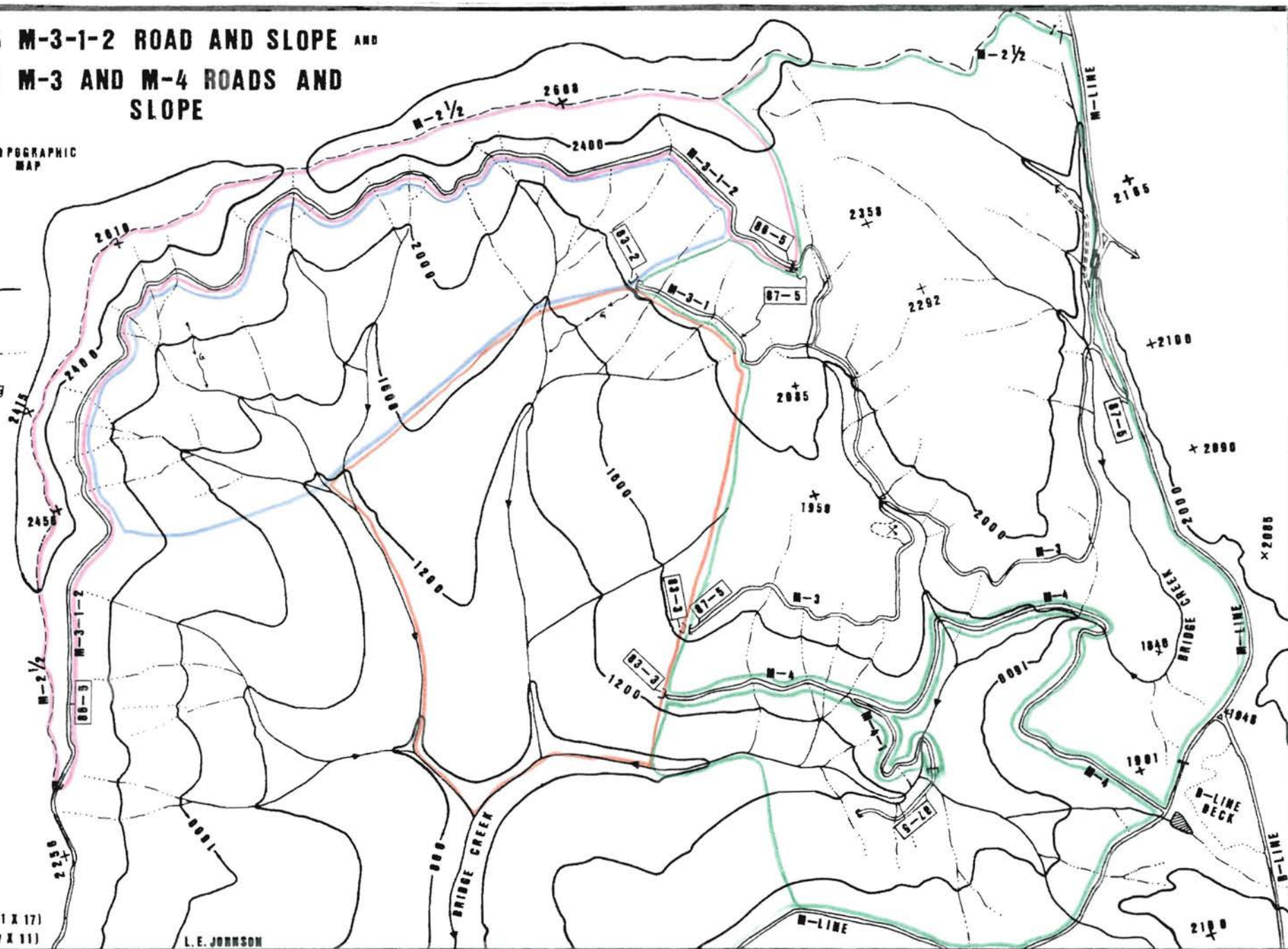
WATERSHED REHABILITATION UNIT LOCATION MAP

**UNIT 86-5 M-3-1-2 ROAD AND SLOPE AND
UNIT 87-5 M-3 AND M-4 ROADS AND
SLOPE**

MAP B TOPOGRAPHIC
MAP

LEGEND:

- LOGGING
HAUL
ROADS
M-3
M-2 1/2
- CONTOURS — 800 —
- POINT
ELEVATIONS + 2358
- DRAINAGE
- REHAB.
UNITS
86-5
- UNIT BOUNDARIES:
- 83-2
83-3
86-5
87-5



SCALE

1:12300 (11 X 17)
1:10500 (7 X 11)

L.E. JOHNSON

Table 1
SUMMARY COSTS OF EROSION CONTROL REHABILITATION WORK
Unit 86-5

	Task	RNP Employees		YCC	Redwoods United	Heavy Equipment Contract	Materials	Total Task Cost	Phase Totals	Phase %
		Geologist & Technician	Laborers							
EVALUATION PHASE	Mapping (1983)	\$1,550.00 ¹	-.-	-.-	-.-	-.-	-.-	\$1,550.00		
	Prescription & Contract Preparation	5,855.79	-.-	-.-	-.-	-.-	-.-	5,855.79	\$7,405.79	7%
HEAVY EQUIPMENT PHASE	Primary Treatment	751.79 ²	-.-	-.-	-.-	\$71,248.00	-.-	71,999.79		
	Secondary Treatment	-.-	-.-	-.-	-.-	-.-	-.-	-.-	\$76,549.79	77%
	Miscellaneous	-.-	-.-	-.-	-.-	4,550.00 ³	-.-	4,550.00		
LABOR INTENSIVE PHASE	Secondary Treatment - Straw Mulch (includes travel)	-.-	\$8,612.02	\$586.25	\$1,462.60	-.-	\$3,513.90	14,174.77	\$14,174.77	14%
DOCUMEN- TATION PHASE	Cost Analysis and Report	1,725.70	-.-	-.-	-.-	-.-	-.-	1,725.70	\$1,725.70	2%
TOTALS:		\$9,883.28	\$8,612.02	\$586.25	\$1,462.60	\$75,798.00	\$3,513.90	\$99,856.05	\$99,856.05	
% OF TOTAL:		10%	9%	.5%	1%	76%	3.5%			

¹Mapping cost is from 1983, M-3-1 Road, by L. Johnson and T. Spreiter.

²Minimal time spent on site since the COR, L. Johnson, was also supervising an hourly rehab. unit 86-3 simultaneously.

