

SUMMARY REPORT

LOWER D-LINE ROAD AND SLOPE
REHABILITATION UNIT 82-5

Resource Management Division
Redwood National Park

by
W. David Burns
and
Paul Routon

February 1983

TABLE OF CONTENTS

	<u>Page</u>
Introduction	1
Unit Description	1
Land Use History	3
Erosion History	3
Erosion Features: 1962-70	3
Erosion Features: 1971	3
Erosion Features: 1972	3
Erosion Features: 1973	5
Erosion Features: 1974	5
Erosion Features: 1975-81	9
Erosion Features: 1982	9
Erosion Control Rehabilitation Work	9
Introduction	9
Procedures	9
Objectives	11
Cost Summary	13
Heavy Equipment Phase	13
Heavy Equipment Application	13
Heavy Equipment Sequencing	13
Heavy Equipment Costs	17
Heavy Equipment Secondary Treatment	24
Evaluation of Heavy Equipment Application	24
Labor Intensive Phase	25
Labor Intensive Application	25
Labor Intensive Costs	26
Evaluation of Labor Intensive Application	28
Discussion and Conclusion	28

LIST OF ILLUSTRATIONS

	<u>Page</u>
Figure 1. Rehabilitation Site Location Map	2
Figure 2. Erosion Features Map, 1972	6
Figure 3. Erosion Features Map, 1974	7
Figure 4. Erosion Features Map, 1982	10
Figure 5. Erosion Control Work Location Map	14
 Plate 1. Aerial Photograph of the Southern Portion of Rehabilitation Unit 82-5. Taken March 7, 1972	 8
 Table 1. Sequence of Rehabilitation Work Phase on Unit 82-5, Lower D-Line	 12
Table 2. Summary Costs of Erosion Control Work on Lower D-Line, 82-5	15
Table 3. Summary of Heavy Equipment Types and Costs	16
Table 4. Summary of Average Costs of Heavy Equipment Treatments . .	18
Table 5. Summary of Haul Road and Skid Trail Excavation Costs . . .	20
Table 6. Summary of Slope Site Costs	21
Table 7. Summary of Landing Costs	22
Table 8. Summary of Road Removal Costs	23
Table 9. Summary of Labor Intensive Treatment Costs	26
Table 10. Analysis of Cost/Hour for Laborers	27

INTRODUCTION

Unit Description

Rehabilitation Unit 82-5 is located in the southeast portion of Redwood National Park between the K & K Road and Redwood Creek (Figure 1). The unit encompasses portions of two intermittent drainages which drain directly into Redwood Creek.

Total relief within the hydrologic unit is about 2,240 feet from Redwood Creek (1,160 feet elevation) to Bald Hills Ridge (3,400 feet elevation). Relief within the rehabilitation unit ranges from about 1,160 feet to 1,600 feet. Generally, slopes within the rehabilitation unit are moderately steep (25-40 percent) with a mean slope of about 32 percent. Localized slopes range from very gentle (<5 percent) to very steep (>100 percent). Drainage and aspect are WSW.

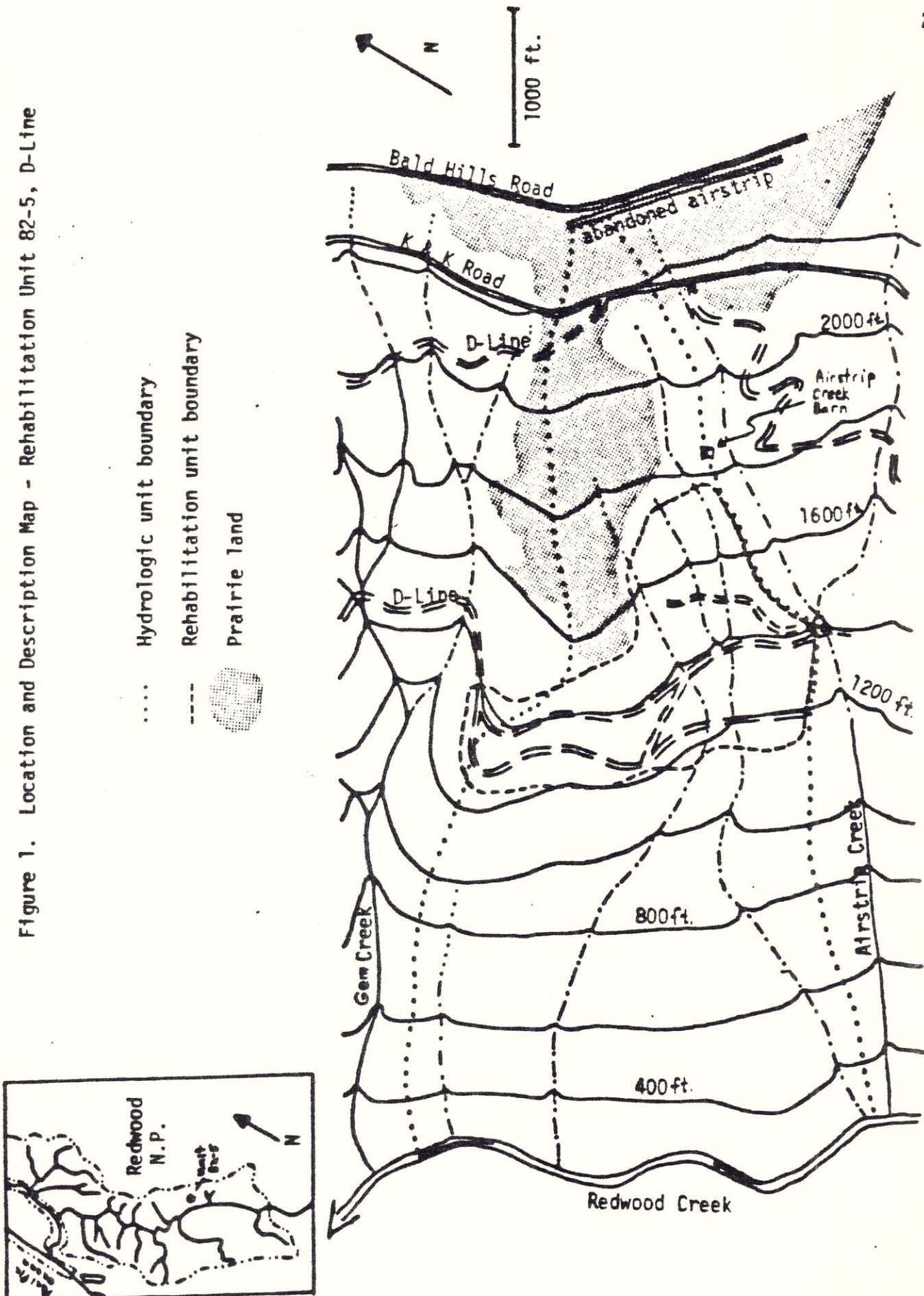
Physiographically and vegetatively, the hydrologic unit is divisible into two types: prairie and conifer forested lands (Figure 1). Prairie is naturally occurring grassland devoid of trees. Topographically the prairies are highly irregular and composed of alternating steep slopes and gentler benches. This staircase-like topography (tread and riser) and hummocky ground indicate some form of mass-movement processes (e.g. slumping or earthflowage) is, or has been, active on these areas. Stream channels on the prairies are only slightly incised if at all. The causes for the existence of this prairie land, whether geologic, pedologic, hydrologic, geomorphic, vegetative succession, or combinations of factors are not known.

The prairie land is a part of Childs Hill Prairie and is in the northeast portion of the hydrologic unit upslope of the forest land. Of the 324 acres of land within the hydrologic unit about 15 percent is prairie with the remainder forested by redwood and Douglas-fir. About 28 percent of the forest land has been clearcut harvested within the last 12 years. The remaining forest is primarily lush old growth redwood and is adjacent to Redwood Creek downslope of the cutover land.

Vegetation within the cutover land is largely brush, ~~and~~ young fir, and redwood. The streams within this area have been severely disrupted such that some channel reaches are well incised and similar to the natural condition while other reaches are not definable. Local topography of the prairie and old growth tends to be somewhat smooth while that of the cutover land is harsh and contrasting due to the high density of roadways and erosion features there.

The rehabilitation unit is composed of about 73 acres of cutover land of which about 95 percent lies within the hydrologic unit, the remainder being an extension of roadway at the northern tip of the unit. The entire hydrologic unit was geomorphically mapped during the winter of 1982 at a scale of 1:2,200 (see detailed geomorphic map).

Figure 1. Location and Description Map - Rehabilitation Unit 82-5, D-Line



LAND USE HISTORY

Prior to 1971, unit 82-5 supported a dense stand of old growth redwood and Douglas-fir trees. During 1971 the entire unit was clearcut utilizing tractor logging methods which resulted in a dense network of skid and haul roads and extensive stream channel disruption. Haul roads consisted of a reach which extended from the D-Line and traversed the hillslope along the lower portion of the site, a middle road which extended diagonally upslope to a switchback, and an upper haul road extending diagonally upslope from the switchback (Figure 2). During the 1971-72 winter, considerable surface erosion and mass movement occurred on the site rendering the lower haul road impassable. Subsequently, a new road reach was constructed in 1972 which connected the D-Line to the middle haul road (Figure 3). Land use within the unit after the 1971 clearcut appears to have been restricted to seasonal haul road repair and equipment travel for harvest activity adjacent to Airstrip Creek and Counts Hill Prairie. Little land use occurred within the site after 1975.

EROSION HISTORY

The following section describes the recent erosion history of the site. The information was obtained from aerial photographs taken in 1962, 1966, 1968, 1970, 1972, 1973, 1974, 1975, 1977, 1978, and 1981. On site mapping occurred during the winter of 1982. A combination of severe drainage disruption and the occurrence of two major storms during 1972 played a major role in the erosional evolution on the site following timber harvest.

Erosion Features: 1962-70

The 1962-70 photographs indicate that the site supported a predominantly old growth redwood/Douglas-fir forest undisturbed by land use activity. The old growth canopy inhibits analysis of surface erosion and does not suggest recent mass movement features.

Erosion Features: 1971

The 1971 photographic coverage is limited to approximately the upper two-thirds of the site. Harvest activity was ongoing and involved most of the site as of July when the photos were taken. The site, most likely, was completely logged by the end of the 1971 harvest season. Erosion features other than harvest disturbance are not evident.

Erosion Features: 1972

The 1972 photo flight was flown several days after the second major storm of 1972 and site coverage is incomplete. Fortunately, most of the site was photographed with portions of the northern and western sections not covered. By March, when the photographs were taken, the site had undergone severe channel disruption and surface erosion. Stream channel disruption was largely due to multiple haul and skid road crossings. Also, portions of

channel were used as skid road ways and as fill sites for road excavations and logging slash. Each of the three major drainage channels within the site was affected by multiple diversions resulting in gully formation, ponded water, and areas of water saturated hillslope. Diversions are typically associated with haul road crossings where culverts plugged or were never placed in crossings, or where inboard ditches plugged and diverted water across road.

Channel "a" had approximately 23 skid road crossings above the lower haul road, some massive; four secondary haul road crossings; one landing; and sections of channel were clogged with road fill and logging slash. There were three diversions from this channel: 1) up-channel of SX-1 a diversion followed a skid road adjacent to the channel for approximately 200 feet before re-entering the channel at SX-2; 2) at the intersection of the channel and SX-5 the water was diverted down the inboard ditch to the switchback between the middle and upper haul roads. The water crossed the road and formed a braided gully system leading downslope across L-3; and 3) the inboard ditch along the lower haul road intercepted drainage a short distance down road of RX-5 past RX-4, and included the drainage that occurred in channel "a" below L-2. Downroad from RX-4, the inboard ditch plugged and diverted water across the road resulting in a downslope gully through the old growth forest.

Channel "a" disappeared for about 300 feet where L-2 was constructed, then reappeared for about 100 feet between L-2 and the lower haul road. The 100 feet of channel above the lower haul road was very disfigured due to multiple skid road crossings and fill/slash storage. Photo coverage is not available below the lower haul road.

Channel "b", prior to timber harvest, joined channel "a" in the vicinity (100 feet below) L-2. On channel "b", there were approximately 20 skid road crossings, 3 haul road crossing, and sections of channel were clogged with road fill and slash. Where the channel intersects SX-4 the drainage was diverted along the upper haul road forming two parallel diversion gullies, possible occurring from the same storm event but probably at different times. One diversion flowed down the inboard ditch and joined with the diversion from channel "a" at SX-5 to continue diverting down the inboard ditch. The other diversion gullied along the outside of the road prism, bypassed channel "a" over the road fill, and diverted approximately 200 feet downroad creating a large gully above L-2. Where the gully intersected L-2, a large alluvial fan, multiple small gullies and rills developed on the landing and diverted flow downslope to the large gully on L-3 where the second diversion from channel "a" and the upper diversion of channel "b" emptied.

Channel "c", approximately 200 feet below the origin of easily definable channel (the boundary between the prairie and conifer forest), is covered by L-1 for about 200 feet. The channel reappears below the landing for about 150 feet with skid roads on both side then is undetectable under a melange of skid roads, haul roads, and debris for the remainder of the site. Drainage from channel "c" became braided rills diverting across L-1 then entered the inboard ditch along the upper haul road between L-1 and SX-4. Water from the inboard ditch was diverted across the upper haul road

immediately uproad of SX-4 and entered channel "b". The diverted drainage followed channel "b" downslope and again diverted, this time along the inboard ditch of the middle haul road. About 60 feet uproad of channel "b" the inboard ditch plugged and the water routed at several places along the road and downslope, primarily gullying along a downslope skid road. This drainage diversion crossed the lower haul road at RX-5 and initiated an active gully which was responsible for the falling of number of old growth redwood (Note Plate 1).

Seeps and springs intercepted by roads added to the numerous smaller water diversions on the site.

Erosion Features: 1973

Because of a missing photograph, stereo view was not possible for this year. It appears that the slide off L-4, and the slide dividing the lower haul road had occurred. These two slides probably occurred in 1972 during one of the two major storms of that year, however, there is no photographic coverage of either slide area in 1972. The road reach connecting D-Line to the middle haul road, which bypassed the slide across the lower road, was constructed prior to June 1973 when the photo was taken. The erosion pattern generally seems the same as in 1972. An indepth analysis of erosion features is not given due to the lack of stereo view.

Erosion Features: 1974 (Note Figure 3)

Several new diversions had occurred since 1972. All involve new water routes from previous diversions and appear to be related, for the most part, to corrective work on the haul road where water was again routed along inboard ditches.

In 1972, water from channel "a" flowed down the inboard ditch at SX-5 to the switchback between the upper and middle haul roads, then down slope. By 1974, water from channel "a" had diverted again, this time to a gully formed during 1972 by water diverted from channel "b". This diversion, about 75 feet uproad of SX-5 diverted flow down slope across L-2 and eventually to the large gully on the downroad end of L-3.

Channel "b", which in 1972 was diverted along the upper haul road in two places, both gullying through L-3, was rediverted by 1974. This new diversion entered channel "a" at the outboard edge of SX-5 and followed the channel to L-2. At L-2 the water was diverted in two directions. One diversion went down the inboard ditch of the middle haul road towards RX-3. From the inboard ditch, water was diverted again in two places across the road, one about 90 feet uproad of channel "b" and the other at RX-3. Both of these diversions across the middle haul road intersected downslope above RX-5 of the lower haul road. Below RX-5 the watercourse remained the same as in 1972. The other diversion at L-2 crossed the landing in two places, both ultimately entering channel "a" above the lower haul road and intersecting the diversion extending downroad from RX-5 past RX-4.

Figure 2. Erosion Features 1972 - Rehabilitation Unite 82-5.

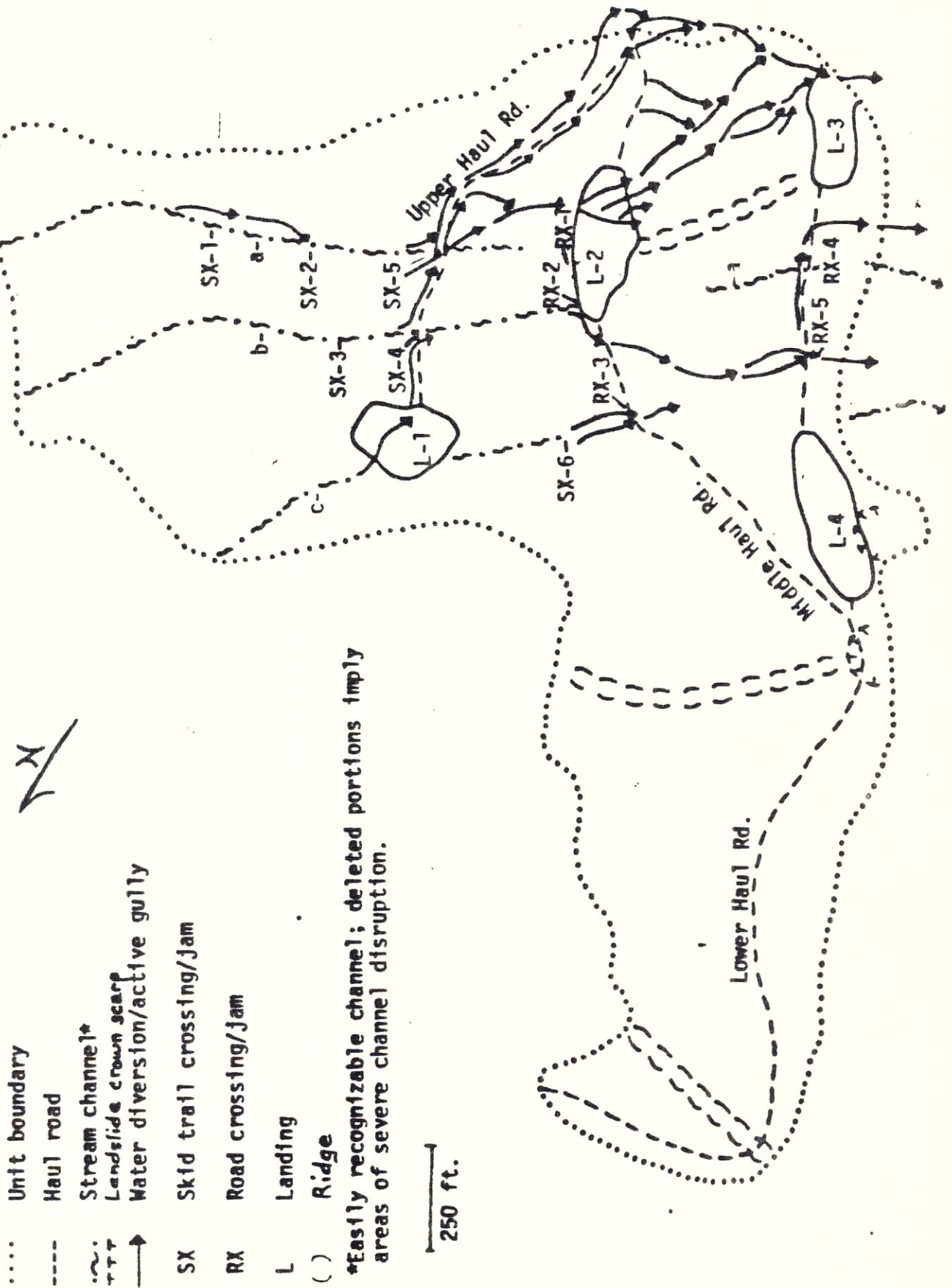
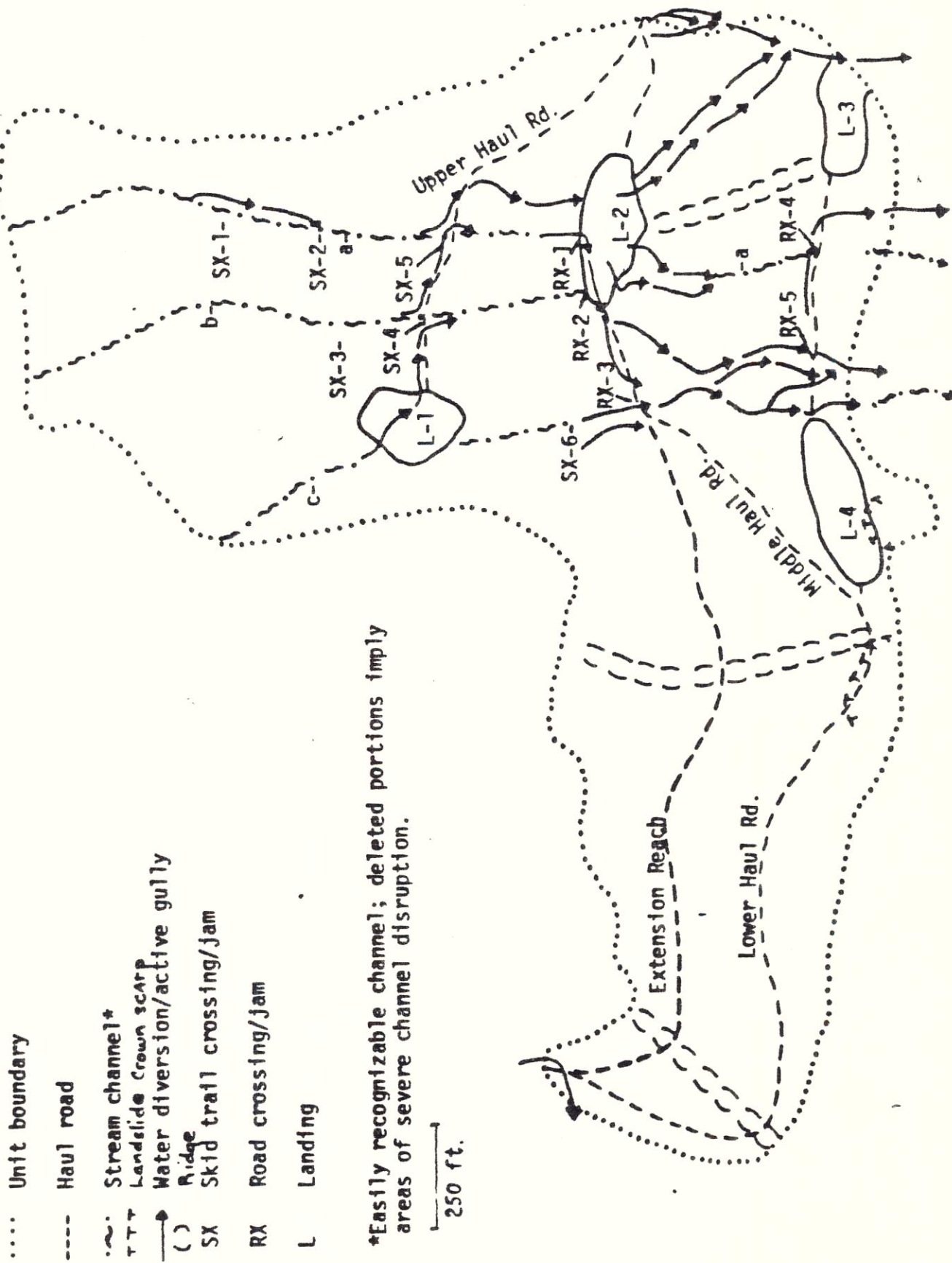


Figure 3. Erosion Features 1974 - Rehabilitation Unit 82-5.