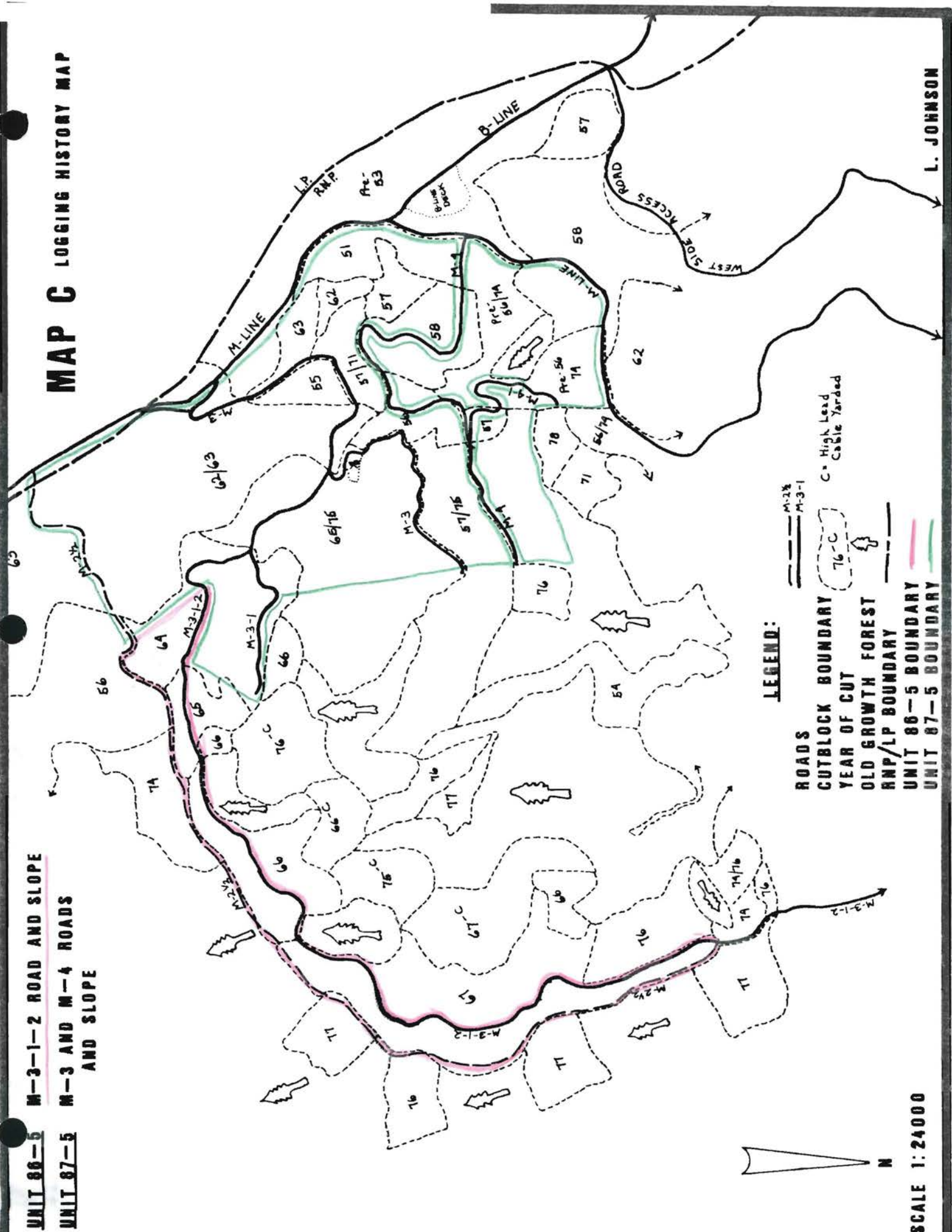
³Includes move in/out (\$4,000.00), miscellaneous cost (\$500.00) and recordkeeping (\$50.00), as bid.

LOGGING HISTORY

Timber harvest and haul road construction activities began in 1954-1955, when Louisiana Pacific Corporation began pioneer road work on the M-3 to a 1955, 23-acre tractor yarded cutblock 0.5 mile east from the M-Line. From that year until 1967, haul road construction (M-3, M-3-1, M-3-1-2 and M-2 1/2) and timber harvest activities coincided and progressed eastward across the upper tributary drainages of Bridge Creek. By 1967, both the M-3-1-2 and M-2 1/2 haul roads were completed to their ridge top intersection at the unit's northern boundary. Between 1964 and 1967, 100 percent of the unit's 225 acres above the M-3-1-2 haul road had been logged using tractor yarded methods (Map C).

UNIT 86-5 M-3-1-2 ROAD AND SLOPE
 UNIT 87-5 M-3 AND M-4 ROADS
 AND SLOPE

MAP C LOGGING HISTORY MAP



SCALE 1:24000

L. JOHNSON

EROSION FEATURES

The most significant erosion features exhibited on Unit 86-5 are mass movement features, and the potential for debris torrent type fill failures at each headwater haul road stream crossing along the M-3-1-2 (Map D-back pocket). The headwaters of Bridge Creek are an inherently unstable area, where mass movements have sculptured the landscape and are a part of the natural processes in the area. However, road building and timber harvest activities have re-activated some dormant features and have contributed to a number of fill failures.

There are several mass movement features on the unit, most of which have been active during the last five winters. The hillslopes are extremely steep, often 55-95 percent, and locally up to 110 percent. In many areas, especially along drainages, the bedrock is sheared black schist, with a veneer of Devils Creek soil, which is very prone to landsliding. The Bridge Creek lineament(s) also passes through the unit, further weakening the rock. In addition, the entire unit was logged from 1964 to 1967, and is beyond the age of minimum root strength (10-20 years after harvest), when man-induced mass movements are most likely to occur.

There were several potential debris torrent zones associated with the M-3-1-2 haul road. One area is where the road crosses a headwater region, between stations V88+88 and V93+50, along steep slopes (80-90 percent) with wet soils and where no culverts existed. The second area was a large complex skid trail crossing above the M-3-1-2 road at station V117+00 (LEJ's E.P. #30, 83-2). The skid trail crossing fill had slumped up to 4 feet, and the 100 feet of stream channel below to the road crossing was completely filled with large organics (40-foot saw logs), and the flow was subsurface through the entire reach (fill volume of 1500 cubic yards). The soils within the drainage are Devils Creek, and the channel gradient is 53 percent. The potential for a large debris torrent involving the fill volume from the skid trail crossing, channel fill, haul road crossing, and an unknown distance downslope was extremely high. During the excavation, sheared black schist was uncovered throughout the finished channel grade. To a much lesser extent, all other headwater road crossings (20 of them) had the same potential for some type of fill failure due to the steepness of the hillslopes and wetness of the soils.

Two natural landslides had become active over the last several years where the M-3-1-2 crossed them at stations V10+00 and V45+00. Displacement along the road at both locations averaged 6 to 24 inches, and the scarps diminished 10 to 20 feet below the road fill. Both landslides are large complex features, and this renewed movement along the road was in part due to inboard ditch water ponding and thus saturating the road fill and causing subsequent slumping.

Several cutbanks had also slumped onto the M-3-1-2 due to seeps and rills upslope on skid trails, and road cuts into steep slopes along wet soils. No erosional impact, other than obstructing the inboard ditch, resulted from these cutbank failures.

The M-3-1-2 haul road was, for the most part, constructed with correctly placed and sized culverts. There are some fluvial sediment source areas along and above the M-3-1-2 with only minimal amounts of material being transported below the haul road. Waterbars placed in 1981 (Unit 81-4 treatment) along the entire

length of the M-3-1-2 (above Units 81-4 and 83-2) were the only significant fluvial sediment source associated with the road. The concentrated flow from some of the waterbars extended up to 300 feet downslope, causing small gullies (2/1 to 6/4) before the flow entered a stream channel.