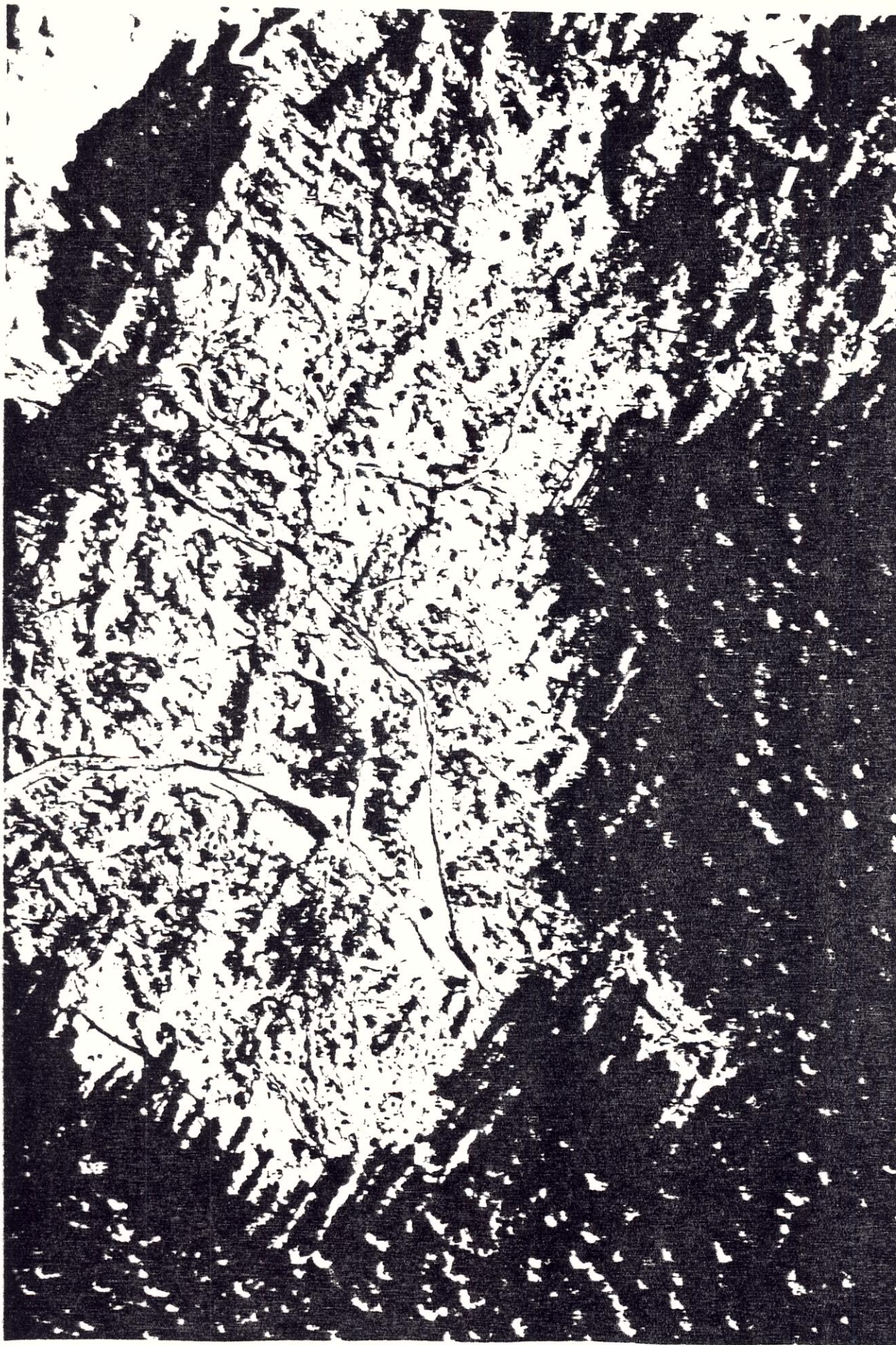


Plate 1. Air Photograph of the southern portion of rehabilitation unit.
Taken 3-7-72.

Channel "c" did not appear to have changed course since its initial diversions in 1972, however, erosion activity of the diversion channels, as was typical of the site, was considerable.

Erosion Features: 1975-81

During this time period the drainage pattern within the unit was largely unchanged. Diversion channels remained active and roadways continued to deteriorate with the exception of the middle haul road. The road reach had been bladed for access to the Airstrip Creek rehabilitation site in 1978 and stayed fairly intact through 1981. Generally, the vegetation growth was good through this time period except on roadways, in active gullies, and on mass movement scars.

Erosion Features: 1982

In the spring of 1982, field evaluation of the rehabilitation unit began. Erosion features were mapped on an enlarged 1978 air photograph at the scale of 1:2,200 (see detailed map). Figure 4 shows the more prominent erosion features during this time (see Figure 5 for complete site locations).

Channel diversions remained virtually unchanged since 1974, however, diverted channels had enlarged. Roadways and landings continued to deteriorate, especially along the lower haul road (R-1, R-4) and the outer end of the middle road (L-2) where the roads traverse steep slopes. On one portion of R-1, between RX-4 and RX-5, several approximately 16 inch scarps developed traversing the roadway. Along R-4, recent tension cracks with minor failure extend the length of the reach on the fill side of the road. Both L-2 and L-4 were still actively failing at the time of mapping. One scarp adjacent to the 1972 debris avalanche on L-4 was approximately 10 feet high. The active gully below RX-5 has enlarged significantly, continuing to fall old growth redwood trees, and eroding approximately 1,260 cubic yards of material (Alpert, 1982 pers. comm.). In the vicinity of SS-1 a large persistent landslide (slump) had developed, crown scarp approximately 4 feet high with sag ponds and multiple channel diversions. Another slump occurred at the junction of R-2 and R-3 of moderate size. The body of the slide was saturated and channel "c" flows across it. Along the ridge between channel "a" and L-3 several en echelon tension cracks and scarps were observed. Further advanced study, beyond the scope of this report, is required to assess the relationship of these features with the rest of the scarps features on the unit.

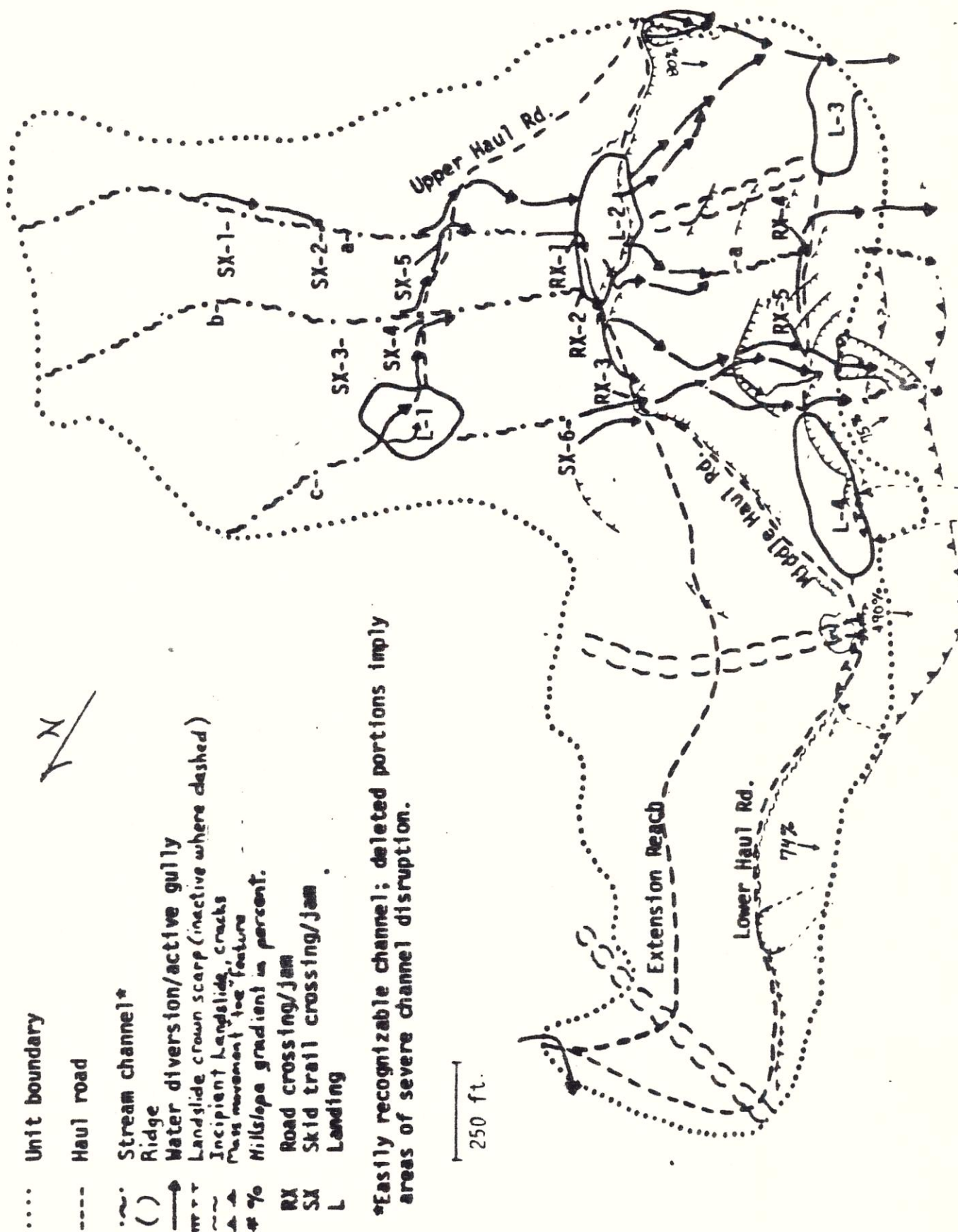
EROSION CONTROL REHABILITATION WORK

Introduction

Procedures

The method of approach to the rehabilitation work passes through four sequential phases: evaluation, heavy equipment, labor intensive, and winter maintenance. The evaluation phase begins with the selection of the hillslope and roads which are encompassed by the proposed rehabilitation

FIGURE 4. EROSION FEATURES: 1982 REHABILITATION UNIT 82-5.



unit. This is followed by aerial photograph interpretation and field reconnaissance of road conditions and erosion problems. Detailed field mapping of geomorphic, erosional, and land use features is then accomplished during the rainy winter months. Included during this period is the evaluation of erosion potential at possible worksites. The final portion of the evaluation phase is the prescription of treatments to be performed to reduce erosion, remove sediment sources, and correct drainage patterns. This entails identifying worksites, formulating a sequence of work, and documenting pre-work conditions by establishing photo point locations. After evaluation, a projection of cost is made and rental of equipment is procured.

The heavy equipment phase involved actual site specific erosion-control work by heavy equipment. The principal function was to excavate potential sediment sources, correct channel diversions, and to distribute rock rip-rap for channel protection at site specific locations.

The principal task of the labor intensive phase involved spreading a straw cover over bare ground to reduce surface erosion from raindrop impaction and to help retain soil moisture. Also, minor rock repositioning in channels is required following the placement with heavy equipment. A team of laborers were used for these distribution efforts.