On the slopes above the M-3-1-2 haul road, there are numerous skid trails that cut across the steep slopes, intercepting ground water, and collecting surface flow. The water ponds in low areas on skid trails, saturating the fill and in several locations the skid trails have slumped. Skid trail fill failures will probably continue to occur. Active fluvial erosion is occurring on several skid trails where runoff has concentrated forming rills and small gullies. These actively eroding skid trails were waterbarred by this year's rehabilitation efforts. Because there is 20+ years of regrowth (mostly douglas fir) present on almost all the skid trails, future surface erosion will probably be minimal.

For more complete detail on potential and existing erosion features for the slopes below the M-3-1-2 road, refer to the "M-3-1 Road and slope Work and Cost Summary Report, Watershed Rehabilitation Unit 83-2," by T. Spreiter and L. Johnson (an inhouse report).

EROSION CONTROL WORK

Evaluation Phase

The evaluation phase includes mapping, prescribing erosion control treatments, surveying, establishing photo points, planning the work schedule and contract preparation. This phase involved approximately 60 person days, between January and July 1986. This rehabilitation unit was previously mapped during the winter of 1982-1983, by L. Johnson and T. Spreiter, as part of the M-3-1 Watershed Rehabilitation Unit 83-2. The following is a more detailed cost breakdown of the evaluation phase:

Mapping (1983)	\$1,550.00
Prescriptions (includes photo points)	1,482.70
Surveying and Staking for Contract	2,979.96
Contract Preparation (office)	<u>1,393.13</u>
Total	\$7,405.79

Prescription costs were relatively low for unit 86-5, because prescribed treatments were straight forward, with only a few complicated treatments located at the mass movement features described in the previous section. Due to the more detailed surveying (and associated flagging and staking) necessary for a contract site, a good deal of time was spent on this category and time records were kept separately for surveying and staking as opposed to all other prescription tasks. This cost for surveying could easily have been cut in half for an hourly equipment rental job because the pre-excavation surveys are used mainly for inhouse cost estimates. However, in order for contractors to make a reasonable bid, they need to be able to see the best possible estimate of size (extent) and bounds of excavation, whether it be a road stream crossing or an outslope reach. This can only be done following detailed surveying and staking in the field. The cost for staking and flagging of this unit was reduced considerably by having just one person doing this in conjunction with the field prescription work. Thus, requiring about half the usual time needed for two people to complete the survey work, since all treatment and control point stakes were already in the ground. Survey work was completed by L. Johnson and T. Spreiter.

The actual contract preparation cost was also fairly reasonable for the unit. All of the headwater haul road stream crossings were surveyed using the Total Outslope (TOS) and Bench Outslope (BOS) prescriptions since channel development was poor to nonexistent at each one. This eliminated the need for detail drafting of centerline profiles and cross sections which are done for road crossing (RX) surveys, thus reducing contract preparation time considerably. Also the technical specifications for Unit 85-2's contract were used, and the compiling and typing of the plan sheets was expedited this year by the use of the computer. All contract preparation work was done by L. Johnson.

To compare the cost of the evaluation phase on contract and hourly jobs, one could eliminate roughly half of the surveying cost and all of the contract preparation cost for an evaluation phase cost of roughly \$4,500.00, saving nearly \$2,900.00. It's also been shown over the last several years that it's necessary to complete the mapping for a contract unit a year or more in advance, since the time spent doing surveying and contract preparation is in the heart of mapping season.

Heavy Equipment Phase

Introduction

The heavy equipment phase of the erosion control work on watershed rehabilitation unit 86-5 was done under a fixed price contract (#8480-G-0002). The contract consisted of 24 headwater stream crossing excavations (prescribed and surveyed as Total and Bench Outslopes), 0.8 mile of outsloping, and 1.2 mile of ripping and crossroad drains. A total of 3.1 miles of the M-3-1-2 haul road was treated. Listed below is a summary of the five bids which were received:

WK Construction	\$75,798.00
Torgersen/Talbott	87,405.80
Twin Parks Lumber Company	89,384.00
Barber Construction	97,179.00
Nally Enterprises	152,456.56

The contract was awarded to the low bidder, WK Construction, on July 24, 1986. The notice to proceed was issued on August 11, 1986 and heavy equipment work began on Monday, August 18th. During the first week of work, the contractor shut down for two full days while major repairs were being performed on the excavator. Once repairs were completed, the contractor worked 60-hour, 5-day work weeks and completed the contract in 5 weeks ending September 18, 1986.

Heavy equipment used by the contractor consisted of a Caterpillar D8 bulldozer with rippers (operated by Bill Campbell), a CASE 980 hydraulic excavator with a 1 1/4 cubic yard bucket (operated by Rob French), and a CASE 1450 bulldozer with a winch (operated by Whitey Brown). The D8 bulldozer and excavator worked together as a team most of the time, while the CASE bulldozer was used mainly for finishing work ("spiffifying") and as Whitey's all-terrain vehicle.

Each bid item (worksite) was written as a Lump Sum Bid on the Bid Schedule, and bids were based on surveyed volumes and linear measurements for each item. Each bid item was paid in full upon completion to specifications of all portions of each bid item and per the Contracting Officer's Representative's (C.O.R., L. Johnson) final approval of the work. Therefore, the final cost of the contract was the same as the initial bid, \$75,798.00. Redwood National Park's cost estimate for completion of this contract was \$68,568.25. Therefore, WK Construction's bid was 10 percent higher than the park's estimate, and the actual Heavy Equipment Rental Equivalent (HERE) total cost was \$60,575.00, which is a net loss of \$15,173.00 to the federal government by doing the unit under a fixed price contract.

Table 2 shows average and total costs for the erosion control work, along with estimates of what it would have cost to do the same work by hourly equipment rental. Heavy Equipment Rental Equivalent (HERE) costs were calculated using actual equipment hours worked, and hourly rental prices from WK Construction's equipment rental list for this year:

Caterpillar D8 bulldozer	\$100 per hour
CASE 980 excavator	100 per hour
CASE 1450 bulldozer	75 per hour

The Contractor's Daily Records (Time Sheet) were used to calculate the HERE costs, since the COR's time spent on the contract site was limited due to having two rehabilitation units running simultaneously (the other being an hourly site).

Table 2

SUMMARY OF AVERAGE COSTS OF HEAVY EQUIPMENT EROSION CONTROL TREATMENTS

Unit 86-5

Treatment	# of Worksites (Bid Items)	Total Quantity	TOTALS			AVERAGES	
			Actual Contract Total Cost	HERE ¹ Total Cost	Government Savings(+) or Losses(-)	HERE ¹ Cost Per Quantity	Average Bid Cost Per Quantity
Haul Road Stream Crossings	24 headwater excavations	15,200 yd ³	\$47,635.00	\$36,400.00	-\$11,235.00	\$2.39/yd ³	\$3.13/yd ³
Outslope	16 4,142 feet of road	8,665 yd ³	19,366.00	11,650.00	-\$7,716.00	\$1.34/yd ³	\$2.23/yd ³
Drains and Ripping	12 6,459 feet of road	54 drains 2,771 feet of drain	4,247.00	6,387.50	+\$2,140.50	\$2.31/ft.	\$1.53/ft.
Misc. (Bid Item 4)	SEE TABLE 7	- - -	500.00	1,137.50	+\$637.50	- - -	- - -
Move In/Out (Bid Items 1 & 2)	- - -	- - -	4,000.00	5,000.00	+\$1,000.00	- - -	- - -
TOTALS	- - -	- - -	\$75,748.00 ²	\$60,575.00	-\$15,173.00	- - -	- - -

¹HERE - Heavy Equipment Rental Equivalent - actual hours spent for each task, using rental rates of \$100.00 per hour for the D8 and 980 excavator, and \$75.00 per hour for the 1450.

²Non-heavy equipment bid items total \$50.00. Total contract is \$75,798.00.

Stream Crossings

Twenty-four stream headwater road crossing excavations were completed along the M-3-1-2 road (Map D), totalling 15,200 cubic yards of material moved. Table 3 shows average stream excavation costs including HERE and contract costs, unit costs and excavation rates for the three size categories listed. Table 4 details this information for each crossing. The total HERE cost for the 24 crossings was \$36,400.00, with a unit cost of \$2.39 per cubic yard and an overall excavation rate of 38 cubic yards per hour. The contract total bid cost was \$47,635.00, with an overall bid unit cost of \$3.13 per cubic yard. This amounted to an \$11,235.00 loss to the government.

These headwater stream crossings were excavated to prevent debris torrents from developing along the extremely steep hillslopes and stream gradients, and in many locations within Devils Creek soil. Excavations were designed to tie into stable base levels at, or near, the original channel bed level, and with sideslopes of 35-45 percent. The contractor approached almost every crossing the same by using the D8 bulldozer first to remove as much volume as possible. Then the excavator would be used to finish sloping the lower extent of the sideslopes and defining the channel grade, with either the D8 or 1450 dozer pushing the spoils to the fillsite. The average push distance to a fillsite was 230 feet.

The contractor used an interesting and very effective excavation method on crossing number V115+19. This was a long, 210 feet of skid trail crossing and channelization directly above the M-3-1-2 road crossing at station V115+72 (discussed earlier in the Erosion History section). The fill volume totalled 1,500 cubic yards, and the finished channel grade was 1.9:1 (53 percent). This was also the most expensive worksite on the unit at \$7,125.00 (HERE cost), with a unit cost of \$4.07 per cubic yard.

The erosion control prescriptions and plan sheets recommended that the fill be pushed down the channel to the road crossing and then down the road to the fillsite, a 500-foot push distance. This was done entirely with both bulldozers, the lighter weight 1450 pushing fill down the channel to the road, where the D8 then pushed the fill out to the fillsite. Approximately 80 percent of the fill volume was removed using this method. At this point, the 1450 dozer had excavated down to mud and sheared black schist and was getting stuck quite often, leaving the last 2-5 feet of fill remaining along the channel bottom.

The Final channelization and grading was completed by the excavator. The excavator started at the top of the 210-foot channel and excavated the remaining fill to grade by "leap-frogging" the fill spoils down the channel. The excavator placed the fill spoils below where it was perched, and when a section of channel above was complete down to its position, the excavator would move down onto the spoils pile below and continue excavating through the material it was just positioned on, above, placing this fill below its present position, and so on until the channelization was complete. The contractor was right on top of this excavation, making sure the grade stayed right at the surveyed 53 percent all the way down.

Table 3
AVERAGE STREAM EXCAVATION COSTS
Unit 86-5

Size Category (cu.yds)	# of work sites	Range of Volumes (cu.yds)	Equipment ¹ percent	Range of Hours (total hrs)	Total Volume (cu.yds)	Total HERE Costs	Range of HERE Costs	Average HERE Cost/yd ³	Ave. HERE Exc.Rate (yd ³ /hr)	Total Contract Bid Cost	Ave.Con. Bid Cost per yd ³
Small 0-400	8	85-360	Bulldozers 66% Excavator 34%	1-7 (32.75) .75-3.25 (17.25)	1,870	\$4675.00	\$175.00- 925.00	\$2.50	37	\$5,350.00	\$2.86
Medium 400-800	10	420-800	Bulldozers 68% Excavator 32%	4.25-14 (90.25) 2.25-7 (43.25)	6,100	12,275.00	600.00- 1925.00	2.01	46	15,161.00	2.49
Large 800-2000	6	860-1650	Bulldozers 69% Excavator 31%	10-58.5 (147.5) 4.5-20 (65)	7,230	19,450.00	1337.50- 7125.00	2.69	34	27,124.00	3.75
24 Worksites		85-1650 Cubic Yards	Bulldozers 68% Excavator 32%	1-58.5 (270.5) .75-20 (125.5)	15,200 Cubic Yards	\$36,400.00	\$175.00- 7,125.00	\$2.39 per Cubic Yard	38 yd ³ per Hour	\$47,635.00	\$3.13 per Cubic Yard

¹Bulldozer hours include the D8 and 1450 combined.

Table 4
Haul Road Stream Headwater Crossing Excavation Costs
Unit 8G-5

Excavation Site Number	Volume (cubic yards)	Contract Bid Cost	ACTUAL EQUIPMENT HOURS:			HERE:		Excavation Rate yd ³ /hour	Ave. Push Dist. to Fillsite (ft.)	\$ Saved (contract vs. hourly)	OR vs.	\$ Lost
			D8 (\$100)	980B (\$100)	1450 (\$75)	Total Cost	Unit cost per yd ³					
15 + 33	115	\$214.00	2.25	0.75	-.-	\$300.00	\$2.61	38	69	\$86.00		-.-
34 + 53	255	1,070.00	2.75	2.75	1.75	681.25	2.67	35	326	-.-		388.75
39 + 68	325	1,070.00	3.25	3.25	3.25	893.75	2.75	33	198	-.-		176.25
43 + 56	85	321.00	1.5	1.5	1.0	375.00	4.41	21	115	54.00		-.-
48 + 57	420	749.00	3.5	3.5	3.5	962.50	2.29	40	139	213.50		-.-
57 + 47	360	856.00	3.0	3.0	2.0	750.00	2.08	45	119	-.-		106.00
59 + 40	1,000	2,354.00	6.5	6.5	6.5	1,787.50	1.79	51	142	-.-		566.50
64 + 09	545	1,284.00	2.25	2.25	2.0	600.00	1.10	84	93	-.-		684.00
88 + 88	675	1,712.00	4.5	3.0	3.0	975.00	1.44	64	162	-.-		737.00
91 + 40	800	1,926.00	7.0	7.0	7.0	1,925.00	2.41	38	188	-.-		1.00
100 + 00	1,175	2,354.00	10.5	8.5	6.5	2,387.50	2.03	46	268	33.50		-.-
103 + 10	680	1,498.00	5.5	5.5	5.0	1,475.00	2.17	43	187	-.-		23.00
107 + 18	435	1,070.00	3.5	4.0	4.0	1,050.00	2.41	38	350	-.-		20.00
112 + 36	860	1,926.00	5.5	4.5	4.5	1,337.50	1.56	59	301	-.-		588.50
115 + 19-SW	1,650	14,712.00	29.5	20.0	29.0	7,125.00	4.07	22	500	-.-		7,587.00
115 + 72	1,430	3,210.00	16.5	18.5	18.5	4,887.50	3.42	27	400	1,677.50		-.-
118 + 52	220	535.00	3.0	2.0	1.0	575.00	2.61	37	206	40.00		-.-
119 + 49	620	1,391.00	7.0	6.0	6.0	1,750.00	2.82	33	309	359.00		-.-
121 + 45	620	2,033.00	5.0	3.0	3.0	1,025.00	1.65	56	470	-.-		1,008.00
123 + 34	660	2,000.00	4.5	4.5	4.5	1,237.50	1.88	49	439	-.-		762.50
126 + 45	1,115	2,568.00	7.0	7.0	7.0	1,925.00	1.73	53	128	-.-		643.00
130 + 60-SW	150	535.00	-.-	1.0	1.0	175.00	1.17	75	50	-.-		360.00
130 + 75	360	749.00	4.0	3.0	3.0	925.00	2.57	36	217	176.00		-.-
132 + 65	645	1,498.00	4.5	4.5	5.0	1,275.00	1.98	46	145	-.-		223.00
24 worksites	15,200 cubic yards	\$47,635.00	142.5 hrs. 36%	125.5 hrs. 32%	128.0 hrs. 32%	\$36,400.00	\$2.39/yd ³	38 yd ³ /hr.	230 feet	LOST		\$11,235.00