Following the labor intensive phase during the fall and early winter months, winter maintenance was performed to correct problems developing from the first storm runoffs. Partly congruent at this time is the analysis of work performed and writing a summary report. Table 1 lists the sequence of the phases as performed on the lower D-Line unit, 82-5.

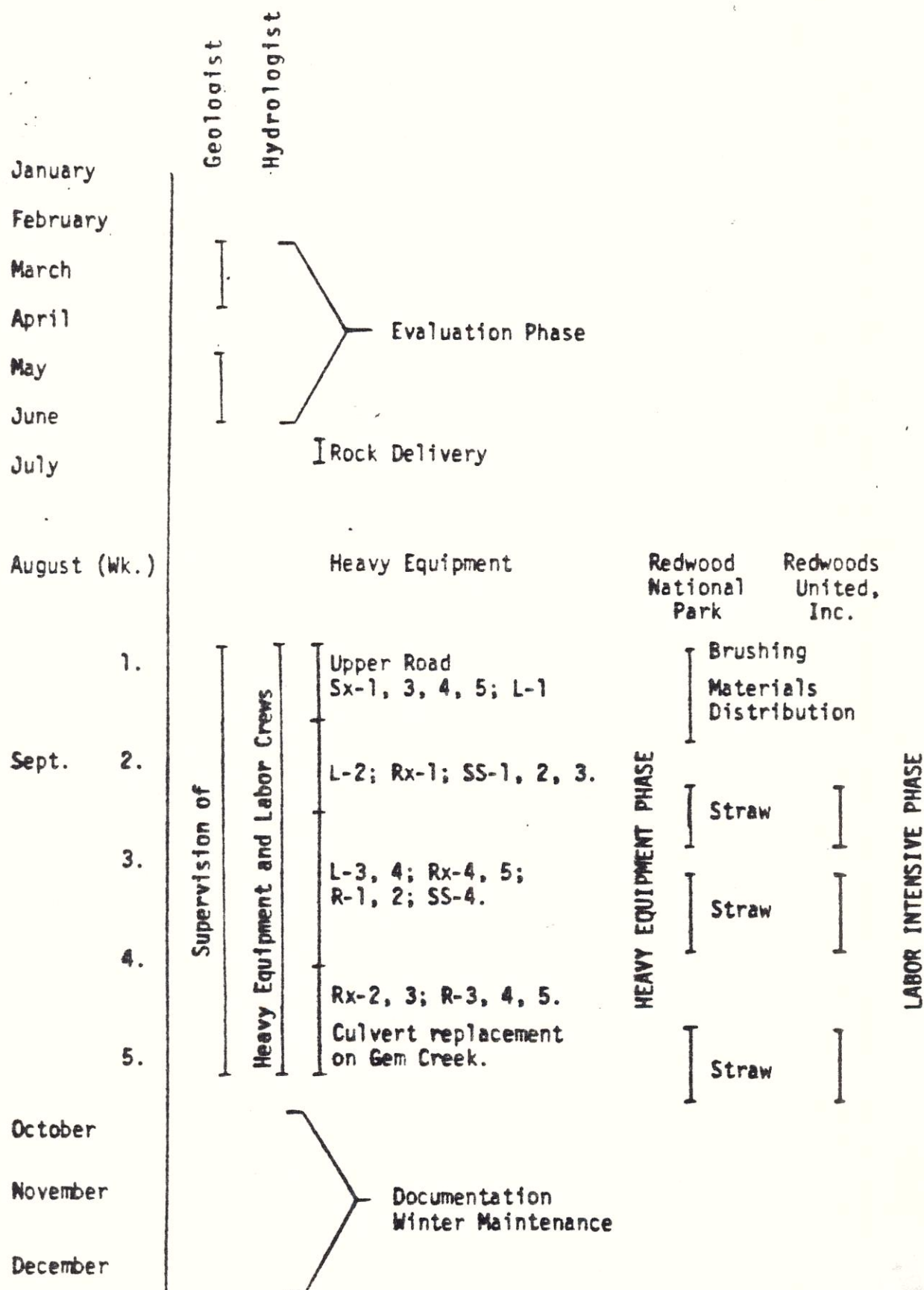
Objectives

The overall objective of rehabilitation work on this unit was to mitigate hillslope erosion induced by past land use practices. The success of this task required the stabilization of potential and active mass-movements on landings, road segments, and hillslope regions; the removal of haul road and skid trail stream crossings; and the reduction of gully erosion. Primary emphasis was the rehabilitation of the severely impacted channel network. The rehabilitation of the channel network required the excavation of road fill from stream crossings at several locations on the lower, middle, and upper roads including across a landing. Also requiring the construction of small drainage ditches and the channelization of a stream reach through the mid-hillslope region.

The objective in constructing the small drainage ditches was to drain exfiltrating areas, correct flow diversions often terminating in hillslope fractures, and direct water along the channel network. The rehabilitation of the channel network will increase slope stability by reducing pore pressure, weight, and gully erosion.

Along much of the lower road and outer edge of the middle road, the objective was to move road fill (outslope) that contributed to overloading and instability of the steep hillslopes, particularly in areas where landings were built. Outsloping the lower road was a priority since over 75 percent of the road had failed or was in the process of failing at the time of mapping, thus endangering the old growth forest below.

Table 1. SEQUENCE OF REHABILITATION WORK PHASE ON UNIT 82-5,
LOWER D-LINE ROAD.



Cost Summary

Table 2 summarizes the costs involved in performing the erosion control rehabilitation work on this unit. Approximately 4 percent of the total cost was entailed during the evaluation phase of mapping erosional features and prescribing erosion control treatments. About 83 percent was spent in implementing the erosion control work with heavy equipment, and the remaining 8 percent was spent in labor intensive secondary treatment work.

Heavy Equipment Phase

Heavy Equipment Application

The heavy equipment used on this unit consisted of two crawler tractors (D-6D, D-7G), and hydraulic excavator (JD-690), and a track loader (955K). All of the equipment had excellent operators and performed very well; however, the loader operator was very new to the types of situations his machine was confronted with. The excavator and both dozers were acquired from another rehabilitation unit completed just prior to the initiation of work on this unit. Table 3 summarizes the specifications, costs, and hours used by the primary pieces of equipment required for rehabilitation of this unit.

The D-7 crawler tractor was equipped with ripper teeth that enabled the dozer to be used extensively in the preliminary excavation (dish out) of road crossings and outsloping procedures, as well as, ripping the rest of the stable road surfaces. The excavator was equipped with a "thumb" making it the most versatile machine on the unit. The thumb enabled the excavator to handle the majority of organics encountered during the course of work and left only the very largest organics to be winched out by the D-6 dozer. The excavator was responsible for completing the excavations of all road and skid trail crossings, hillslope sites, and outsloping of landings and road segments. The D-6 would alternate between helping the D-7 and assisting the excavator by removing the "spoil" generated during excavation. Throughout the course of this phase the D-7 would always work ahead of the excavator. The track loader was used primarily to transport rock from the stockpile to worksites (SS-2, SS-3, RX-1, RX-2), in conjunction with the excavator placing rock during secondary treatment to armor channels. A wheel loader, crawler tractor, and several dump trucks were used briefly during the initial access and rock delivery stages of the heavy equipment phase.

Heavy Equipment Sequencing (Note Figure 5)

Prior to the heavy equipment phase, access was opened and rock was delivered during the rock pit operation at the end of June. In general, the heavy equipment sequence plan began at the top of the hillslope on the upper road and worked downslope to the middle road. Then the middle road was worked out to RX-1. At this time, all isolated hillslope work was completed and the equipment was relocated to the southern end of the lower road. The lower road was "worked back" to the middle road. Next, the equipment proceeded to remove the middle road up to the junction with the extension road, then relocated back at RX-1. After completing the secondary treatment on the rechannelized stream reach, the equipment worked their way up the extension road to the junction with the lower road. The equipment was

FIGURE 5. REHABILITATION WORK LOCATION MAP, UNIT 82-5.

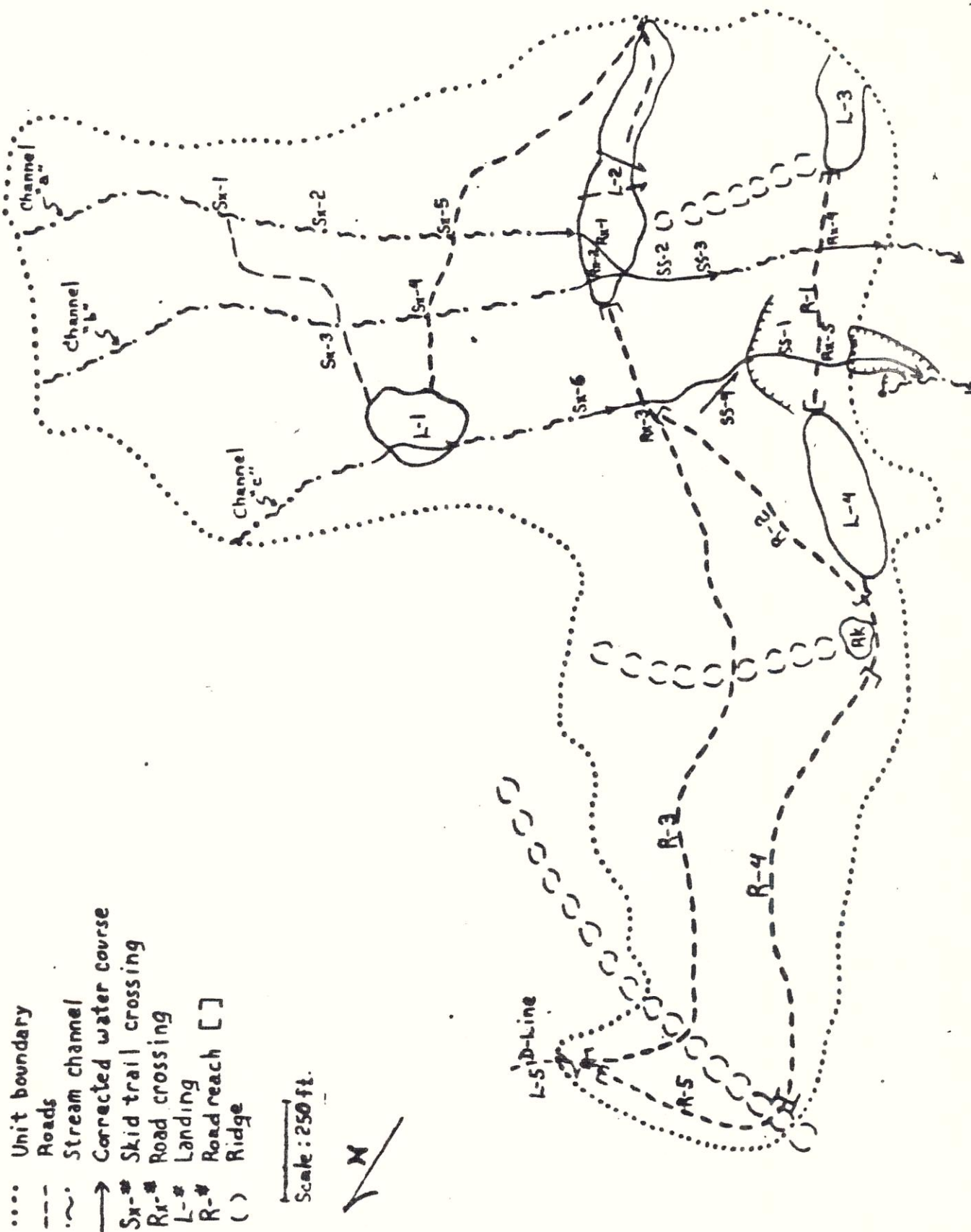


Table 2. SUMMARY COSTS OF EROSION-CONTROL WORK ON REHABILITATION UNIT 82-5, LOWER D-LINE

	RNP Employees		Heavy Equipment Rental	Redwoods United, Inc.	Total Task Cost	Phase Total	Phase % Grand Total Cost
	Geologist & Hydrologist	Laborers					
Evaluation Phase							
Mapping	\$1,706.67 ¹	--	--	--	\$1,706.67	\$2,092.51	4%
Prescription	385.84 ²	--	--	--	385.84		
Access	--	--	\$3,305.83	--	3,305.83		
Primary Treatment	2,677.50 ³		29,259.60	--	31,937.10		
Secondary Treatment	--	--	6,656.90	--	6,656.90	44,843.71	83%
Misc.	--	--	2,943.88	--	2,943.88		
Intensive Labor Phase							
Secondary Treatment	--	\$967.76	--	\$1,343.11	2,310.87		
Misc.	--	495.61	--	1,631.91 ⁴	2,127.52	4,438.39	8%
Cost Analysis Documentation	2,796.00 ⁵					2,796.00	5%
TOTALS	\$7,556.01	\$1,463.37	\$42,166.21	\$2,975.02	GRAND TOTAL	\$54,170.61	
% of GRAND TOTAL	14%	3%	78%	5%			

¹ Estimate cost includes mapping 460 acres of the hydrologic basin encompassing D-Line Road.