\$3.13/yd³
Average

TOTAL HOURS - 396

**RNP Est. - \$36,200.00; Ave. Unit Cost \$2.38/yd³

Prescriptions for all haul road stream headwater crossings are called Exported Outslopes (Total or Bench) in the contract, and these will appear on Map D as TOS 15 + 33, BOS 34 + 53, etc.

SW - slopework worksite

Road Treatments

There were two types of erosion control road treatments completed on this unit: Outsloping, and ripping and draining (Map D). Eight-tenths of a mile (4,142 feet) of the M-3-1-2 haul road was outsloped, with a total of 8,665 cubic yards of fill material moved. Road sections that were outsloped were located along steep hillslopes (65-85 percent) in areas where outboard fill tension cracks were forming, road sections adjacent to drainages, and along sections with old-growth forests below. First the D8 bulldozer ripped the road between the balance point (near mid-road) inward and including the inboard ditch. Both the excavator and the D8 bulldozer worked together on the outsloping, with the excavator pulling the outboard edge fill and placing it against the cutbank, while the dozer worked behind shaping the fill and creating the finished contoured slopes.

The contract bid and HERE costs are detailed for each outslope reach in Table 5. The total cost for outsloping as bid was \$19,366.00. The HERE cost was \$11,650.00, the government could have saved \$7,716.00 by doing the work under an hourly rental agreement. The overall HERE unit cost was \$1.34 per cubic yard with an excavation rate of 71 cubic yards per hour. The contract bid unit cost averaged \$2.23 per cubic yard. All outslope costs include 4,142 feet of ripping.

A total of 1.2 mile of the M-3-1-2 haul road was ripped and drained. The road was ripped to a depth of 18-24 inches, using the D8 bulldozer with two rear mounted ripper teeth. Decompacting the road increases infiltration through the road surface and makes it easier for vegetation to become established. For the most part, inboard ditches were not ripped, because they were to be used to collect slope runoff and direct flow to the crossroad drains. Where inboard ditches were expected to carry considerable spring flow, they were cleared of vegetation and widened. This work was generally done by the excavator. Crossroad drains were constructed at frequent intervals to disperse the runoff. These were mostly done by the two bulldozers, with the excavator used to open the outlet of each drain.

The contract bid and HERE costs are detailed for each drain reach in Table 6. The total cost for ripping and draining as bid was \$4,247.00. The HERE cost was \$6,387.50, the government saved \$2,140.50 by doing the work under a fixed price contract. Overall, crossroad drains averaged 51 feet in length and had a HERE cost of \$2.31 per foot of drain. The contract bid average was \$1.53 per foot of drain. Road drain construction costs include linear feet of crossroad drain, inboard ditch improvements and spring drains, and 5,645 feet of road ripping.

Miscellaneous Heavy Equipment Costs

This category includes all equipment time which can not be assigned to a specific worksite, including travel, down time, and helping with repairs. None of these were listed as individual bid items, but have been lumped under Item 4, "Miscellaneous Cost", for comparison purposes. Table 7 shows the HERE costs for each miscellaneous category, totalling \$1,137.50. The contract bid was \$500.00, the government saved \$637.50.

Table 5
OUTSLOPE ROAD REACH COSTS
Unit 86-5

Excavation Site Number	Volume (cubic yards)	Contract Bid Cost	ACTUAL EQUIPMENT HOURS:			HERE:		Excavation Rate yd. ³ /hr.	\$ Saved (contract vs. hourly)	OR	\$ Lost
			D8 (\$100)	980B (\$100)	1450 (\$75)	Total Cost	Unit Cost per Cu.yd.				
0 + 28	1,070	\$1,605.00	9.0	9.0	2.0	\$1,950.00	\$1.82	54	345.00		-. -
14 + 39	130	214.00	0.5	0.5	-. -	100.00	.77	130	-. -		114.00
16 + 37	690	1,551.00	4.25	4.25	-. -	850.00	1.23	81	-. -		701.00
31 + 56	375	856.00	3.0	3.0	-. -	600.00	1.60	63	-. -		256.00
36 + 10	145	428.00	1.0	1.0	-. -	200.00	1.38	73	-. -		228.00
55 + 00	620	1,498.00	5.0	5.0	-. -	1,000.00	1.61	62	-. -		498.00
66 + 00	255	642.00	1.75	1.75	-. -	350.00	1.37	73	-. -		292.00
77 + 00	3,700	8,560.00	15.5	17.0	12.0	4,150.00	1.12	83	-. -		4,410.00
93 + 28	160	428.00	-. -	1.0	-. -	100.00	.63	160	-. -		328.00
117 + 62	340	749.00	-. -	2.0	2.0	350.00	1.03	85	-. -		399.00
118 + 84	195	428.00	1.5	1.5	-. -	300.00	1.54	65	-. -		128.00
120 + 13	85	267.00	1.0	1.0	1.0	275.00	3.24	28	8.00		-. -
122 + 31	320	749.00	2.5	2.5	2.5	687.50	2.15	43	-. -		61.50
124 + 00	185	428.00	1.0	1.0	1.0	275.00	1.49	62	-. -		153.00
125 + 48	285	642.00	1.5	1.5	1.5	412.50	1.45	63	-. -		229.50
133 + 45	110	321.00	-. -	0.5	-. -	50.00	.45	220	-. -		271.00
16 worksites	8,665 cubic yards	\$19,366.00 Bid Average \$2.23 per cu. yd.	47.5 Hrs. 39%	52.5 Hrs. 43%	22.0 Hrs. 18%	\$11,650.00	\$1.34 per cu. yd.	71 cu. yd. per hour	LOST		\$7,716.00
Total Hours - 122											

**RNP Estimate - \$15,318.50 Ave. \$1.77/yd³
Outslope costs include 4,142 feet of Ripping.

Table 6
DRAIN CONSTRUCTION COSTS¹
Unit 86-5

Road Station Number	Quantity: No. of Drains	Linear Ft. of Drain	Contract Bid Cost	ACTUAL EQUIPMENT HOURS:			HERE:		Production Rate Linear Feet/hour	\$ Saved (contract vs. hourly)	OR	\$ Lost
				D8 (\$100)	980B (\$100)	1450 (\$75)	Total Cost	Unit Cost Per Linear Foot of Drain				
0 + 00	1	33	\$20.00	1.0	1.0	0.5	\$237.50	\$7.20	13	\$217.50		-. -
9 + 38	5	217	214.00	1.5	3.0	-. -	450.00	2.07	48	236.00		-. -
21 + 41	7	355	268.00	3.0	3.0	2.0	750.00	2.11	44	482.00		-. -
44 + 47	3	159	642.00	2.5	2.5	2.5	687.50	4.32	21	45.50		-. -
50 + 53	3	147	214.00	1.0	0.5	1.0	225.00	1.53	59	11.00		-. -
51 + 60SW	3	88	214.00	-. -	0.5	-. -	50.00	.57	176	-. -		164.00
62 + 45	2	128	214.00	1.0	1.0	-. -	200.00	1.56	64	-. -		14.00
67 + 61	8	653	642.00	4.5	4.5	4.5	1,237.50	1.90	48	595.50		-. -
95 + 25	3	134	214.00	1.0	1.0	2.0	350.00	2.61	34	136.00		-. -
105 + 22	2	84	214.00	1.0	1.0	1.0	275.00	3.27	28	61.00		-. -
109 + 81	1	63	107.00	-. -	0.5	0.5	87.50	1.39	63	-. -		19.50
135 + 04	16	710	1,284.00	7.0	6.5	6.5	1,837.50	2.59	36	553.50		-. -
12 work- sites	54 Drains	2,771 Linear Feet of Drain	\$4,247.00 Average: \$1.53 per foot of drain	23.5 Hrs. 34%	25 Hrs. 36%	20.5 Hrs. 30%	\$6,387.50 Total Hours - 69	\$2.31 per linear foot of drain	40 feet of drain per hour	Saved \$2,140.50		

**RNP Estimate - \$6,049.75 average \$2.18/ft. of drain

¹Drain construction costs include linear feet of crossroad drains, inboard ditch improvements and spring drains, and 5,645 feet of road ripping.

Table 7
MISCELLANEOUS COSTS
Unit 86-5

Category	ACTUAL EQUIPMENT HOURS:			HERE:
	D8 (\$100)	980B (\$100)	1450 (\$75)	Total Cost
Travel	2.0	1.5	--	\$350.00
Down ¹ and Helping	2.5	3.5	2.5	787.50
TOTALS -	4.5 hrs.	5.0 hrs.	2.5 hrs.	\$1,137.50

¹There were two full days at the beginning of equipment work when the 980B excavator was broke down. Both the D8 and 1450 (operators) were shut down and helping with repairs. On an hourly equipment rental site, the project supervisor would normally continue to work both bulldozers while the excavator was down. Therefore, the 20 hours of down time per each piece of equipment is not included in this table.

Labor Intensive Phase

The labor intensive phase involved only one task which was the distribution and application of straw mulch. Costs are shown in Table 8. Straw mulch was applied to the entire M-3-1-2 haul road, except road sections that were ripped and drained. The total area disturbed by rehabilitation efforts was 13 acres, and a 6000 lbs/acre straw mulch application rate was prescribed due to the moderate to steep finished slopes along outsloped road reaches and at stream headwater excavations. The total number of straw bales used on the unit was 1,105 bales. The contract did not include any straw related bid items.

Straw bales were distributed by Redwood National Park (RNP) and Youth Conservation Corp (YCC) labor crews, totalling 428 person hours and costing \$3,444.82, with a unit cost of \$3.12 per bale. The distribution of 1,105 bales took 10 days to complete. Distribution involved some brush cutting on top of each cutbank stockpile location, then the bales were either manually hauled up to the top or the boom truck or backhoe was used to place bales on much higher cutbanks. This was done so the bales would be out of the way of all contract work and would therefore not have to be moved by the contractor. The bales were distributed in stockpiles of 5-30 bales placed every 50-150 feet along the haul road.

Redwood National Park (RNP) and Redwood United Inc. (RUI) labor crews were responsible for spreading the straw, totalling 755 person hours and costing \$7,216.05, with a unit cost of \$6.53 per bale. The spreading of 1,105 bales took 11 days to complete. The higher than normal application costs on this unit is probably due to longer walk-in distances (3 miles round trip on some days), and in numerous locations the crews had to move the bales, from the stockpile, 50-100 feet along steep outsloped road sections.

The total cost for straw mulch on Unit 86-5, including acquisition, distribution and application, was \$14,174.77, involving 1,183 person hours, with a total unit cost of \$12.83 per bale.

Documentation Phase

Following completion of the erosion control phase, the work was surveyed where needed, photo points were retaken, cost data was compiled, and the annual report was prepared. Total cost of this phase was \$1,725.70. Work was done by L. Johnson, and was completed by December, 1987.

Table 8
LABOR INTENSIVE COSTS
Unit 86-5

Work Types	Type of Laborers	Person Hours	Cost	Total Cost	Quantity	Cost/Quantity	% of Total
<u>SECONDARY TREATMENTS:</u>							
Straw Acquisition	--	--	--	\$3,513.90	1,105 Bales	\$3.18/Bale	25%
Straw Distribution	RNP	253	\$2,858.57	3,444.82	1,105 Bales	3.12/Bale	24%
	YCC	175	586.25				
Straw Application	RNP	525	5,753.45	7,216.05	1,105 Bales	6.53/Bale	51%
	RUI	230	1,462.60				
TOTALS -	RNP	778		\$14,174.77	1,105 Bales	\$12.83/Bale	
	YCC	175					
	RUI	230					
		<u>1,183</u>	Person Hours				

**Wages used to determine costs are 1987 wages including benefits.
All person hours and costs include round trip travel time.

CONCLUSIONS

In general, watershed rehabilitation heavy equipment contracts are likely to cost more than work done under hourly rental agreements. First of all, contracts take considerably more government personnel time to prepare than do rental sites. On this contract approximately \$2,900.00 was spent on contract preparation, over and above what would be spent to prepare a rental site. The contract preparation cost for this unit is much lower than costs have been in the past due to better standardization of contract terminology and layout. The bids and final cost are likely to be higher than the inhouse cost because the contractor must shoulder the responsibility for managing the work. The cost of bid and performance bonding will also tend to keep bid prices high.

Comparing the final heavy equipment contract cost with the HERE cost, the government could have saved \$15,173.00 by doing the unit under hourly rental agreement. Table 2, Summary of Average Costs of Heavy Equipment Costs, shows the government's savings and losses per job category.

However, the park can learn more efficient techniques or uses of equipment from contractors. They are inspired to work at peak efficiency and are free to try whatever methods seem appropriate. Also, having the contractors in charge allows them to use the most efficient piece of equipment for a task. Often the operator knows long before an observer when his piece of equipment is no longer at peak efficiency, and adjustments in the plan of attack can be made as soon as possible.

WK Construction did an excellent job on the M-3-1-2 contract, due, in part, to the operator's and contractor's years of experience doing watershed rehabilitation work. All worksites were completed to and beyond the technical specifications and COR expectations, showing how much pride the operators had in completing their work, which was greatly appreciated. Not one problem arose with the contract technical specifications, plan sheets, or on ground situations.