² Estimate cost.

³ Includes all heavy equipment and labor intensive supervision.

⁴ Includes transportation and administration costs.

⁵ Estimate cost.

Table 3. SUMMARY OF HEAVY EQUIPMENT TYPES AND COSTS

Equipment Type	Make/Model	Year	Rate/ Hour	Total Hours
Hydraulic excavator	John Deere JD 690B with 3/4 yd ³ bucket and thumb.	1979	\$80.00	200
Crawler tractor	Catepillar D6-D with winch	1977	\$59.00 ¹	200
Crawler tractor	Catepillar D7-G with rippers	1981	\$68.50	100
Tractor loader	Catepillar 955K	1973	\$42.00	21.5

¹Includes prompt discount payment of 1% if paid within 10 days.

next moved to the northern end of the landslide/road block on the lower road and removed the northern road reach back to the junction with the extension road. The lower road was divided into two segments because of the portion of road which had failed during the winter of 1972 creating a point of no pass. The equipment phase ended with the replacement of a culvert on the D-Line and some general maintenance of the untreated D-Line Road.

The D-7 dozer was procured on August 23, 1982, two days before the starting date for the D-6 dozer and the excavator. During this time preliminary work on the lower road (R-4) was completed and the dozer moved to begin preparatory work on landing #2. The track loader was procured on September 1, 1982, for two days for secondary treatments (transfer rock). The heavy equipment phase ended on September 21, 1982. The itinerary is shown on Table 1.

Heavy Equipment Costs

Table 4 summarizes the average costs for heavy equipment use for treatments performed on this rehabilitation unit. Access costs, in this report, are those entailed in bringing the equipment to the unit, opening roads to do the work, moving the equipment between roads on the unit, and removing the equipment from the unit at the end of work. Primary treatment costs are those entailed in restoring drainage patterns disrupted by past land use practices and in removing eroding and potentially erodible material from landings and roads. Secondary treatment costs are those entailed in protecting stream channel excavations. Rock rip-rap was the only type or armor used to protect channel reaches on this unit and was placed at five worksites. When access was possible, rock was placed in highly unstable excavations where substantial erosion was predicted unless some form of channel protection was initiated. In inaccessible areas, channel excavations were either hand rocked if local rock was available or left unprotected. Miscellaneous costs include a variety of tasks; such as, waterbar construction both on the unit and on the access road leading to the unit (D-Line), inboard ditch maintenance, and culvert replacement on the Gem Creek crossing at the D-Line Road (64 percent of total miscellaneous costs).

Haul road and skid trail excavations were grouped together for analysis and are divisible into five classifications: extra-small, small, medium, large, extra-large. These are classed by the volume of fill removed during excavation and are summarized for this unit in Table 5. Generally, stream crossing excavations are cost-effective in reducing fluvial erosion. Often, road fill in a stream channel functions as a small dam and diverts stream flow away from an equipoise channel system. Stream equilibrium or "graded condition" is a theoretical condition and may not have existed. In many cases, diverted stream courses create gullies and initiate mass movements creating relatively high sediment yields. Thus, by removing the road fills in stream channels, potentially large sediment sources are eliminated.

The small class of the stream crossing excavations is the most expensive and variable on a cost per cubic yard basis and reflects the variability of the conditions encountered by the equipment (e.g. time spent in access relative total site time and whether two pieces of equipment were needed to efficiently

Table 4. SUMMARY OF AVERAGE COSTS OF HEAVY EQUIPMENT TREATMENTS

Treatment	# of Worksites	Total Quantity	Total Cost	Avg. Cost Worksite	Avg. Cost Quantity	Range in Cost/Quantity	% of Total
Haul road crossings	5	2,111 yd ³	\$6,351.75	\$1,270.35	\$3.00/yd ³	\$1.64-4.05 yd ³	15%
Skid trail crossings	6 ¹	1,806 yd ³	3,172.63	528.77	1.76/yd ³	\$1.55-3.10 yd ³	7%
Landings	3 ²	1,081.6 ft.	11,876.50	3,058.83	10.98/LF	\$1.29-14.20 LF	28%
Road Reaches: Outsloping	4	3,159 ft.	6,510.12	1,627.53	2.06/LF	\$1.47-3.39 LF	
Cross-road drains	15 drains	--	558.00	37.20	--	--	19%
Ripping	5 ³	3,953 ft.	790.60	158.12	0.23/LF		
TOTAL PRIMARY TREATMENT			\$29,259.60				
Channel armor	5	401 yd ³	\$2,207.25	\$441.45	\$5.50/yd ³	\$2.66-8.61 yd ³	16%
Armor acquisition	7	871 loads	4,449.65	635.66	\$1.14/load	\$36.45-72.03 load	
TOTAL SECONDARY TREATMENT			\$6,656.90				
Access	--	--	\$3,305.83				8%
Miscellaneous: Itemized	--	--	\$1,668.00				
Non-itemized	--	--	1,275.88				7%
TOTAL HEAVY EQUIPMENT TREATMENTS			\$42,166.21				

¹Includes the analysis of L-1.²Does not include landing #1 and #5.³Includes L-5.

⁴Dump trucks averaged nine cubic yards per load, forty-five loads went to five future worksites on D-Line Road. Fifty-five loads were hauled from W-Line rock pit while thirty-two loads were acquired from a stockpile on D-Line delivered and paid for in 80-5.

SECONDARY TREATMENT

PRIMARY TREATMENT

dispose of road fill, stumps, etc.). The magnitude of the range of costs is due to two extreme cases: the low end representing a worksite (SX-6) where only one piece of equipment (D-6) having optimum working space was used to perform all the excavation of the crossing; the high end representing a worksite (RX-5) where two pieces of equipment were needed to remove fill and had to alternate movements within limited work space.

The large class of stream crossing excavations was the only other division to encounter site difficulties. The two worksites in this class both required the removal of large stumps where excavation into the natural ground was necessary. Under the circumstances, it was impractical to channelize along the alignment of the natural channel because of past logging disturbance. As a result, the stumps were uncovered and additional time was required to remove them. Because of the size of the excavation the time could be easily absorbed, thus not as noticeable, unlike the small class excavations.

The slope site category refers to treatments performed in areas not indicative of haul road or skid trail crossings. Slope sites are areas on the hillslope where work was required for channelization and ditch construction to route overland flow through sensitive erosional locations. These locations are characterized by mass-movement and/or highly disrupted drainage. Table 6 summarizes slope site costs.

The longest channelized stream reach encompasses four worksites, three on channel "a" (RX-1, SS-2, SS-3) and one on channel "b" (RX-2). Total length of the constructed stream reach on channel "a" is 346 feet and on channel "b" the last 95 feet to the confluence with channel "a". The project required excavating 1,461 cubic yards of fill material at a cost of \$2,597.38 and placing approximately 370 cubic yards (30 cubic yards local) of rock or channel armor at a cost of \$2,217.25; total cost of the project \$4,814.63.

Landing rehabilitation represent a wide range of treatments depending on severity of decay relative to the grade of the hillslope, proximity to stream channels, and the amount of overburden. Landings #2 and #4 showed evidence of the greatest amount of decay and were actively failing at the time of rehabilitation, most of the excavation work involved the removal of the unstable overburden. In both of these cases the two dozers worked alone and in tandem to remove the bulk of material. Generally for unstable landings, the bulldozers worked ahead of the excavator cutting the outboard edge down to the appropriate depth, or as far as possible, and sloping the fill up against the cutbank. The excavator would then follow to remove the outboard fill crown and the D-6 would finish outsloping procedures by packing and smoothing the given work area. Landings not situated on steep hillslopes or not close to stream channels receive minimal treatment, often requiring only surface ripping and construction of drains to disperse surface runoff. Table 7 summarizes landing rehabilitation costs.

Two types of road removal procedures occurred on this unit, outsloping and ripping with cross road drains. Outsloping was divided into three categories depending on road prism width and grade of hillslope: slight, moderate, and high. The term slight outsloping is used when only that portion of the outboard fill material is removed and placed against the cutbank to produce

Table 5. SUMMARY OF HAUL ROAD AND SKID TRAIL EXCAVATION COSTS

Type of Worksite	# of Worksites	Equipment	Total Site Cost ¹	Total Yd ³	Average Cost/ Worksite	Average Cost/ Yd ³	Range: Cost/ Yd ³
Extra-small 0-100 yd ³	1	JD-690, D-6	\$164.25	est. 100	\$164.25	\$1.64	same
Small 101-400 yd ³	7	JD-690, D-6	2,423.00	1,129	427.57	2.65	\$.55-4.05
Medium 401-800 yd ³	1	D-7, D-6, JD-690	1,214.75	652	1,214.75	1.86	same
Large 801-2000 yd ³	2 ²	D-7, D-6 JD-690	5,722.38	2,688	2,861.19	2.12	1.87-2.32
Extra-large >2000 yd ³	none						
TOTALS:	11		\$9,524.38	4,569 Yd ³	\$865.85	\$2.08/ Yd ³	\$.55-4.05 Yd ³

¹ Does not include rock placement costs.² Includes L-1, 1,138 yd³ excavated.

Table 6. SUMMARY OF SLOPE SITE COSTS.

Site Number	Equipment	Hours	H.E. Costs	Site ¹ Cost	Volume (Yd ³)	Cost/Yd ³
SS-1	JD-690	2.0 ²	\$160.00			
	D-6	0.75	44.25	\$204.25	50	\$4.08
SS-2 ³	D-6	0.75	44.25			
	D-7	0.75	51.38			
	JD-690	1.0	80.00	175.63	352	.50
SS-3	D-7	1.0	68.50			
	D-6	1.5	88.50			
	JD-690	6.0	480.00	637.00	195	3.27
SS-4 ⁴	JD-690	2.0	160.00	160.00		
TOTAL				\$1,176.88		
Analysis excluding SS-4				\$1,016.88	597 yd ³	\$1.70/yd ³

¹Excludes rock costs.

²The JD-690 sat for 45 minutes while the D-6 opened access and removed large organics at this isolated worksite. Excavated to route water across active slump with a high diversion potential.

³Sixty percent of the excavation was completed by crawler tractor pushing down slope.

⁴Shallow ditch dug to concentrate overland flow from spring area into channel network.