ABBREVIATIONS

CSP = Color Stereo Pair
B/W = Single B/W Photo
Color ASA 64 Kodachrome
B/W ASA 400 Tri-X
Pre-pp 7-2-86
Post-pp 11-5-86
All 35 mm lens
All CSP B/W

UNIT 86-5
M-3-1-2 ROAD
PHOTO POINT LOCATIONS AND DESCRIPTIONS

PHOTO POINT NUMBER	SITE LOCATION: STATION NO.	DESCRIPTION:
1	0 + 00 OS 0 + 28	Taken mid-road looking upstation to OS 0 + 28. Stake on Cutbank; Nail with flag in mid-road. Scale mid-road in outslope section.
2 A/B	6 + 60 OS 0 + 28	Taken mid-road between tire tracks looking downstation (A) and upstation (B). Stake on rotten stump above cutbank. Scale mid-road both directions.
3	11 + 55 XRD 9 + 38	Taken from rocky cutbank looking downstation. Stake on cutbank. Scale mid-road.
4	14 + 39 XRD 13 + 34	Taken from charred redwood stump on outboard edge of road looking downstation. Stake on stump. Scale mid-road.
5 A/B	18 + 00 16 + 37	Taken from a redwood stump on outboard edge of road looking OS downstation (A) and upstation (B). Stake in stump. Scale mid-road.
6	26 + 25 XRD 26 + 64	Taken from a dougfir stump on outboard edge of road looking upstation. Stake on stump. Scale mid-road at the XRD.
7	34 + 20 BOS 34 + 53	Taken from top of cutbank looking upstation. Stake on cutbank. Scale mid-road. (Also taken from mid-road looking upstation.)
8	38 + 75 BOS 39 + 68	Taken from top of cutbank looking upstation. Stake on cutbank. Scale mid-road.
9	47 + 25 XRD 45 + 95	Taken from stake on cutbank looking downstation. Scale mid-road by XRD.
10	48 + 75	Taken from stake on cutbank above the right bank of the TOS. View looking up-station. Scale in Thalweg.
11	55 + 00 OS 55 + 00	Taken from a stump on the outboard edge of the road looking upstation. Stake in stump. Scale mid-road.

PHOTO POINT NUMBER	SITE LOCATION: STATION NO.	DESCRIPTION:
12	60 + 70 TOS 59 + 40	Taken by the stake on the cutbank slope looking downstation. Scale mid-road.
13	64 + 50 TOS 64 + 09	Taken by a staked redwood sprout at the BOTTOM of the TOS fill cone at the CTH stake looking up the culvert downspout. Scale on outboard edge of road.
14	65 + 15 TOS 64 + 09	Taken from the stake on top of cutbank (on a skid trail LB) looking downstation. Scale mid-road.
15	68 + 50 OS 66 + 00	Taken from a rotten log above the inboard ditch frog pond by a burnt snag looking downstation. Stake on log. Scale mid-road near XRD 68 + 00.
16	78 + 15 OS 77 + 00	Taken mid-road looking upstation. Stake is nailed to an old-growth redwood tree on the outboard edge of road. Scale mid-road.
17	88 + 00 OS 77 + 00	Taken mid-road looking downstation. Stake is on a stump on outboard edge of road 10 feet away. Scale mid-road.
18	90 + 50 BOS 88 + 88	Taken from the stake half way up the cutbank looking downstation. Scale mid-road.
19	93 + 04 BOS 91 + 40	Taken from the stake half way up the cutbank looking downstation. Scale mid-road.
20	107 + 75 BOS 107 + 10	Taken from base of cutbank, near a log, looking upstation. Stake in log on cutbank. Scale mid-road.
21	112 + 25 TOS 112 + 36	Taken on the rocky cutbank slope looking upstation. State on cutbank. Scale mid-road.
22	117 + 55	Taken from stake on cutbank slope looking downstation. Scale mid-road.
23 A/B	117 + 40 (A) BOS 115 + 45 and SX-1 (B) OS 117 n+ 62	Taken from a stump on outboard edge of road, stake in stump. (A) looking downstation and up towards SX 1 (115+19) channelization. View (B) is looking upstation. Scale mid-channel on (A) and mid- road on (B).
24	124 + 25 Outslopes and Total Outslopes	Taken from the stake on a rock outcrop on the cutbank slope (above the FTH) looking downstation. Scale mid-road.
25	123 + 40 TOS 123 + 34 OS 124 + 00	Taken from the stake on the cutbank slope looking upstation. Scale mid-road.

PHOTO POINT NUMBER	SITE LOCATION: STATION NO.	DESCRIPTION:
26	133 + 45 TOS 132 + 65	Taken from the stake on the cutbank slope looking downstation. Scale mid-road.
27	151 + 30	Taken from the stake on a skid trail, above the inboard ditch, looking downstation. Scale mid-road by XRD.
22*	117 + 72 BOS 115 + 72	Taken from the BOTTOM of excavation in the thalweg looking up channel. Flagged location only. Post Photo Point Only. Scale mid-channel.

UNIT 86-5 M-3-1-2 ROAD AND SLOPE
UNIT 87-5 M-3 AND M-4 ROADS AND SLOPE

MAP D: EROSION FEATURES AND REHABILITATION TREATMENT MAP

L. JOHNSON

LEGEND:

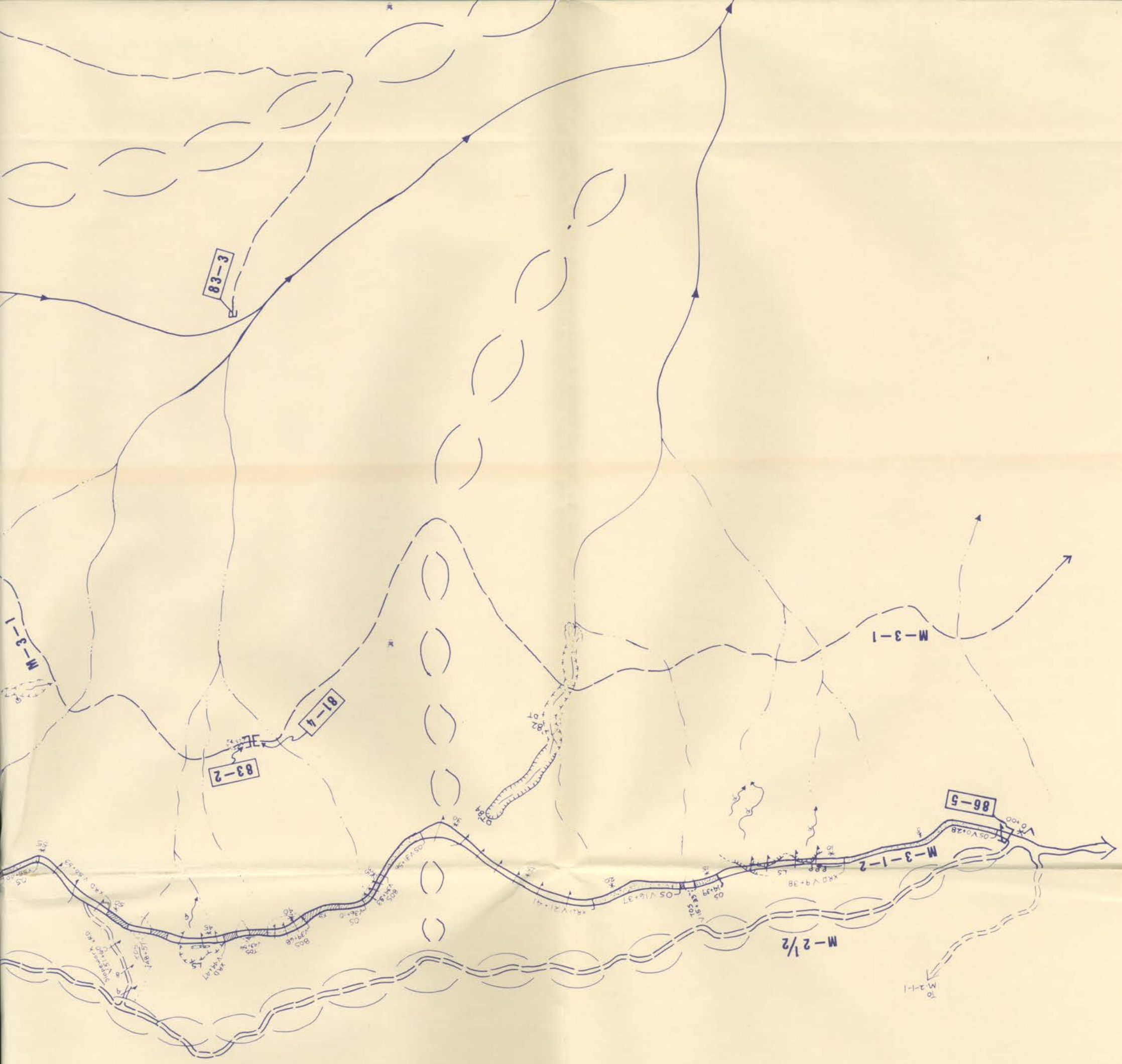
Scale: 1: 6000

- Drainage
- Major Ridge
- Scarp, inactive
- Scarp, active
- Toe feature
- Rill (R), Gully (G)
- Spring, Seep
- EF, LS, DT Earthflow, Landslide, Debris torrent
- FF, CBF Fill failure, Cutbank failure
- Haul road
- Secondary haul road or skid trail



REHAB TREATMENTS:

- XRD V 9+38 Rip and Drain (XRD)
- OS V 16+37 Outslope (OS)
- Fillsite (FS)
- TOS V 57+47 Total Outslope (TOS)
- BOS V 39+68 Bench Outslope (BOS)
- Rx V 166+04 Haul Road Stream Crossing Excavation (RX)
- Skid Trail Stream Crossing Excavation (SX) and access trail
- Photo Point Location and Number









Unit: 86-5 Date: 7-2-1986, PP5B, M-3-1-2 STA 18+00 pre HE upstation outslope, 35mm, (LEJ)



Unit: 86-5 Date: 11-12-1986, PP5B, M-3-1-2 STA 18+00 post HE, 35mm, (LEJ)



Unit: 86-5 Date: 7-2-1986, PP12, M-3-1-2 STA 60+70 TOS 59+40 pre HE, 35mm, (LEJ)



Unit: 86-5 Date: 11-12-1986, PP12, M-3-1-2 STA 60+70 TOS 59+40 post HE, 35mm, (LEJ)



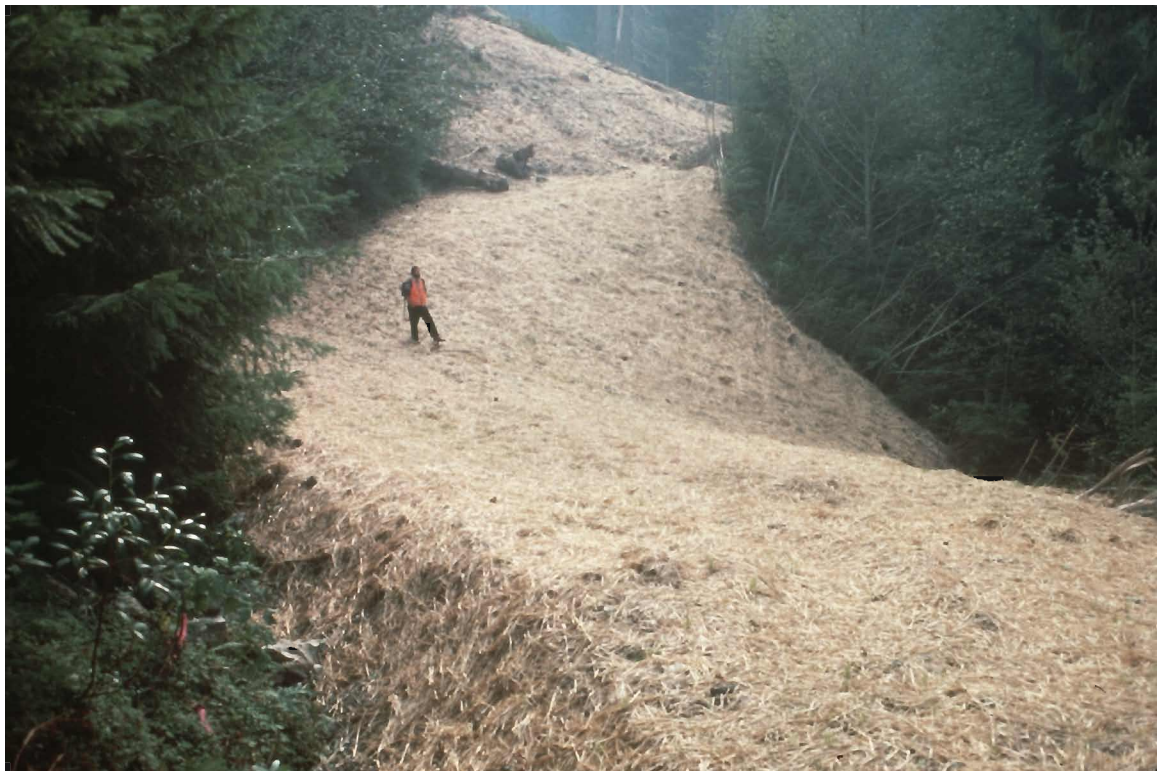
Unit: 86-5 Date: 7-2-1986, PP17, M-3-1-2 STA 88+00 pre HE outsloping, 35mm, (LEJ)



Unit: 86-5 Date: 11-12-1986, PP17, M-3-1-2 STA 88+00 post HE outsloping, 35mm, (LEJ)



Unit: 86-5 Date: 7-2-1986, PP21, M-3-1-2 STA 112+25 TOS 112+36 pre HE, 35mm, (LEJ)



Unit: 86-5 Date: 11-5-1986, PP21, M-3-1-2 STA 112+25 TOS 112+36 post HE, 35mm, (LEJ)



Unit: 86-5 Date: 7-2-1986, PP24, M-3-1-2 STA 124+25 OS looking down sta. pre HE, 35mm, (LEJ)



Unit: 86-5 Date: 11-5-1986, PP24, M-3-1-2 STA 124+25 OS looking down sta. post HE, 35mm, (LEJ)