Table 7. SUMMARY OF LANDING COSTS

Site Number	Equipment	H.E. Cost	Length Ft.	Avg. Finished Width (ft.)
L-1	D-7, D-6, JD-690	\$2,129.38 ¹	--	--
L-2 ²	D-7, D-6, JD-690	6,508.75	555	112
L-3 ³	D-7, D-6	235.00	188	76
L-4 ⁴	D-7, D-6, JD-690	5,132.75	373	147
L-5 ⁵	D-7, JD-690	148.50	420	--
TOTAL		\$14,154.38		
TOTAL excluding L-1, L-5		\$11,876.50		

¹Analyzed in Haul Road, Skid Trail Excavation costs.

²This landing was the largest and most expensive to excavate taking approximately three days to complete. During the course of work large exotic rocks were uncovered 4 to 6 feet below the road bed on a portion of the landing indicating the area required continual maintenance in the past for harvest activities. One possible explanation is that the landing was built on top of natural slump associated with shallow groundwater. Seventy-four percent of the corrective work was done by the two crawler tractors.

³This landing was used as a fill storage sites for RX-4. The cost reflects the initial ripping and final shaping procedures, very little excavation work was required here.

⁴This landing was perched over a stream channel and was failing with a 8 to 10 foot crown scarp and complex. Approximately two and a half days were required to stabilize the land mass, 70 percent removed by the two crawler tractors. Two hours were spent by the excavator digging cross road drains.

⁵This landing is not complete and was analyzed with ripping costs.

Table 8. SUMMARY OF ROAD REMOVAL COSTS

Treatment	Equipment	Total Cost	Length Feet	Width		Area (A)	Cost/ L.F.	Cost/ Acre
				Avg. Finish	Range (Ft.)			
Outsloping:								
Slight ¹	JD-690, D-6	\$969.00	659 LF	25.2	16.5-38.4	0.38	\$1.47	\$2,543.64
Moderate ²	D-7, D-6, JD-690	2,276.12	1,538.0	33.7	23-43	1.19	1.48	1,912.70
High ³	D-7, D-6, JD-690	3,365.00	962.0	95.7	19.8-115.5	1.26	3.39	2,591.26
Sub-Totals		\$6,510.12	3,159.0	51.5	16.5-115.5	2.83	\$2.06	\$3,160.00
Ripping ⁴	D-7	924.75	395.3	36.0	16.5-49.5	3.27	\$0.23	\$282.80
Cross-road drains	JD-690, D-6	558.00	15 drains	--	--	--	\$37.20/drain	
TOTAL ROAD REMOVAL COST		\$7,924.37						

¹ 73 percent done by the D-6.² 54 percent done by both crawler tractors.³ 64 percent done by both crawler tractors.⁴ All ripping done by the D-7, also includes L-5.

a shallow slope to insure dispersed runoff. When roads are built on excessively steep hillslopes and a large amount of fill is perched creating an unstable situation most of overburden may need to be removed. In this case the term high outsloping is used. Table 8 summarizes road removal costs.

In circumstances between the two extremes the term moderate outsloping is used. Road removal costs for outsloping range from \$1.47 to \$3.39 per linear foot. The low cost in the range reflects slight outsloping procedures along R-3 and the high cost represents high outsloping procedures occurring at R-4. At R-4 both dozers and the excavator were required to remove the overburden, which if dislodged could endanger the old growth forest below. Road reaches not outsloped were treated by ripping the road surface and constructing cross road drains at specific intervals. The D-7 was used to rip all road reaches at a cost of \$0.23 per foot (\$1,214.40/mile) and the excavator dug the drains for an average cost of \$37.20.

Heavy Equipment Secondary Treatment

Heavy equipment for secondary treatment on this unit was utilized for channel armor acquisition and installation. Five worksites received rock rip-rap treatment (RX-1, RX-2, RX-3, SS-2, SS-3) ranging from \$2.66/yd³ to \$8.61/yd³. Over 99 percent of the rock installation costs occurred in the rechannelized stream reach of RX-1, RX-2, SS-2, and SS-3; of which SS-3 was the most expensive. Due to the inaccessibility of SS-3 the track loader had a long turn-around time to move rock from the stockpile to the worksite there by increasing the cost of the channel protection. As rock installation proceeded up the channel rocking cost decreased. However, working through SS-2 presented complications for the equipment due to the narrow confines of the reach. Access was restricted to one machine at a time. Consequently, the excavator was inactive while the loader brought in rock (five or six loads at a time), and the loader was inactive as the excavator placed the rock. This worked well but was time consuming due to the nature of the work. It was not possible to have the excavator work constantly because once in the channel it could not swing 180 degrees around (i.e. stumps, side banks).

Miscellaneous costs are divided into two categories: itemized and non-itemized. Itemized costs include such tasks as inboard ditch maintenance, waterbars, culvert removal, or placement. The culvert placement work at Gem Creek on D-Line Road represent 74 percent of the total cost. Non-itemized costs are tasks such as paid downtime (under 30 minutes), safety talks, minor rock relocations, etc. See Table in appendix.

Evaluation of Heavy Equipment Application

First, all of the heavy equipment worked exceptionally well. Rarely would the prescribed treatment exceed the equipment capability. In circumstances such as at L-4 where the spoil site was a long push upslope, the two dozers would work the material in tandem. It was only in this situation that larger machines would have been useful. Nevertheless, the D-7 was a work-horse and proved to be invaluable. The D-7 had the added advantage of the ripper teeth and would use them extensively to help facilitate digging.

Secondly, all of the equipment operators with the one exception of the tractor loader operations, were very competent and enthusiastic about their work. Once the prescribed treatment was discussed and the work laid out, the operators would diligently and efficiently complete the assignment. In cases when more than one piece of equipment was working together, the operators worked wonderfully making both of their jobs easier. The problem with the tractor loader operators was that he was very young and inexperienced with loading rock and working on hillslopes. The experience he gained on this job will be highly beneficial for his development.

For the most part, the evaluation of prescribed erosion control treatments time will tell. Generally a field review of prescriptions with peers occurs prior to heavy equipment procurement; however, this was not the case on unit 82-5. Due to the short notice of money being available the review took place while heavy equipment was already at work.

There were two major debates resulting from the review:

- 1) How channel "c" originally joined with the naturally existing channel in the vicinity of RX-5; and
- 2) Where channel "b" converged with channel "a".

In light of the severity of the hillslope disturbance, best possible corrective measures for these cases were hereby reached to the present configuration. In both cases, the current alignments are not in their original position and will adjust through time. No secondary treatment occurred at RX-5, due to access problem for dump trucks, so channel adjustment may be more extensive. The channel banks and bed of RX-5 was comprised of fine grain, sheared up shale "blue goo" structurally incompetent. Check dam stability at this location was questionable.

As for the rest of the hillslope treatments, they were very straightforward and not unique to go into detail.

Labor Intensive Phase

Labor Intensive Application

Two types of labor intensive personnel were used on this unit: Redwood National Park laborers and Redwoods United, Inc., employees. Redwoods United, Inc., is a non-profit, Samoa, California, based organization for the handicapped which is specifically mentioned in the legislature establishing the 1978 Park Expansion. The labor intensive personnel were used for secondary treatments, the principal of which was spreading straw mulch on disturbed ground.

Straw delivery and brush removal preceded heavy equipment activity. Distribution of straw occurred, for the most part, after the primary and during the final heavy equipment phases when access routes were open. In order that the labor crews could be transported as close to the worksite as possible, the spreading of straw occurred soon after completion of a given area by heavy equipment.

Labor Intensive Costs

As shown on Table 9, the distribution and spreading of straw accounted for the large majority of labor intensive treatment costs. A total of \$4,208.93 was spent on this treatment of which \$409.75 (9.7 percent) was for the distribution and the remainder for the actual spreading. The average unit cost for this treatment was \$502.85 per acre.

The cost effectiveness of the labor intensive treatments was reduced due to a large portion of time spent off the worksite by laborers. Redwood National Park laborers and the Redwoods United crew average 33.9 percent and 35.3 percent of non-productive off-site time, respectively. Approximately 44 percent of the off-site time (1.5 hours per day) is associated with travel between the duty station in Orick and the worksite, the remainder presumably spent at Orick. In addition, Redwood United incur indirect costs for administration and vehicle travel while these costs are not accounted for Redwood National Park laborers. The relationship between total person hours, actual field hours, non-productive time and overhead are shown on Table 10. If indirect cost for Redwood National Park laborers were considered, their cost per field hour would be higher than that of Redwoods United personnel.

Table 9. SUMMARY OF LABOR INTENSIVE TREATMENT COSTS

Treatment	Crew	Person Hour	Avg. Cost Per Hour	Cost	Total Cost	Cost/ Acre
Straw delivery	RNP	8	\$8.20	\$65.56	\$65.56	
Brush removal	RNP	20	8.20	163.90	163.90	
Straw distribution	RNP	50	8.20	409.75	409.75	\$48.95/A
Spreading straw	RNP	103	8.00	824.16		
	RUI	354	8.40	2,975.02	3,799.18	453.90/A
Total Labor Treatment Cost					\$4,438.39	\$530.27/A

Table 10. ANALYSIS OF COST/HOUR FOR LABORERS

	Total Person Hours	Field Hours	Non-Prod. Hours	¹ Avg. Wage/Hr.	Trans. ²	Admin. ³	Total Cost	Avg. Cost Per Field Hr.
RNP Laborers	181	119.7	61.3	\$8.08	--	--	\$1,463.37	\$12.23 ⁴
Redwoods United	354	229.2	124.8	5.86	\$446.75	\$453.83	2,975.02	12.98

¹ Travel time; miscellaneous tasks before and after travel; unaccounted for time prior to arrival and after departure from the site.

² \$50.00 charge for crew cab at \$.50/mi; two hour overtime charge for driver.

³ 18 percent charge on wages and transportation costs.

⁴ Administrative and transportation costs are not included for RNP personnel.

Evaluation of Labor Intensive Application

For the most part, the labor intensive treatment on this unit involved the spreading of straw on the surface of disturbed areas. Disturbed areas amounted to about 8.4 acres and typically involved outsloped roads and landings and stream crossing excavations. Strawing of disturbed surfaces functions in reducing the effect of raindrop impact and rill erosion, and acts as mulch for surface soil. Research by the Technical Services Division of Redwood National Park indicates that revegetation is significantly enhanced by this treatment.

While strawing of disturbed surfaces is expected to be effective relative to those variables described above, the cost effectiveness of this treatment could have been improved. There were two cases where straw distribution interfered with heavy equipment operation. They were at L-1 and R-1 past RX-5. In both cases, truck access to the areas were non-existent and required straw distribution during a small window of time while heavy equipment was working and access was open. To compound the problem, there was limited storage space on R-1 past RX-5 for straw that was not being utilized for fill. On 50 percent of the days that Redwoods United was assigned to this unit, only a few hours were spent on the unit due to movement to or from another rehabilitation unit. Since the labor crews are often required to drive and walk a considerable distance to begin work at a site, the time spent driving and walking to and from multiple sites during a single day may greatly reduce productive work. Excluding routine travel time, unproductive time amounted to about two hours per day per laborer. During the 1982 rehabilitation season, Redwoods United personnel did not arrive at Orick until about 7:30 a.m. with departure about 4:30 p.m. Currently, Redwoods United crews arrive for duty at 7:00 a.m. and depart at 5:30 p.m. No equipment preparation, etc., is required by the Redwoods United personnel, whereas the Redwood National Park personnel require at least one-half hour or more per day at the Orick station for report, equipment, etc. If the Redwoods United workday were shortened to compensate for the non-productive time spent waiting for Redwood National Park personnel (five to ten percent of a workday), unproductive losses could be reduced.

DISCUSSION AND CONCLUSION

Detailed geomorphic field mapping in combination with aerial photographic interpretation are the most important tools in evaluation of erosional conditions on a proposed rehabilitation site. When a comprehensive analysis of geomorphic and hydrologic processes and patterns are understood for a proposed site then adequate rehabilitation plans can be made. In most cases, complete restoration (i.e. removal of all logging scars) of a site is cost prohibitive and not necessarily warranted to insure slope stability. Therefore, it is best to address the "erosion potential" at site specific locations on the rehabilitation unit and make corrective prescriptions accordingly. Erosion potentials are determined from assessing the erosion activity, diversion potential and sediment potential. Areas with a high erosion potential receive the most thorough attention in forming the rehabilitation prescriptions. The affects of the eroded sediment on downslope resources and how that sediment reacts through time should be analyzed when access prohibits heavy equipment treatment. One possible method for corrective treatment in these inaccessible areas could be the use of explosives to remedy high erosion potentials at skid trail crossings, primarily at stream diversion points.

The rectification of stream diversions should always remain high on the list of priorities. The adverse affects of the diversions are often incalculable and result in long term degradation. The reduction of long term degradation usually has short term consequences in response from new hydrologic regimes, especially in sensitive areas. However, through time these natural adjustments will enhance long term stability. Landings perched over stream channels also have high erosion potentials. The preventative rehabilitation on these landings is always better than the corrective rehabilitation. In some cases of the later, only the fill removed is the sediment saved. Removing unstable overburden from landings with heavy equipment remains the single most expensive rehabilitation treatment and generally requires the maximum excavations.

Rehabilitation unit 82-5 is one such project in which the overriding factor had to be the long-term goal. From aerial photographic history and field observations, site 82-5 was progressing from severe surface erosion, induced by past land use activity, to complex mass movement features. Furthermore, the geomorphic map indicated a close relationship in some areas between the severely disrupted drainage network and the mass movement features.

Rehabilitation prescriptions for site 82-5 were based on the hypothesis that the mass movement features were largely the result of water saturation from stream diversions which caused increased weight and pore pressure on the slope. Loss of root strength and high road cut density also influenced slope instability. In short, the rehabilitation attitude emphasized minimizing unstable overburdens and maximizing efficient drainage. Due to the extensive erosion problems on this site, no significant rehabilitation measures could have succeeded without the use of heavy equipment.

While the objectives of rehabilitation have been met, such that the unit is much more hydrologically sound than before rehabilitation, natural adjustments to the new hydrologic regime may progress for years. Sensitive areas of the stream channels, especially where road crossings were removed, can be expected to adjust with storm flows and in the process undergo erosion. Where stream channel protection (i.e. rock armor) was not initiated, adjustment will be more extensive, influenced largely by geologic factors such as rock and soil type and characteristics of the channel banks and bed.

Further study is needed to assess the impacts of fluvial erosion from site specific locations to the rest of the channel system. Incomplete channel protection, such as at SS-2, may cause discontinuity and create undue stress on channel morphology by increasing lateral corrosion and hydraulicking. Additional study should be conducted on bedload transport in small streams and how it affects channel bank stability; how geologic and soil structure influences mass movements and there relationship with seeps, springs, and groundwater migration.

APPENDIX

PHOTO POINT LOCATIONS AND DESCRIPTIONS
LOWER D-LINE ROAD & SLOPE, UNIT 82-5

PP#	Lense	Type	Worksite Location	Description	Dates, Remarks
1	35mm 50mm	Csp B/W	Sx-1	Taken from the centerline (C) of stream at the lower end of excavation, view up channel. Stake located on right bank behind log.	Post H.E. 9/22/82
2	35mm 50mm	Csp B/W	Sx-3	Taken from right bank 4 ft. from thalweg towards large R _w stump at the lower end of excavation, view up channel.	Post H.E. 9/22/82
3A	35mm 50mm	Csp B/W	L-1	Taken from left bank at the upper end of excavation, view south up upper road.	Post H.E. 9/22/82
3B	35mm 50mm	Csp B/W	L-1	Same location, view down excavation.	Post H.E. 9/22/82
4	35mm 50mm	Csp B/W	L-1	Taken from bottom of excavation, stake on right bank below baccharis; view up channel.	Post H.E. 9/22/82
5	35mm 50mm	Csp B/W	Sx-5	Taken from bottom of excavation in C of channel, stake on left bank; view up channel.	Post H.E. 9/28/82
6	35mm 50mm	Csp B/W	Sx-6	Taken from C of bottom of channel in front of willow tree, stake 4' away on left bank; view up channel.	Post H.E. 9/28/82
7	35mm 50mm	Csp B/W	Sx-6	Taken from centerline of channel at upper end of channel, stake 5' away on right bank; view up channel.	Post H.E. 9/28/82
8	35mm 50mm	Csp B/W	L-2	Taken from top of large rock at the south end of landing; view north up landing.	Post H.E. 9/28/82
9A	35mm 50mm	Csp B/W	L-2	Taken 10 ft down from CB between CRD's; view south down landing.	Post H.E. 9/28/82
9B	35mm 50mm	Csp B/W	L-2	Same location; view up landing Rx 1/2 in background.	Post H.E. 9/28/82
10	35mm 50mm	Csp B/W	Rx-1	Taken from top of fir stump (2' diam.) on left bank at at top of excavation; view down channel.	Post H.E. 9/28/82

PHOTO POINT LOCATIONS AND DESCRIPTIONS
LOWER D-LINE ROAD & SLOPE, UNIT 82-5

PP#	Lense	Type	Worksite Location	Description	Dates, Remarks
11A	35mm 50mm	Csp B/W	Rx-1	Taken 10 ft down from confluence on Rx-1/2 on right bank; view up Rx-1.	Post H.E. 9/28/82
11B	35mm 50mm	Csp B/W	Rx-2	Same location; view up Rx-2	9/28/82
11C	35mm 50mm	Csp B/W	SS-2	Same location; view down SS-2, 31% slope.	9/28/82
12A	35mm 50mm	Csp B/W	SS-2	Taken from stake on right bank opposite ST = 60ft up from bottom of channel; view up channel.	9/28/82
12B	35mm 50mm	Csp B/W	SS-3	Same location; view down channel.	9/28/82
13	35mm 50mm	Csp B/W	SS-3	Taken from centerline of channel on top of log 5' up slope from 1' diam. Rw tree, stake on tree; view up channel.	9/28/82
14	35mm 50mm	Csp B/W	SS-1	Taken from centerline of of channel, stake on left bank on top of log in channel 5 ft. out; view up channel.	9/28/82
15	35mm 50mm	Csp B/W	Rx-2	Taken from centerline of channel at top of excavation stake on right bank 5 ft out; view down channel.	9/28/82
16A	35mm 50mm	Csp B/W	R-3	Taken from middle of road between CRD's, view down road towards Rx-2	9/28/82
16B	35mm 50mm	Csp B/W	R-3	Same location; view up road towards Rx-3.	9/28/82
17	35mm 50mm	Csp B/W	Rx-3	Taken from centerline of channel next to willow tree at bottom of excavation, stake on left bank 6 ft from centerline; view up channel.	9/28/82
18	35mm 50mm	Csp B/W	R-2/3	Taken from stake up road = 20' from Rx-3; view up R-3; down R-2.	9/28/82

PHOTO POINT LOCATIONS AND DESCRIPTIONS
LOWER D-LINE ROAD & SLOPE, UNIT 82-5

PP#	Lense	Type	Worksite Location	Description	Dates, Remarks
19	35mm 50mm	Csp B/W	Sx-6	Taken from stake on right bank in front of ceanothus bush at lower end of excavation, view up channel.	9/28/83
20A	35mm 50mm	Csp B/W	L-3	Taken from stake at north end of landing; view down landing.	9/28/82
20B			R-1	Same location; view up road.	9/28/82
21	35mm 50mm	Csp B/W	Rx-4	Taken from centerline of channel at top of excavation stake is 6 ft on left bank; view down channel.	9/28/82
22	35mm 50mm	Csp B/W	Rx-4	Taken from centerline of channel at bottom of excavation, stake approx. 9 ft away on left bank opposite large boulder on right bank; view up channel.	9/28/82
23A	35mm 50mm	Csp B/W	R-1	Taken from approx. 30 ft above Redwood stump; view down road towards Rx-4.	9/28/82
23B	35mm 50mm	Csp B/W	R-1	Same location, view up road towards Rx-5	9/28/82
24	35mm 50mm	Csp B/W	Rx-5	Taken from centerline of channel at top end of excavation, stake approx. 3 ft away on left bank 12 ft from small fir; view down channel.	9/28/82 SEE *NOTE
25	35mm 50mm	Csp B/W	Rx-5	Taken from centerline of channel at bottom of excavation, stake nailed to Rdwd rootwad on right bank; view up channel.	9/28/82
26A	35mm 50mm	Csp B/W	L-4	Taken from stake at upslope portion southend of L-4 approx. 20 ft down from veg.; view down R-1.	9/28/82
26B	35mm 50mm	Csp B/W	L-4	Same location view up landing (north).	9/28/82

*NOTE: Pre-Heavy Equipment photos (Csp) were taken from right bank near redwood stump - location changed.

PHOTO POINT LOCATIONS AND DESCRIPTIONS
LOWER D-LINE ROAD & SLOPE, UNIT 82-5

PP#	Lense	Type	Worksite Location	Description	Dates, Remarks
27	35mm 50mm	Csp B/W	L-4	Taken from stake at lower south end of landing near alder; view north across landing.	9/28/82
28A	35mm 50mm	Csp B/W	R-1	Taken from center of road just north of CRD; view down road toward upper portion of L-4.	9/28/82
28B	35mm 50mm	Csp B/W	R-1	Same location; view north up road.	9/28/82
29A	35mm 50mm	Csp B/W	R-2	Taken from stake approx. 60 yds above CRD; view down road.	9/28/82
29B	35mm 50mm	Csp B/W	R-2	Same location; view up road.	9/28/82
30	35mm 50mm	Csp B/W	SS-4	Taken from bottom left side of channel, stake 4 ft on left bank; view up ditch.	9/28/82
31A	35mm 50mm	Csp B/W	R-3	Taken from stake approx. 70 yds up road from junction of R-2/3; view down road.	9/28/82
31B	35mm 50mm	Csp B/W	R-3	Same location; view up road.	9/28/82
32A	35mm 50mm	Csp B/W	R-3	Taken from stake approx. 90 yds north of PP31 up road on bend; view down road.	9/28/82
32B	35mm 50mm	Csp B/W	R-3	Same location; view up road	9/28/82
33A	35mm 50mm	Csp B/W	R-3	Taken from stake approx. 120 yds south of junction between D-Line/D-10 roads, mid road; view down road.	9/28/82
33B	35mm 50mm	Csp B/W	R-3	Same location; view up road.	9/28/82
34	35mm 50mm	Csp B/W	L-5	Taken from left bank of CRD at stake; view down road at intersection of R-3/5.	9/28/82

PHOTO POINT LOCATIONS AND DESCRIPTIONS
LOWER D-LINE ROAD & SLOPE, UNIT 82-5

PP#	Lense	Type	Worksite Location	Description	Dates, Remarks
35	35mm 50mm	Csp B/W	R-4	Taken from end of (OS) just north of knocker; view up road.	9/28/82
36A	35mm 50mm	Csp B/W	R-4	Taken from stake approx. 15 yds upslope of stump in middle of reach; view down road.	9/28/82
36B	35mm 50mm	Csp B/W	R-4	Same location; view up road	9/28/82
37A	35mm 50mm	Csp B/W	R-5	Taken from stake at north end of R-4 at mouth of first CRD; view down road (R-4).	9/28/82
37B	35mm 50mm	Csp B/W	R-5	Same location; view up road (R-5).	9/28/82

Appendix
ACCESS COSTS

Site Number	Equipment	Function Hours		
		Road Clearance	Relocation	Misc.
Upper Road	JD-690		2.5	
	D-6	1.0	1.5	
	D-7	0.25		
D-Line	D-6			0.75
	955		1.0	1.0
	W20B	3.0	3.0	4.0
	Dump trucks	3.0		2.0
	HD-16	4.0	1.0	
D-10 (lower)	D-7			0.5
	JD-690		2.75	

			Move in/ Out	Cost
	JD-690	(5.25 x 80.00) = 420.00	+ 483.00	= \$903.00
	D-6	(3.25 x 59.00) = 191.75	+ 420.00	= 611.75
	D-7	(0.75 x 68.50) = 51.38	+ 200.00	= 251.38
	W20B	(10.0 x 48.00) = 480.00		= 480.00
(2) Dump trucks		(5.0 x 68.64) = 343.20		= 343.20
	HD-16	(5.0 x 50.00) = 250.00		= 250.00
	955	(2.0 x 42.00) = 84.00	+ 382.50	= 466.50
				<u>\$3,305.83</u>

HEAVY EQUIPMENT PRIMARY TREATMENT, 82-5.

LANDINGS COSTS

Appendix

Site Number	H.E.	Hours	H.E. Cost	Site Cost	Volume	Remarks
L-1	D-7	4.75	\$ 325.38			Cost assigned to skid trail Excavations.
	D-6	16.0 *	944.00			*0.5 access, 1.5 ditch above.
	JD-690	10.75*	860.00	\$ 2,129.38	1138.00yd ³	*0.5 access.
L-2	D-7	29.0	1986.50			OS
	D-6	42.75	2522.25			14.75 shape
	JD-690	25.0	2000.00	6508.75	537.61n.ft (6400yd ³)	est.
L-3	D-7	3.05*	205.50			*1.0hr. Rip shape
	D-6	0.5	29.50	235.00	182 1n.ft (730 yd ³)	est.
L-4	D-7	18.0	1233.00			
	D-6	35.25	2079.75			*2.0hr. deep CRD
	JD-690	22.75*	1820.00	5132.75	361 1n.ft (6700 yd ³)	est.
L-5	D-7	1.0	68.50			rip
	JD-690	1.0*	80.00	148.50	480 1n.ft	cross drains
			Total	\$74154.38		

APPENDIX
HEAVY EQUIPMENT PRIMARY TREATMENTS, 82-5
Haul Road Crossing Costs

Site Number	Heavy Equipment	Hours	H.E. Cost	Excavation Cost	Volume		Cost/Yard	Drainage Area		Remarks
					EP	Total Yards		A	Q	
Rx-1	D-7	11.0	\$753.50							Rock
	D-6	3.75*	221.25							*.5 sit
	JD-690	3.0	240.00	\$1,214.75	300	652	\$1.86	27.4	20	
Rx-2	JD-690	4.5	360.00			261	2.18	9.5	6.8	Rock
	955	5.0	210.00	570.00						
Rx-3	D-6	0.75	44.25							
	JD-690	1.5	120.00	164.25	175	100	1.64	41.	51.0	Rock
Rx-4	D-7	2.0	137.00							*5 hr stump removal
	D-6	24.0*	1,416.00							unprotected
	JD-690	25.5	2,040.00	3,593.00	550	1550	2.32	43	28.6	*1.0 sitting
Rx-5	D-6	5.25	309.75							*1.5 sitting,
	JD-690	6.25	500.00	809.75	200	200	4.05	41	61.0	unprotected
TOTALS						2111.0	3.00/yd ³			*1.5 sitting

Appendix.
HEAVY EQUIPMENT PRIMARY TREATMENT, 82-5, SKID TRAIL CROSSINGS COST

Site Number	Equipment	Hours	H.E. Cost	Site Cost	Volume (yd ³)	Cost/Yd	Remarks
SX-1	JD-690	2.5*	\$200.00	\$200.00	130	\$1.54	*0.5 access
SX-2	NOT REHABED.						
SX-3	D-6 JD-690	0.75 2.50	44.25 200.00	244.25	213	1.15	
SX-4	JD-690	2.25*	180.00	180.00	102	1.76	*0.5 access
SX-5	JD-690	4.5	360.00	360.00	116	3.10	
SX-6	D-6	1.0	59.00	59.00	107	.55	
TOTALS					668	\$1.56/yd	

APPENDIX
HEAVY EQUIPMENT SECONDARY TREATMENT, 82-5
Rock Costs

Site Number	Equipment	Hours	H.E. Cost	Rock Volume (yd ³)	Cost/ Yd ³	Delivery Cost	Rock Cost	Remarks
Rx-1	JD-690 955	3.0*	\$240.00					*1.0 hr sit
		2.5*	105.00					*0.5 hr sit
		Sub-Total	345.00	90	3.83			
Rx-2	JD-690 D-6	5.0*	400.00					*0.5 hr sit
		2.75	162.25					
		Sub-Total	562.25	96	5.86			
Rx-3	JD-690	1.0	80.00	30	2.66			
SS-2	JD-690 955	4.0*	320.00					*2.0 hr sit
		4.0*	168.00					*2.0 hr sit
		Sub-Total	488.00	100	4.88			
SS-3	JD-690 955	6.0*	480.00					*0.5 hr sit
		6.0*	252.00					*1.25 hr sit
		Sub-Total	732.00	85	8.61			
TOTALS			\$2,207.25	401 yd ³	\$5.50/yd ³			

LABOR INTENSIVE SECONDARY TREATMENTS, 82-5
REDWOOD NATIONAL PARK LABORERS

Date	Task	Total Person Hours	Cost Per Hour	Total Cost
8/9	Straw delivery	8	\$8.20	\$65.56
8/23	Brush removal	20	8.20	163.90
8/24	Straw distribution	20	8.20	163.90
8/25	Straw distribution	20	8.20	163.90
8/26	Straw distribution	10	8.20	81.95
8/30	Spreading straw	10*	8.20	81.95
9/2	Spreading straw	10*	7.90	79.00
9/7	Spreading straw	20	8.20	163.90
9/8	Spreading straw	8*	8.20	65.56
9/9	Spreading straw	20*	8.20	163.90
9/16	Spreading straw	8*	7.71	61.68
	Rocking	2*	7.71	15.42
9/20	Spreading straw	10*	7.71	77.10
9/21	Spreading straw	10*	7.71	77.10
9/23	Spreading straw	5*	7.71	38.55
	TOTALS	181		\$1,463.37

*Supervised Redwoods United

LABOR INTENSIVE SECONDARY TREATMENTS, 82-5
REDWOODS UNITED

Date	Task	Total Person Hours	Cost Per Hour	Wages ¹ (69.7%)	Trans. (15%)	Admin. (15.3%)	Total Cost
8/30	Spreading straw	30	\$8.40	\$175.80	\$37.86	\$38.46	\$252.12
9/2	Spreading straw	30	8.40	175.80	37.86	38.46	252.12
9/8	Spreading straw	24	8.40	140.64	30.29	30.77	201.70
9/9	Spreading straw	60	8.40	351.60	75.72	76.92	504.24
9/16	Spreading straw	60	8.40	351.60	75.72	76.92	504.24
9/20	Spreading straw	60	8.40	351.60	75.72	76.92	504.24
9/21	Spreading straw	60	8.40	351.60	75.72	76.92	504.24
9/23	Spreading straw	30	8.40	175.80	37.86	38.46	252.12
TOTALS		354		\$2,074.44	\$446.75	\$453.83	\$2,975.02

¹ Percents are the ratio of the amount shown over the total cost.



Unit: 82-5 Date: 8/30/1982, PP13, SOC, (WDB)



Unit: 82-5 Date: 9/22/1982, PP13, Post HE, SOC



Unit: 82-5 Date: 7/5/1983, PP13, SOC



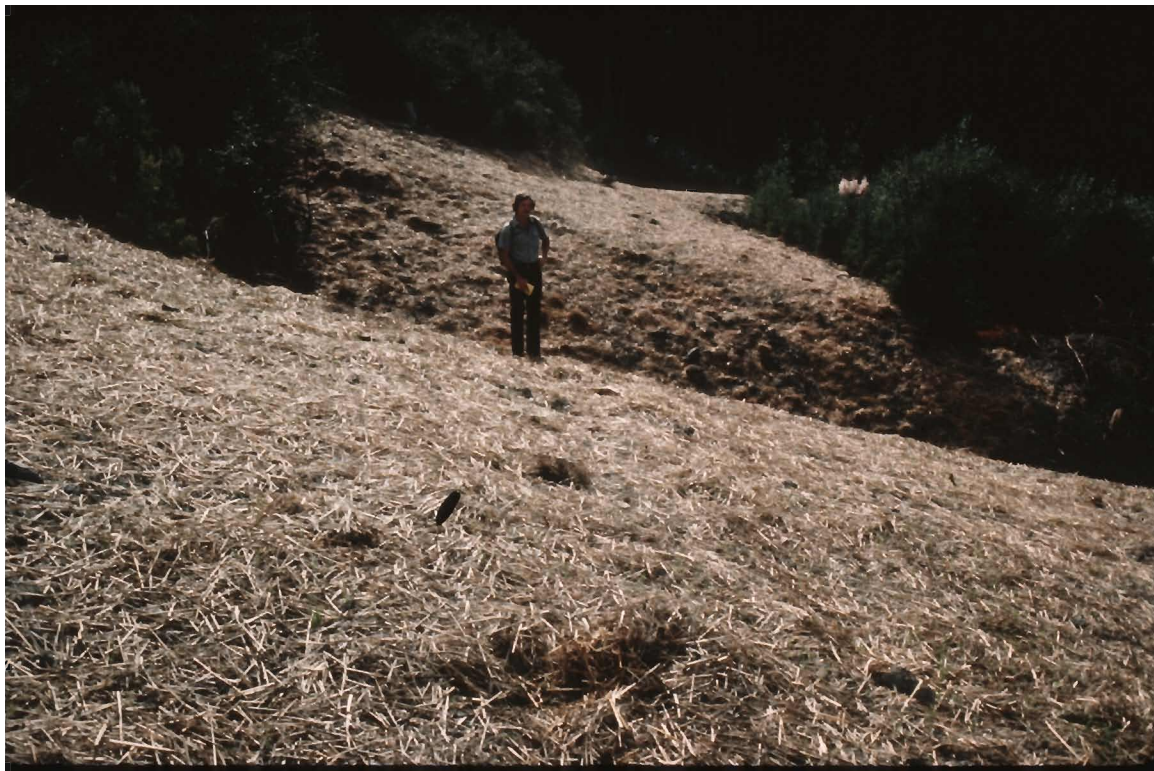
Unit: 82-5 Date: 8/30/1982, PP23B, SOC



Unit: 82-5 Date: 9/22/1982, PP23B, SOC



Unit: 82-5 Date: 8/30/1982, PP23A, SOC



Unit: 82-5 Date: 9/22/1982, PP23A, SOC



Unit: 82-5 Date: 7/19/1984, PP23A, SOC



Unit: 82-5 Date: 8/30/1982, PP25, SOC



Unit: 82-5 Date: 9/22/1982, PP27, SOC, 35mm



Unit: 82-5 Date: 7/5/1983, PP27, SOC